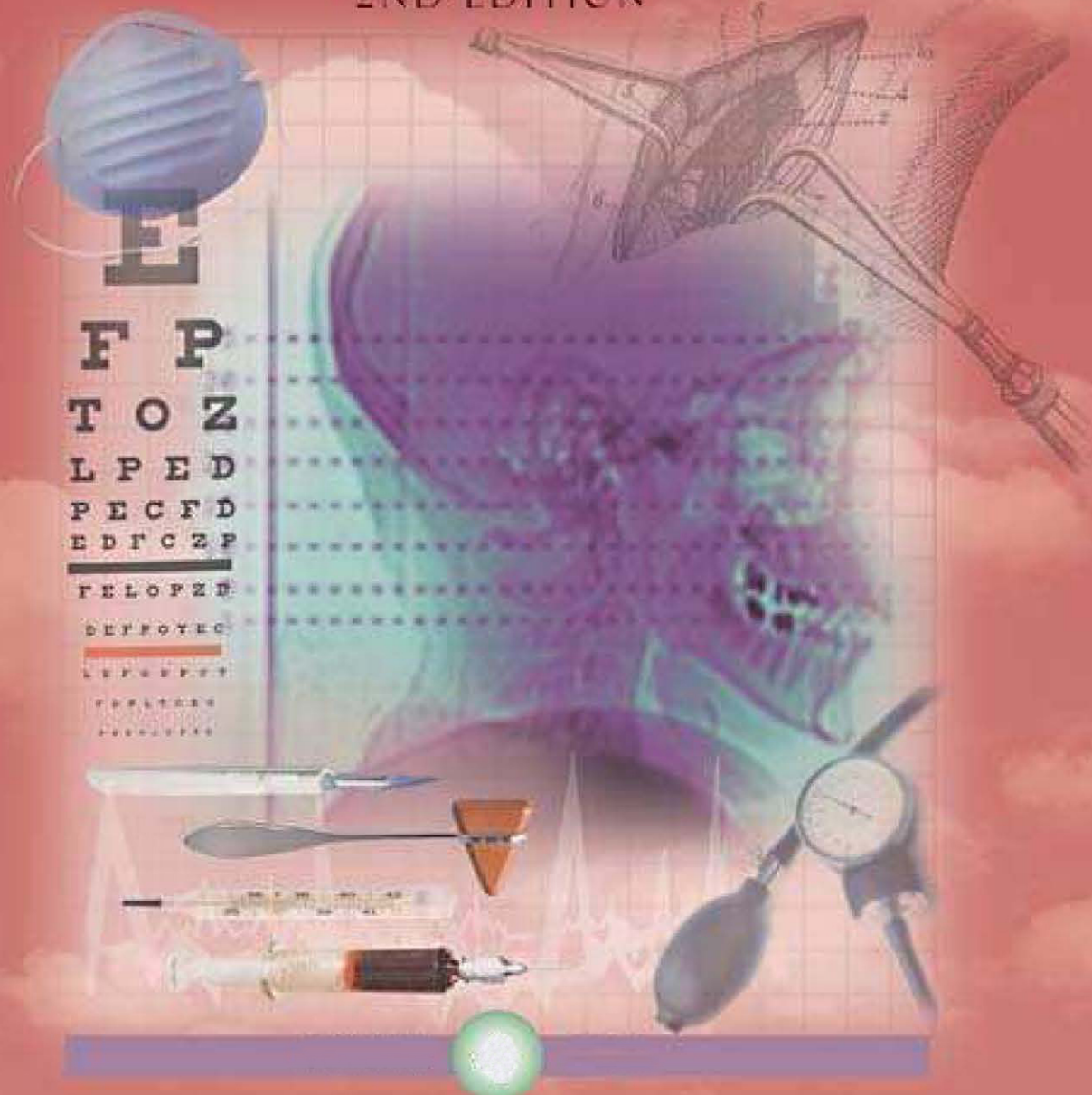


# *The GALE* ENCYCLOPEDIA *of* SURGERY *and* MEDICAL TESTS

A GUIDE FOR PATIENTS AND CAREGIVERS

2ND EDITION



*The* GALE  
ENCYCLOPEDIA *of*  
SURGERY AND  
MEDICAL TESTS

SECOND EDITION





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BRIGHAM NARINS, EDITOR



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# LIST OF ENTRIES BY BODY SYSTEM

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Cardiac monitor  
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Carotid endarterectomy  
Coronary artery bypass graft surgery  
Coronary stenting  
Defibrillation  
Echocardiography  
Electrocardiogram  
Electrocardiography  
Electrophysiology study of the heart  
Endovascular stent surgery  
Femoral hernia repair  
Heart surgery for congenital defects  
Heart transplantation  
Heart-lung machines  
Heart-lung transplantation  
Hemangioma excision  
Implantable cardioverter-defibrillator  
Magnetic resonance angiogram

Magnetic resonance venogram  
Maze procedure for atrial fibrillation  
Mechanical circulation support  
Minimally invasive heart surgery  
Mitral valve repair  
Mitral valve replacement  
Multiple-gated acquisition (MUGA) scan  
Myocardial resection  
Pacemakers  
Pericardiocentesis  
Peripheral endarterectomy  
Peripheral vascular bypass surgery  
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Sclerotherapy for varicose veins  
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Vascular surgery  
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Esophagogastrectomy  
Esophagogastroduodenoscopy  
Gastrectomy  
Gastric acid inhibitors  
Gastric bypass  
Gastroduodenostomy

Gastroenterologic surgery  
 Gastroesophageal reflux scan  
 Gastroesophageal reflux surgery  
 Gastrostomy  
 Glossectomy  
 Heller myotomy  
 Hemorrhoidectomy  
 Hepatectomy  
 HIDA Scan  
 Ileoanal anastomosis  
 Ileoanal reservoir surgery  
 Ileostomy  
 Intestinal obstruction repair  
 Intussusception reduction  
 Liver biopsy  
 Liver transplantation  
 Laxatives  
 Parotidectomy  
 Pyloroplasty  
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 Rectal resection  
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 Aspartate aminotransferase test  
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 Blood carbon dioxide level  
 Blood culture  
 Blood donation and registry  
 Bloodless surgery

Blood phosphate level  
 Blood potassium level  
 Blood pressure measurement  
 Blood salvage  
 Blood sodium level  
 Blood type test  
 Blood urea nitrogen test  
 Bone marrow aspiration and biopsy  
 Bone marrow transplantation  
 BUN-creatinine ratio  
 Chemistry screen  
 Cholesterol and triglyceride tests  
 Complete blood count  
 Creatine phosphokinase (CPK)  
 Electrolyte tests  
 Enhanced external counterpulsation  
 Hematocrit  
 Hemoglobin test  
 Hemoperfusion  
 Human leukocyte antigen test  
 LDL cholesterol test  
 Lipid profile  
 Lipid tests  
 Liver function tests  
 Meckel's diverticulectomy  
 Partial thromboplastin time  
 Phlebography  
 Phlebotomy  
 Photocoagulation therapy  
 Prothrombin time  
 Pulse oximeter  
 Red blood cell indices  
 Rh blood typing  
 Rheumatoid factor testing  
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 Eye muscle surgery  
 Finger reattachment  
 Fracture repair  
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 Hip osteotomy  
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 Knee revision surgery  
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 Limb salvage  
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 Craniotomy  
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 Hemispherectomy  
 Meningocele repair  
 Myelography  
 Neurosurgery  
 Pallidotomy  
 Rhizotomy  
 Stereotactic radiosurgery  
 Sympathectomy  
 Vagal nerve stimulation

## Reproductive, Female

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 Breast biopsy  
 Breast implants  
 Breast reconstruction  
 Breast reduction  
 Cervical cerclage  
 Cervical cryotherapy  
 Cesarean section  
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 Colposcopy  
 Colpotomy  
 Cone biopsy  
 Dilatation and curettage  
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*In vitro* fertilization  
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 Lumpectomy  
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 Mastectomy  
 Modified radical mastectomy  
 Myomectomy  
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 Oophorectomy  
 Quadrantectomy  
 Salpingo-oophorectomy  
 Salpingostomy  
 Simple mastectomy  
 Tubal ligation  
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 Pharyngectomy  
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 Corneal transplantation  
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 Cyclocryotherapy  
 Endolymphatic shunt  
 Enucleation, eye  
 Extracapsular cataract extraction  
 Goniotomy  
 Iridectomy  
 Laser in-situ keratomileusis (LASIK)  
 Laser iridotomy  
 Laser posterior capsulotomy  
 Myringotomy and ear tubes

Ophthalmologic surgery  
Ophthalmoscopy  
Otoplasty  
Phacoemulsification for cataracts  
Photorefractive keratectomy (PRK)  
Retinal cryopexy  
Scleral buckling  
Sclerostomy  
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Tarsorrhaphy  
Trabeculectomy  
Tube-shunt surgery  
Tympanoplasty

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Nephrectomy  
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Retropubic suspension  
Sacral nerve stimulation  
Sling procedure  
Transurethral bladder resection  
Ureteral stenting  
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Ureterostomy, cutaneous  
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Emergency surgery  
Essential surgery  
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General surgery  
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Laser surgery  
Lymphadenectomy  
Microsurgery  
Necessary surgery  
Omphalocele repair  
Outpatient surgery  
Pediatric surgery  
Plastic, reconstructive, and cosmetic surgery  
Radical neck dissection  
Rhinoplasty  
Robot-assisted surgery  
Root canal treatment  
Scar revision surgery  
Second-look surgery  
Segmentectomy  
Sex reassignment surgery  
Splenectomy  
Telesurgery  
Thoracic surgery  
Thoracotomy  
Tonsillectomy  
Tooth extraction  
Tooth replantation  
Trabeculectomy  
Transplant surgery  
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Anaerobic bacteria culture  
Antibody tests, immunoglobulins  
Biofeedback  
Chest x ray  
Cryotherapy  
CT scans  
Dental implants  
Epidural therapy  
Glucose tests  
Hair transplantation  
Immunoassay tests  
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Intravenous rehydration  
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Parentage testing  
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 Fluoroquinolones  
 Immunosuppressant drugs  
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 Sedation, conscious  
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 Medicaid  
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 Surgical instruments  
 Surgical mesh  
 Surgical oncology  
 Surgical risk  
 Surgical team  
 Surgical training  
 Surgical triage  
 Syringe and needle  
 Talking to the doctor  
 Thermometer  
 Trocars  
 Vital signs  
 Wound care  
 Wound culture



## PLEASE READ—IMPORTANT INFORMATION

The *Gale Encyclopedia of Surgery and Medical Tests*, 2<sup>nd</sup> Edition is a health reference product designed to inform and educate readers about a wide variety of surgeries, tests, diseases and conditions, treatments and drugs, equipment, and other issues associated with surgical and medical practice. Cengage Learning believes the product to be comprehensive, but not necessarily definitive. It is intended to supplement, not replace, consultation with physicians or other healthcare practitioners. While Cengage Learning has made substantial efforts to provide information that is accurate, comprehensive, and up-to-date, Cengage Learning makes no

representations or warranties of any kind, including without limitation, warranties of merchantability or fitness for a particular purpose, nor does it guarantee the accuracy, comprehensiveness, or timeliness of the information contained in this product. Readers should be aware that the universe of medical knowledge is constantly growing and changing, and that differences of opinion exist among authorities. Readers are also advised to seek professional diagnosis and treatment for any medical condition, and to discuss information obtained from this book with their healthcare provider.

# INTRODUCTION

The *Gale Encyclopedia of Surgery and Medical Tests, 2<sup>nd</sup> Edition* is a unique and invaluable source of information. This collection of 535 entries provides in-depth coverage of various issues related to surgery, medical tests, diseases and conditions, hospitalization, and general health care. These entries generally follow a standard format, including a definition, purpose, demographics, description, diagnosis/preparation, aftercare, precautions, risks, side effects, interactions, morbidity and mortality rates, alternatives, normal results, questions to ask your doctor, and information about who performs the procedures and where they are performed. Topics of a more general nature related to surgical hospitalization and medical testing round out the set. Examples of this coverage include entries on Adult day care, Ambulatory surgery centers, Death and dying, Discharge from the hospital, Do not resuscitate (DNR) order, Exercise, Finding a surgeon, Hospice, Hospital services, Informed consent, Living will, Long-term care insurance, Managed care plans, Medicaid, Medicare, Patient rights, Planning a hospital stay, Power of attorney, Private insurance plans, Second opinion, Talking to the doctor, and others.

## Scope

The *Gale Encyclopedia of Surgery and Medical Tests, 2<sup>nd</sup> Edition* covers a wide variety of topics relevant to the user. Entries follow a standardized format that provides information at a glance. Rubrics include the following (not every entry will make use of all of them):

- Definition
- Description
- Purpose
- Demographics
- Diagnosis/preparation
- Aftercare

- Precautions
- Risks
- Side effects
- Interactions
- Morbidity and mortality rates
- Alternatives
- Normal results
- “Questions to ask the doctor”
- “Who performs the procedure and where is it performed?”
- Resources
- Key Terms

## Inclusion criteria

A preliminary list of topics was compiled from a wide variety of sources, including health reference books, general medical encyclopedias, and consumer health guides. The advisory board evaluated the topics and made suggestions for inclusion. Final selection of topics to include was made by the advisory board in conjunction with the editor.

## About the contributors

The essays were compiled by experienced medical writers, including medical doctors, pharmacists, and registered nurses. The advisers reviewed the completed essays to ensure that they are appropriate, up-to-date, and accurate.

## How to use this book

The *Gale Encyclopedia of Surgery and Medical Tests, 2<sup>nd</sup> Edition* has been designed with ready reference in mind.

- Straight **alphabetical arrangement** of topics allows users to locate information quickly.
- **Bold-faced terms** within entries direct the reader to related articles.
- **Cross-references** placed throughout the encyclopedia direct readers from alternate names and related topics to entries.
- A list of **Key terms** is provided where appropriate to define terms or concepts that may be unfamiliar to the user. A **glossary** of key terms in the back of the fourth volume contains a concise list of terms arranged alphabetically.
- The **Resources** section directs readers to additional sources of information on a topic.
- Valuable **contact information** for health organizations is included with most entries. An Appendix of **organizations** in the back of the fourth volume contains an extensive list of organizations arranged alphabetically.
- A comprehensive **general index** guides readers to significant topics mentioned in the text.

## Graphics

The *Gale Encyclopedia of Surgery and Medical Tests, 2<sup>nd</sup> Edition* is also enhanced by color photographs, illustrations, and tables.

## Acknowledgements

The editor wishes to thank all of the people who contributed to this encyclopedia. There are too many names to list here, so the reader is urged to review the Advisory board and Contributors pages for the list of writers, physicians, and health-care experts to whom he is indebted. Special thanks must go to Rosalyn Carson-DeWitt for all the writing, updating, and advising she did; the project could not have been completed without her. L. Fleming Fallon provided invaluable assistance at every step of the way; his writing, advice, and good humor made this project a pleasure. Laurie Cataldo's expertise in so many areas helped make this book as good as it is. And Maria Basile provided not only many beautifully written entries, but she performed some last-minute review work for which the editor is most grateful. To all of you, my deepest thanks.

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# A

## Abdominal ultrasound

### Definition

Abdominal **ultrasound** uses high-frequency sound waves to produce two-dimensional images of the body's soft tissues, which are used for a variety of clinical applications, including diagnosis and guidance of treatment procedures. Ultrasound does not use ionizing radiation to produce images, and, in comparison to other diagnostic imaging modalities, it is inexpensive, safe, fast, and versatile.

### Purpose

Abdominal ultrasound is used in the hospital radiology department and emergency department, as well as in physician offices, for a number of clinical applications. Ultrasound has a great advantage over x-ray imaging technologies in that it does not damage tissues with ionizing radiation. Ultrasound is also generally far better than plain x rays at distinguishing the subtle variations of soft tissue structures, and can be used in any of several modes, depending on the area of interest.

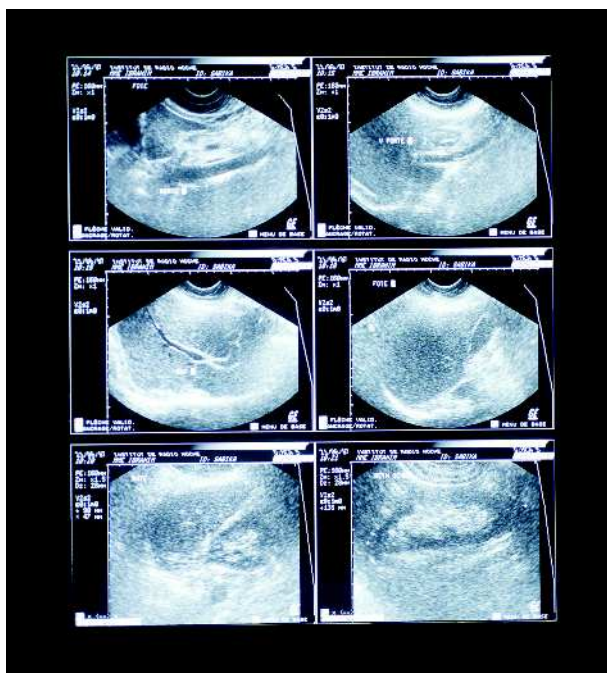
As an imaging tool, abdominal ultrasound is generally indicated for patients afflicted with chronic or acute abdominal pain; abdominal trauma; an obvious or suspected abdominal mass; symptoms of liver or biliary tract disease, pancreatic disease, gallstones, spleen disease, kidney disease, and urinary blockage; evaluation of ascites; or symptoms of an abdominal aortic aneurysm.

The specifics include:

- **Abdominal pain.** Whether acute or chronic, pain can signal a serious problem—from organ malfunction or injury to the presence of malignant growths. Ultrasound scanning can help doctors quickly sort through potential causes when presented with general or ambiguous symptoms. All of the major abdominal organs can

be studied for signs of disease that appear as changes in size, shape, or internal structure.

- **Abdominal trauma.** After a serious accident such as a car crash or a fall, internal bleeding from injured abdominal organs is often the most serious threat to survival. Neither the injuries nor the bleeding may be immediately apparent. Ultrasound is very useful as an initial scan when abdominal trauma is suspected, and it can be used to pinpoint the location, cause, and severity of hemorrhaging. In the case of puncture wounds, from a bullet for example, ultrasound can locate the foreign object and provide a preliminary survey of the damage. (Computed tomography [CT] scans are sometimes used in trauma settings.)



An abdominal ultrasound. (Mike Hill/Alamy)

## KEY TERMS

**Accessory organ**—A lump of tissue adjacent to an organ that is similar to it, but which serves no important purpose (if it functions at all). While not necessarily harmful, such organs can cause problems if they are confused with a mass, or in rare cases, if they grow too large or become cancerous.

**Ascites**—Free fluid in the abdominal cavity.

**Benign**—In medical usage, benign is the opposite of malignant. It describes an abnormal growth that is stable, treatable, and generally not life-threatening.

**Biopsy**—The surgical removal and analysis of a tissue sample for diagnostic purposes. Usually the term refers to the collection and analysis of tissue from a suspected tumor to establish malignancy.

**Calculus**—Any type of hard concretion (stone) in the body, but usually found in the gallbladder, pancreas, and kidneys. Calculi (the plural form) are formed by the accumulation of excess mineral salts and other organic material, such as blood or mucous. They can cause problems by lodging in and obstructing the

proper flow of fluids, such as bile to the intestines or urine to the bladder.

**Cirrhosis**—A chronic liver disease characterized by the degeneration of proper functioning. Jaundice is often an accompanying symptom. Causes of cirrhosis include hepatitis, alcoholism, and metabolic diseases.

**Common bile duct**—The branching passage through which bile—a necessary digestive enzyme—travels from the liver and gallbladder into the small intestine. Digestive enzymes from the pancreas also enter the intestines through the common bile duct.

**Computed tomography scan (CT scan)**—A specialized type of x-ray imaging that uses highly focused and relatively low-energy radiation to produce detailed two-dimensional images of soft-tissue structures, such as the brain or abdomen. CT scans are the chief competitor to ultrasound and can yield higher-quality images not disrupted by bone or gas. They are, however, more cumbersome, time consuming, and expensive to perform, and they use ionizing radiation.

- Abdominal mass. Abnormal growths—tumors, cysts, abscesses, scar tissue, and accessory organs—can be located and tentatively identified with ultrasound. In particular, potentially malignant solid tumors can be distinguished from benign fluid-filled cysts. Masses and malformations in any organ or part of the abdomen can be found.
- Liver disease. The types and underlying causes of liver disease are numerous, though jaundice tends to be a general symptom. Sometimes, liver disease manifests as abnormal laboratory results, such as abnormal liver function tests. Ultrasound can differentiate between many of the types and causes of liver malfunction, and it is particularly good at identifying obstruction of the bile ducts and cirrhosis, which is characterized by abnormal fibrous growths and altered blood flow.
- Pancreatic disease. Inflammation of the pancreas—caused by, for example, abnormal fluid collections surrounding the organ (pseudocysts)—can be identified by ultrasound. Pancreatic stones (calculi), which can disrupt proper functioning, can also be detected.
- Gallstones. These are an extremely common cause of hospital admissions. In the non-emergency or non-acute setting, gallstones can present as abdominal pain, or fatty-food intolerance. These calculi can cause painful inflammation of the gallbladder and obstruct the bile ducts that carry digestive enzymes from the gallbladder and liver to the intestines. Gallstones are readily identifiable with ultrasound.
- Spleen disease. The spleen is particularly prone to injury during abdominal trauma. It may also become painfully inflamed when infected or cancerous. The spleen can become enlarged with some forms of liver disease.
- Kidney disease. The kidneys are also prone to traumatic injury and are the organs most likely to form calculi, which can block the flow of urine and cause further systemic problems. A variety of diseases causing distinct changes in kidney morphology can also lead to complete kidney failure. Ultrasound imaging has proved extremely useful in diagnosing kidney disorders, including blockage and obstruction.
- Abdominal aortic aneurysm. This aneurysm is a bulging weak spot in the abdominal aorta, which supplies blood directly from the heart to the entire lower body. A ruptured aortic aneurysm is imminently life-threatening. However, it can readily be identified and monitored with ultrasound before acute complications result.
- Appendicitis. Ultrasound is useful in diagnosing appendicitis, which causes abdominal pain.

**Doppler**—The Doppler effect refers to the apparent change in frequency of sound-wave echoes returning to a stationary source from a moving target. If the object is moving toward the source, the frequency increases; if the object is moving away, the frequency decreases. The size of this frequency shift can be used to compute the object's speed—be it a car on the road or blood in an artery.

**Frequency**—Sound, whether traveling through air or the human body, produces vibrations—molecules bouncing into each other—as the shock wave travels along. The frequency of a sound is the number of vibrations per second. Within the audible range, frequency means pitch: the higher the frequency, the higher a sound's pitch.

**Ionizing radiation**—A type of radiation that can damage living tissue by disrupting and destroying individual cells at the molecular level. All types of nuclear radiation, including x rays, gamma rays, and beta rays, are potentially ionizing. Sound waves

physically vibrate the material through which they pass, but do not ionize it.

**Jaundice**—A condition that results in a yellow tint to the skin, eyes, and body fluids. Bile retention in the liver, gallbladder, and pancreas is the immediate cause, but the underlying cause could be as simple as obstruction of the common bile duct by a gallstone or as serious as pancreatic cancer. Ultrasound can distinguish between these conditions.

**Malignant**—The term literally means growing worse and resisting treatment. It is used as a synonym for cancerous and connotes a harmful condition that generally is life threatening.

**Morphology**—Literally, the study of form. In medicine, morphology refers to the size, shape, and structure rather than the function of a given organ. As a diagnostic imaging technique, ultrasound facilitates the recognition of abnormal morphologies as symptoms of underlying conditions.

Ultrasound technology can also be used for treatment purposes, most frequently as a visual aid during surgical procedures, such as guiding needle placement to drain fluid from a cyst, or to guide biopsies.

## Description

Ultrasound includes all sound waves above the frequency of human hearing—about 20 thousand hertz (Hz), or cycles per second. Medical ultrasound generally uses frequencies between 1 and 10 megahertz (1–10 MHz). Higher-frequency ultrasound waves produce more detailed images, but they are also more readily absorbed and so cannot penetrate as deeply into the body. Abdominal ultrasound imaging is generally performed at frequencies between 2–5 MHz.

An ultrasound scanner consists of two parts, the transducer and the data processing unit. The transducer both produces the sound waves that penetrate the body and receives the reflected echoes. Transducers are built around piezoelectric ceramic chips. (Piezoelectric refers to electricity that is produced when pressure is put on certain crystals, such as quartz.) These ceramic chips react to electric pulses by producing sound waves (transmitting) and react to sound waves by producing electric pulses (receiving). Bursts of high-frequency electric pulses supplied to the transducer cause it to

produce the scanning sound waves. The transducer then receives the returning echoes, translates them back into electric pulses, and sends them to the data processing unit, a computer that organizes the data into an image on a television screen.

Because sound waves travel through all the body's tissues at nearly the same speed—about 3,400 miles per hour—the microseconds it takes for each echo to be received can be plotted on the screen as a distance into the body. (The longer it takes to receive the echo, the farther away the reflective surface must be.) The relative strength of each echo, a function of the specific tissue or organ boundary that produced it, can be plotted as a point of varying brightness. In this way, the echoes are translated into an image.

Four different modes of ultrasound are used in medical imaging:

- **A-mode.** This is the simplest type of ultrasound in which a single transducer scans a line through the body with the echoes plotted on screen as a function of depth. This method is used to measure distances within the body and the size of internal organs.
- **B-mode.** In B-mode ultrasound, which is the most common use, a linear array of transducers simultaneously scans a plane through the body that can be viewed as a two-dimensional image on screen.

- **M-Mode.** The M stands for motion. A rapid sequence of B-mode scans whose images follow each other in sequence on screen enables doctors to see and measure range of motion, as the organ boundaries that produce reflections move relative to the probe. M-mode ultrasound has been put to particular use in studying heart motion.
- **Doppler mode.** Doppler ultrasonography includes the capability of accurately measuring velocities of moving material, such as blood in arteries and veins. The principle is the same as that used in radar guns that measure the speed of a car on the highway. Doppler capability is most often combined with B-mode scanning to produce images of blood vessels from which blood flow can be directly measured. This technique is used extensively to investigate valve defects, arteriosclerosis, and hypertension, particularly in the heart, but also in the abdominal aorta and the portal vein of the liver.

The actual procedure for a patient undergoing an abdominal ultrasound is relatively simple, regardless of the type of scan or its purpose. Fasting for at least eight hours prior to the procedure ensures that the patient's stomach is empty and as small as possible, and that the intestines and bowels are relatively inactive. This also helps the gallbladder become more visible. Prior to scanning, an acoustic gel is applied to the skin of the patient's abdomen to allow the ultrasound probe to glide easily across the skin and to better transmit and receive ultrasonic pulses. The probe is moved around the abdomen's surface to obtain different views of the target areas. The patient will likely be asked to change positions from side to side and to hold the breath as necessary to obtain the desired views. Usually, a scan will take from 20 to 45 minutes, depending on the patient's condition and the anatomical area being scanned.

Ultrasound scanners are available in different configurations, with different scanning features. Portable units, which weigh only a few pounds and can be carried by hand, are available for bedside use, office use, or use outside the hospital, such as at sporting events and in ambulances. Portable scanners range in cost from \$10,000 to \$50,000. Mobile ultrasound scanners, which can be pushed to the patient's bedside and between hospital departments, are the most common configuration and range in cost from \$100,000 to more than \$250,000, depending on the scanning features purchased.

### Preparation

A patient undergoing abdominal ultrasound will be advised by his or her physician about what to expect

and how to prepare. As mentioned above, preparations generally include fasting.

### Aftercare

In general, no aftercare related to the abdominal ultrasound procedure itself is required. Discomfort during the procedure is minimal.

### Risks

Properly performed, ultrasound imaging is virtually without risk or side effects.

### Results

As a diagnostic imaging technique, a normal abdominal ultrasound is one that indicates the absence of the suspected condition that prompted the scan. For example, symptoms such as abdominal pain radiating to the back suggest the possibility of, among other things, an abdominal aortic aneurysm. An ultrasound scan that indicates the absence of an aneurysm would rule out this life-threatening condition and point to other, less serious causes.

Because abdominal ultrasound imaging is generally undertaken to confirm a suspected condition, the results of a scan often will confirm the diagnosis, be it kidney stones, cirrhosis of the liver, or an aortic aneurysm. At that point, appropriate medical treatment as prescribed by a patient's physician is in order.

Ultrasound scanning should be performed by a registered and trained ultrasonographer, either a technologist or a physician (radiologist, obstetrician/gynecologist). Ultrasound scanning in the emergency department may be performed by an emergency medicine physician, who should have appropriate training and experience in ultrasonography.

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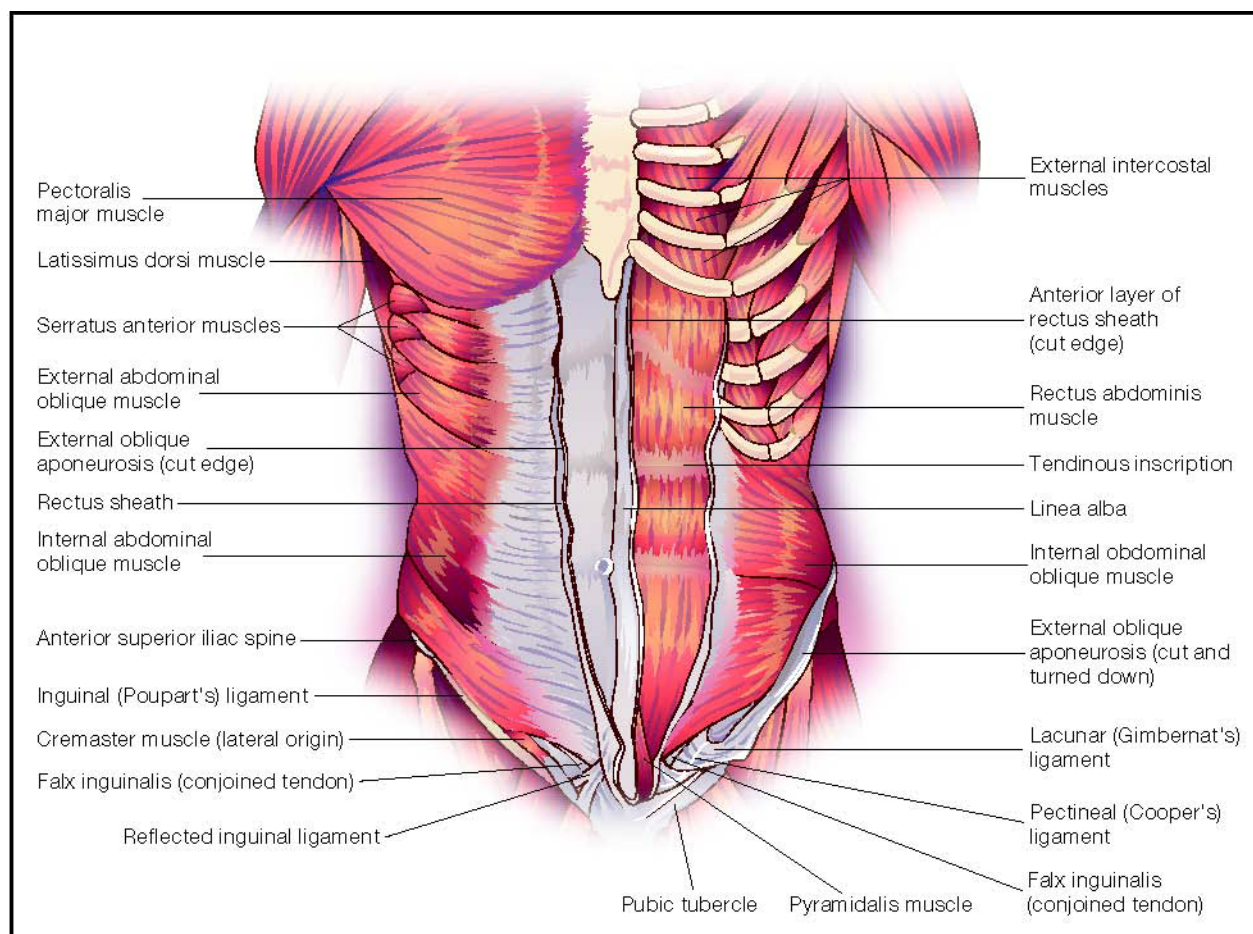
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## Abdominal wall defect repair

### Definition

Abdominal wall defect repair is a surgery performed to correct one of two birth defects of the abdominal wall: gastroschisis or omphalocele. Depending on the defect treated, the procedure is also known as omphalocele repair/closure or gastroschisis repair/closure.



**Muscles of the abdomen.** (Illustration by Electronic Illustrators Group.)

## Purpose

In some cases, for some unknown reason, while in utero, the abdominal wall muscles do not form correctly. And, when the abdominal wall is incompletely formed at birth, the internal organs of the infant can either protrude into the umbilical cord (omphalocele) or to the side of the navel (gastroschisis). The size of an omphalocele varies: some are very small, about the size of a ping pong ball, while others may be as big as a grapefruit. **Omphalocele repair** is performed to repair the omphalocele defect in which all or part of the bowel and other internal organs lie on the outside of the abdomen in a hernia (sac). Gastroschisis repair is performed to repair the other abdominal wall defect through which the bowel protrudes with no protective sac present. Gastroschisis is a life-threatening condition that requires immediate medical intervention. Surgery for abdominal wall defects aims to return the abdominal organs back to the abdominal cavity, and to repair the defect if possible. It can also be performed to create a pouch to protect the intestines until they are inserted back into the abdomen.

## Demographics

Abdominal wall defects occurs in the United States at a rate of one case per 2,000 births, which means that some 2,360 cases are diagnosed per year. Mothers below the age of 20 are four times as likely as mothers in their late twenties to give birth to affected babies.

## Description

Abdominal wall defect surgery is performed soon after birth. The protruding organs are covered with **dressings**, and a tube is inserted into the stomach to prevent the baby from choking or from breathing in the contents of the stomach into the lungs. The surgery is performed under **general anesthesia**. First, the pediatric surgeon enlarges the hole in the abdominal wall in order to examine the bowel for damage or other birth defects. Damaged portions of the bowel are removed and the healthy bowel is reconnected with **stitches**. The exposed organs are replaced within the abdominal cavity, and the opening is closed. Sometimes closure of the opening is not possible, for example when the abdominal cavity is too small or when the organs are too large or swollen to close the skin. In such cases, the surgeon will place a plastic covering pouch, commonly called a silo because of its shape, over the abdominal organs on the outside of the infant to protect the organs. Gradually, the organs are squeezed through the pouch into the opening and returned to the body. This procedure can take up to

## KEY TERMS

**Abdomen**—The portion of the body that lies between the thorax and the pelvis. It contains a cavity with many organs.

**Amniotic membrane**—A thin membrane that contains the fetus and the protective amniotic fluid surrounding the fetus.

**Anesthesia**—A combination of drugs administered by a variety of techniques by trained professionals that provide sedation, amnesia, analgesia, and immobility adequate for the accomplishment of the surgical procedure with minimal discomfort, and without injury, to the patient.

**Gastroschisis**—A defect of the abdominal wall caused by rupture of the amniotic membrane or by the delayed closure of the umbilical ring. It is usually accompanied by protrusion of internal organs in the abdomen.

**Hernia**—The protrusion or thrusting forward of an organ or tissue through an abnormal opening into the abdominal sac.

**Omphalocele**—A hernia that occurs at the navel.

**Peritonitis**—Inflammation of the membrane lining the abdominal cavity. It causes abdominal pain and tenderness, constipation, vomiting, and fever.

**Short bowel syndrome**—A condition in which digestion and absorption in the small intestine are impaired.

**Ultrasound**—An imaging technology that allows various organs in the body to be examined.

**Umbilical ring**—An opening through which the umbilical vessels pass to the fetus; it is closed after birth and its site is indicated by the navel.

a week, and final closure may be performed a few weeks later. More surgery may be required to repair the abdominal muscles at a later time.

## Diagnosis/Preparation

Prenatal screening can detect approximately 85% of abdominal wall defects. Gastroschisis and omphalocele are usually diagnosed by **ultrasound** examinations before birth. These tests can determine the size of the abdominal wall defect and identify the affected organs. The surgery is performed immediately after delivery, as soon as the newborn is stable.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Abdominal wall defect surgery is performed by a pediatric surgeon. A pediatric surgeon is specialized in the surgical care of children. He or she must have graduated from medical school, and completed five years of postgraduate general surgery training in an accredited training program. A pediatric surgeon must complete an additional accredited two-year fellowship program in pediatric surgery and be board-eligible or board-certified in general surgery. (Board certification is granted when a fully trained surgeon has taken and passed first a written, then an oral examination.) Once the general surgery boards are passed, a fellowship-trained pediatric surgeon becomes eligible to take the pediatric surgery examination. Other credentials may include membership in the American College of Surgeons, the American Pediatric Surgical Association, and/or the American Academy of Pediatrics. Each of these organizations require that fellows meet well-established standards of training, clinical knowledge, and professional conduct.

If prenatal screening indicates that abdominal wall defects are present in the fetus, delivery should occur at a hospital with an neonatal intensive care unit (NICU) and a pediatric surgeon on staff.

### Aftercare

After surgery, the infant is transferred to an **intensive care unit (ICU)** and placed in an incubator to keep warm and to prevent infection. Oxygen is provided. When organs are placed back into the abdominal cavity, this may increase pressure on the abdomen and make breathing difficult. In such cases, the infant is provided with a breathing tube and ventilator until the swelling of the abdominal organs has decreased. Intravenous fluids, **antibiotics**, and pain medication are also administered. A tube is also placed in the stomach to empty gastric secretions. Feedings are started very slowly, using a nasal tube as soon as bowel function starts. Babies born with omphaloceles can stay in the hospital from one week to one month after surgery, depending on the size of the defect. Babies are discharged from the hospital when they are taking all their feedings by mouth and gaining weight.

## QUESTIONS TO ASK THE DOCTOR

- What will happen when my baby is born?
- Does my baby have any other birth defects?
- What are my baby's chances of full recovery?
- Will my baby have a "belly button"?
- How many abdominal wall defect surgeries do you perform each year?
- How many infants have you operated on during your practice?

### Risks

The risks of abdominal wall repair surgery include peritonitis and temporary paralysis of the small bowel. If a large segment of the small intestine is damaged, the baby may develop short bowel syndrome and have digestive problems.

### Normal results

In most cases, the defect can be corrected with surgery. The outcome depends on the amount of damage to the bowel.

### Morbidity and mortality rates

The size of the abdominal wall defect, the extent to which organs protrude out of the abdomen, and the presence of other birth defects influence the outcome of the surgery. The occurrence of other birth defects is uncommon in infants with gastroschisis, and 85% survive. Approximately half of the babies diagnosed with omphalocele have heart defects or other birth defects, and approximately 60% survive to age one.

### Alternatives

Gastroschisis is a life-threatening condition requiring immediate surgical intervention. There is no alternative to surgery for either gastroschisis or omphalocele.

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## Abdominoplasty

### Definition

Also known as a tummy tuck, abdominoplasty is a surgical procedure in which excess skin and fat in the abdominal area is removed and the abdominal muscles are tightened.

### Purpose

Abdominoplasty is a cosmetic procedure that treats loose or sagging abdominal skin, resulting in a protruding abdomen that typically occurs after significant weight loss. Good candidates for abdominoplasty are individuals in good health who have one or more of the above conditions and who have tried to address these issues with diet and **exercise** with little or no results.

Women who have had multiple pregnancies often seek abdominoplasty as a means of ridding themselves of loose abdominal skin. While in many cases diet and exercise are sufficient in reducing abdominal fat and loose skin after pregnancy, in some women these conditions may persist. Abdominoplasty is not recommended for women who wish to have further pregnancies, as the beneficial effects of the surgery may be undone.

Another common reason for abdominoplasty is to remove excess skin from a person who has lost a large amount of weight or is obese. A large area of overhanging skin is called a pannus. Older patients are at

## KEY TERMS

**Abdominal hernia**—A defect in the abdominal wall through which the abdominal organs protrude.

**Morbidly obese**—A term defining individuals who are more than 100 lb (45 kg) over their ideal body weight.

an increased risk of developing a pannus because skin loses elasticity as one ages. Problems with hygiene or wound formation can result in a patient who has multiple hanging folds of abdominal skin and fat. If a large area of excess tissue is removed, the procedure is called a panniculectomy.

In some instances, abdominoplasty is performed simultaneously or directly following gynecologic surgery such as **hysterectomy** (removal of the uterus). One study found that the removal of a large amount of excess abdominal skin and fat from morbidly obese patients during gynecologic surgery results in better exposure to the operating field and improved wound healing.

### Contraindications

Certain patients should not undergo abdominoplasty. Poor candidates for the surgery include:

- Women who wish to have subsequent pregnancies.
- Individuals who wish to lose a large amount of weight following surgery.
- Patients with unrealistic expectations (those who think the surgery will give them a "perfect" figure).
- Those who are unable to deal with the post-surgical scars.
- Patients who have had previous abdominal surgery.
- Heavy smokers.

### Demographics

According to the American Academy of Plastic Surgeons, in 2005 there were approximately 169,314 abdominoplasties performed in the United States, relating to 4% of all **plastic surgery** patients and less than 0.5% of all plastic surgery procedures. Female patients accounted for 97% of all abdominoplasties. Most patients undergoing cosmetic plastic surgery were between the ages of 35 and 50 (47%), with patients between 19 and 35 years of age accounting for 24%, and patients between the ages of 51 and 64 accounting for 24%. Eighty percent of all plastic surgery patients during 2001 were white, 9% were Hispanic, 6% were African American, and 6% were Asian American.

## Description

The patient is usually placed under **general anesthesia** for the duration of surgery. The advantages to general anesthesia are that the patient remains unconscious during the procedure, which may take from two to five hours to complete; no pain will be experienced nor will the patient have any memory of the procedure; and the patient's muscles remain completely relaxed, lending to safer surgery.

Once an adequate level of anesthesia has been reached, an incision is made across the lower abdomen. For a complete abdominoplasty, the incision will stretch from hipbone to hipbone. The skin will be lifted off the abdominal muscles from the incision up to the ribs, with a separate incision being made to free the umbilicus (belly button). The vertical abdominal muscles may be tightened by stitching them closer together. The skin is then stretched back over the abdomen and excess skin and fat are cut away. Another incision will be made across the stretched skin through which the umbilicus will be located and stitched into position. A temporary drain may be placed to remove excess fluid from beneath the incision. All incisions are then stitched closed and covered with **dressings**.

Individuals who have excess skin and fat limited to the lower abdomen (i.e., below the navel) may be candidates for partial abdominoplasty. During this procedure, the muscle wall is not tightened. Rather, the skin is stretched over a smaller incision made just above the pubic hairline, and excess skin is cut away. The incision is then closed with **stitches**. The umbilicus is not repositioned during a partial abdominoplasty; its shape, therefore, may change as the skin is stretched downward.

## Additional procedures

In some cases, additional procedures may be performed during or directly following abdominoplasty. **Liposuction**, also called suction lipectomy or lipoplasty, is a technique that removes fat that cannot be removed by diet or exercise. During the procedure, which is generally performed in an outpatient surgical facility, the patient is anesthetized and a hollow tube called a cannula is inserted under the skin into a fat deposit. By physical manipulation, the fat deposit is loosened and sucked out of the body. Liposuction may be used during abdominoplasty to remove fat deposits from the torso, hips, or other areas. This may create a more desired body contour.

Some patients may choose to undergo breast augmentation, reduction, or lift during abdominoplasty. Breast augmentation involves the insertion of a silicone- or saline-filled implant into the breast, most

often behind the breast tissue or chest muscle wall. A **breast reduction** may be performed on patients who have large breasts that cause an array of symptoms such as back and neck pain. Breast reduction removes excess breast skin and fat and moves the nipple and area around the nipple (called the areola) to a higher position. A breast lift, also called a mastopexy, is performed on women who have low, sagging breasts, often due to pregnancy, nursing, or aging. The surgical procedure is similar to a breast reduction, but only excess skin is removed; **breast implants** may also be inserted.

## Breast reconstruction

A modified version of abdominoplasty may be used to reconstruct a breast in a patient who has undergone **mastectomy** (surgical removal of the breast, usually as a treatment for cancer). Transverse rectus abdominis myocutaneous (TRAM) flap reconstruction may be performed at the time of mastectomy or as a later, separate procedure. Good candidates for the surgery include women who have had or will have a large portion of breast tissue removed and also have excess skin and fat in the lower abdominal region. Women who are not in good health, are obese, have had a previous abdominoplasty, or wish to have additional children are not considered good candidates for TRAM flap reconstruction.

The procedure is usually performed in three separate steps. The first step is the TRAM flap surgery. In a procedure similar to traditional abdominoplasty, excess skin and fat is removed from the lower abdomen, and then stitched into place to create a breast. The construction of a nipple takes place several months later to enable the tissue to heal adequately. Finally, once the new breast has healed and softened, tattooing may be performed to add color to the constructed nipple.

## Costs

Because abdominoplasty is considered to be an elective cosmetic procedure, most insurance policies will not cover the procedure, unless it is being performed for medical reasons (for example, if an abdominal hernia is the cause of the protruding abdomen).

A number of fees must be taken into consideration when calculating the total cost of the procedure. Typically, fees include those paid to the surgeon, the anesthesiologist, and the facility where the surgery is performed. If liposuction or breast surgery is to be performed, additional costs may be incurred. The average cost of abdominoplasty is \$6,500, but may range between \$5,000–\$9,000, depending on the surgeon and the complexity of the procedure.

## Diagnosis/Preparation

There are a number of steps that the patient and plastic surgeon must take before an abdominoplasty may be performed. The surgeon will generally schedule an initial consultation, during which a **physical examination** will be performed. The surgeon will assess a number of factors that may impact the success of the surgery. These include:

- the patient's general health
- the size and shape of the abdomen and torso
- the location of abdominal fat deposits
- the patient's skin elasticity
- what medications the patient may be taking

It is important that the patient come prepared to ask questions of the surgeon during the initial consultation. The surgeon will describe the procedure, where it will be performed, associated risks, the method of anesthesia and pain relief, any additional procedures that may be performed, and post-surgical care. The patient may also meet with a staff member to discuss how much the procedure will cost and what options for payment are available.

The patient will also receive instructions on how to prepare for abdominoplasty. Certain medications should be avoided for several weeks before and after the surgery; for example, medications containing **aspirin** may interfere with the blood's ability to clot. Because tobacco can interfere with blood circulation and wound healing, smokers are recommended to quit for several weeks before and after the procedure. A medicated antibacterial soap may be prescribed prior to surgery to decrease levels of bacteria on the skin around the incision site.

## Aftercare

The patient may remain in the hospital or surgical facility overnight, or return home the day of surgery after spending several hours recovering from the procedure and anesthesia. Before leaving the facility, the patient will receive the following instructions on post-surgical care:

- For the first several days after surgery, it is recommended that the patient remain flexed at the hips (i.e., avoid straightening the torso) to prevent unnecessary tension on the surgical site.
- Walking as soon as possible after the procedure is recommended to improve recovery time and prevent blood clots in the legs.
- Mild exercise that does not cause pain to the surgical site is recommended to improve muscle tone and decrease swelling.

- The patient should not shower until any drains are removed from the surgical site; sponge baths are permitted.
- Work may be resumed in two to four weeks, depending on the level of physical activity required.

Surgical drains will be removed within one week after abdominoplasty, and stitches from one to two weeks after surgery. Swelling, bruising, and pain in the abdominal area are to be expected and may last from two to six weeks. Recovery will be faster, however, in the patient who is in good health with relatively strong abdominal muscles. The incisions will remain a noticeable red or pink for several months, but will begin to fade by nine months to a year after the procedure. Because of their location, scars should be easily hidden under clothing, including bathing suits.

## Risks

There are a number of complications that may arise during or after abdominoplasty. Complications are more often seen among patients who smoke, are overweight, are unfit, have diabetes or other health problems, or have scarring from previous abdominal surgery. Risks inherent to the use of general anesthesia include nausea, vomiting, sore throat, fatigue, headache, and muscle soreness; more rarely, blood pressure problems, allergic reaction, heart attack, or stroke may occur.

Risks associated with the procedure include:

- bleeding
- wound infection
- delayed wound healing
- skin or fat necrosis (death)
- hematoma (collection of blood in a tissue)
- seroma (collection of serum in a tissue)
- blood clots
- pulmonary embolism (a blood clot that travels to the lungs)
- numbness to the abdominal region or thighs (due to damage to nerves during surgery)

## Normal results

In most cases, abdominoplasty is successful in providing a trimmer abdominal contour in patients with excess skin and fat and weak abdominal muscles. A number of factors will influence how long the optimal results of abdominoplasty will last, including age, skin elasticity, and physical fitness. Generally, however, good results will be long lasting if the patient remains in good health, maintains a stable weight,

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Abdominoplasty is usually performed by a plastic surgeon, a medical doctor who has completed specialized training in the repair or reconstruction of physical defects or the cosmetic enhancement of the human body. In order for a plastic surgeon to be considered board certified by the American Board of Plastic Surgery, he or she must meet a set of strict criteria (including a minimum of five years of training in general surgery and plastic surgery) and pass a series of examinations. The procedure may be performed in a hospital operating room or a specialized outpatient surgical facility.

and exercises regularly. One study surveying patient satisfaction following abdominoplasty indicated that 95% felt their symptoms (excess skin and fat) were improved, 86% were satisfied with the results of the surgery, and 86% would recommend the procedure to a friend.

### Morbidity and mortality rates

The overall rate of complications associated with abdominoplasty is approximately 32%. This percentage, however, is higher among patients who are overweight; one study placed the complication rate among obese patients at 80%. Rates are also higher among patients who smoke or are diabetic. The rate of major complications requiring hospitalization has been reported at 1.4%.

### Alternatives

Before seeking abdominoplasty, an individual will want to be sure that loose and excess abdominal skin and fat cannot be decreased through a regimen of diet and exercise. Abdominoplasty should not be viewed as an alternative to weight loss. In fact, some doctors would suggest that a patient be no more than 15% over his or her ideal body weight in order to undergo the procedure.

Liposuction is a surgical alternative to abdominoplasty. There are several advantages to liposuction. It is less expensive (an average of \$2,000 per body area treated compared to \$6,500 for abdominoplasty). It also is associated with a faster recovery, use of less anesthesia, a smaller rate of complications, and significantly smaller incisions. What liposuction cannot

## QUESTIONS TO ASK THE DOCTOR

- How long have you been practicing plastic surgery?
- Are you certified by the American Board of Plastic Surgeons?
- How many abdominoplasties have you performed, and how often?
- What is your rate of complications?
- How extensive will the post-surgical scars be?
- What method of anesthesia will be used?
- What are the costs associated with this procedure?
- Will my insurance pay for part or all of the surgery?
- Do you provide revision surgery (i.e., if I experience suboptimal results)?

do is remove excess skin. Liposuction is a good choice for patients with localized deposits of fat, while abdominoplasty is a better choice for patients with excess abdominal skin and fat.

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## ABO blood typing

### Definition

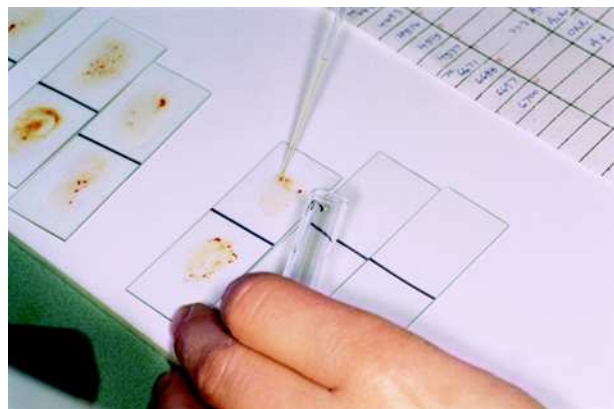
Of the many different bases for typing blood, the most commonly used and the most important are the ABO groups. Specific combinations of antigens and antibodies defines the blood type of all humans and many primates.

### Purpose

The purpose of the ABO typing system is to allow successful sharing of blood and blood products by avoiding rejections after transfusions.

### Description

The ABO blood groups were discovered by Karl Landsteiner in 1900 and 1901 at the University of Vienna. All humans and most other primates can be



Testing blood type. (Image Source Black / Alamy)

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

ABO blood typing involves personnel from several allied health disciplines. A phlebotomist usually obtains an initial blood sample. A medical technologist typically runs the tests to determine specific blood types. A physician or surgeon commonly prescribes blood or blood products. A nurse typically administers the blood or blood products to a recipient.

typed using the ABO blood group system. Four principal blood types have been defined on the basis of antigens and antibodies.

- Type A blood is positive for antigen A and anti-B antibody and is negative for Antigen B and anti-A antibody.
- Type B blood is positive for antigen B and anti-A antibody and is negative for Antigen A and anti-B antibody.
- Type O blood is negative for both antigen A and antigen B and is positive for both anti-A antibody and anti-B antibody.
- Type AB blood is positive for both antigen A and antigen B and is negative for both anti-A antibody and anti-B antibody.

The presence or absence of antigens and antibodies determines the type of blood that a person can give (donate) or receive. People will not destroy blood of their own type but will destroy other types of blood. For example, the absence of anti-A antibodies allows people with type A blood to receive type A blood. However, the anti-B antibodies in type A blood will destroy type B blood. This immune system mechanism protects people from alien organisms.

Individuals with type O blood do not produce any ABO antigens. As a consequence, their blood usually will not be rejected when it is given to others with different ABO types. People with type O blood are called universal donors for transfusions. However, they can only receive type O blood. Persons having type AB blood do not have any ABO antibodies. They are universal receivers for transfusions, but their blood will be rejected when given to people with every other type because they produce both kinds of antigens.

## KEY TERMS

**Agglutination**—An immunochemical reaction. It is termed positive when two chemicals that are mixed cause clumps to form.

**Hematoma**—An accumulation of blood outside of the circulatory system

**Phlebotomist**—a person trained to obtain a blood sample.

**Rhesus factor**—A secondary component of ABO typing that was first observed in rhesus monkeys.

To determine an individual's ABO type, serum containing anti-A antibodies is mixed with a few drops of their blood. Another serum containing anti-B antibodies is mixed with a different few drops of blood. The results determine the ABO type by a process of elimination.

ABO blood types are inherited through genes on chromosome 9, and they do not change as a result of environmental influences during life.

The Rhesus factor is associated with ABO blood typing. This further describes the reactivity of each type. The Rhesus factors are positive (+) and negative (-). The Rhesus factor is abbreviated as Rh. The Rh factors of a donor and recipient must match to avoid sensitization or rejection. Thus, for example, type O blood includes O+ and O-. Including the Rh factor, the ABO system includes 8 different blood types: A+, A-, B+, B-, AB+, AB-, O+ and O-.

## Precautions

ABO typing is not routinely used to determine genetic inheritance patterns from their parents. In fact, paternity in the U.S. and many other nations can no longer be legally established based on conventional blood typing. HLA types or DNA sequencing are more precise than ABO typing. DNA is the most costly test to use.

## Risks

The risks associated with obtaining a blood sample are minimal. They include fainting, feeling lightheaded, pain from the needle used to obtain a blood sample (venipuncture), bleeding at the site of venipuncture, blood accumulating at the venipuncture site (hematoma), and infection.

## Side effects

The most common physical side effect of ABO typing is a bruise at the site of venipuncture used to obtain a blood sample. A lab error has the potential to sensitize or kill a recipient if blood of the wrong type is given.

## Interactions

ABO blood typing does not interact with pharmaceutical products.

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## Abortion, induced

### Definition

Induced abortion is the intentional termination of a pregnancy before the fetus can live independently. An abortion may be elective, based on a woman's personal choice; or therapeutic, to preserve the health or save the life of a pregnant woman.

### Purpose

An abortion may be performed whenever there is some compelling reason to end a pregnancy. An abortion is termed "induced" to differentiate it from a spontaneous abortion in which the products of conception are lost naturally. A spontaneous abortion is also called a miscarriage.

An abortion is considered to be elective if a woman chooses to end her pregnancy, and it is not for maternal or fetal health reasons. Some reasons a woman might choose to have an elective abortion are:

- continuation of the pregnancy may cause emotional or financial hardship;
- the woman is not ready to become a parent;
- the pregnancy was unintended;
- the woman is pressured into aborting by her partner, parents, or others; and
- the pregnancy was the result of rape or incest.

A therapeutic abortion is performed in order to preserve the health or save the life of a pregnant woman. A health care provider might recommend a therapeutic abortion if the fetus is diagnosed with

significant abnormalities or not expected to live, or if it has died *in utero*. Therapeutic abortion may also be used to reduce the number of fetuses if a woman is pregnant with multiples; this procedure is called multifetal pregnancy reduction (MFPR).

A therapeutic abortion may be indicated if a woman has a pregnancy-related health condition that endangers her life. Some examples of such conditions include:

- severe hypertension (high blood pressure);
- cardiac disease;
- severe depression or other psychiatric conditions;
- serious kidney or liver disease;
- certain types of infection;
- malignancy (cancer); and
- multifetal pregnancy.

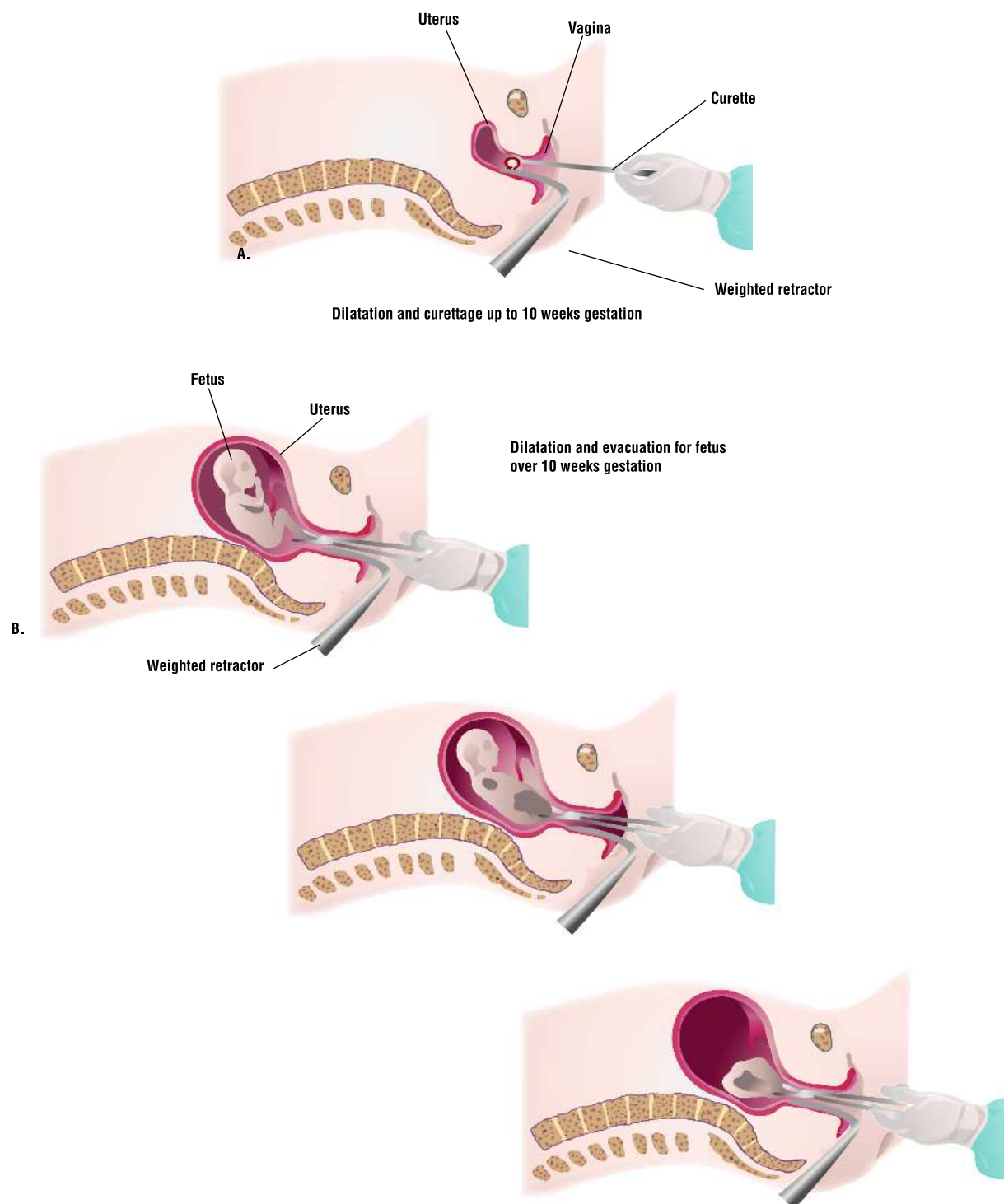
### Demographics

Abortion has been a legal procedure in the United States since 1973. Since then, more than 39 million abortions have taken place. It is estimated that approximately 1.3–1.4 million abortions occur in the United States annually. Induced abortions terminate approximately half of the estimated three million unplanned pregnancies each year and approximately one-fifth of all pregnancies.

The total number of abortions performed has declined from 1.31 million in 2000, to 1.21 million performed in 2005. From 1973 through 2005, more than 45 million legal abortions took place. The estimated number of abortions during 2004–2006 were 1,287,000. In 2000 an estimated 21 out of 1,000 women aged 15–44 had an abortion. Out of every 100 pregnancies that year that ended in live birth or abortion, approximately 24 were elective terminations. The highest abortion rates in 2000 occurred in New Jersey, New York, California, Delaware, Florida, and Nevada (greater than 30 per 1,000 women of reproductive age). Kentucky, South Dakota, Wyoming, Idaho, Mississippi, Utah, and West Virginia had the lowest rates (less than seven per 1,000 women).

In 2000 and 2001, the highest percentage of abortions were performed on women between the ages of 20 and 30, with women ages 20–24 having the highest rate (47 per 1,000 women). Adolescents ages 15–19 accounted for 19% of elective abortions, while 25% were performed on women older than 30. Approximately 73% of women having an abortion had previously been pregnant; 48% of those had a previous abortion.

## Abortion, induced



A dilatation and curettage is used to perform an abortion up to 10 weeks gestation (A). Over 10 weeks, the physician may use dilatation and evacuation to achieve the abortion (B). (Illustration by GGS Information Services. Cengage Learning, Gale.)



## KEY TERMS

**Curette**—A spoon-shaped instrument used to remove tissue from the inner lining of the uterus.

**Endocarditis**—An infection of the inner membrane lining of the heart.

**Fibroid tumors**—Non-cancerous (benign) growths in the uterus; they occur in 30–40% of women over age 40 and do not need to be removed unless they are causing symptoms that interfere with a woman's normal activities.

**Lupus erythematosus**—A chronic inflammatory disease in which inappropriate immune system reactions cause abnormalities in the blood vessels and connective tissue.

**Prostaglandin**—Responsible for various hormonal reactions such as muscle contraction.

**Rh negative**—Lacking the Rh factor, which are genetically determined antigens in red blood cells that produce immune responses. If an Rh-negative woman is pregnant with an Rh-positive fetus, her body will produce antibodies against the fetus's blood, causing a disease known as Rh disease. Sensitization to the disease occurs when the woman's blood is exposed to the fetus's blood. Rh immune globulin (RhoGAM) is a vaccine that must be given to a woman after an abortion, miscarriage, or prenatal tests in order to prevent sensitization to Rh disease.

Non-Hispanic, white women reported the highest percentage of abortions in 2000 and 2001 (41%). African American women accounted for 32%, Hispanic women for 20%, Asian and Pacific Islander women for 6%, and Native American women for 1%. The highest abortion rates occurred among African American women (49 per 1,000 women), with Hispanic and Asian women also reporting higher-than-average rates (33 and 31 per 1,000 women, respectively). The rate was the lowest among white women (13 per 1,000 women). As of 2005, 50% of women in the United States who obtained abortions were younger than age 25, 33% of those having abortions were between the ages of 20–25, and 17% were teenagers. About 60% of women having abortions were women who already had one or more children.

### Description

Abortions are safest when performed within the first six to 10 weeks after the last menstrual period

(LMP). This calculation is used by health care providers to determine the stage of pregnancy. About 90% of women who have abortions do so in the first trimester of pregnancy (before 13 weeks) and experience few complications. Abortions performed between 13 and 24 weeks (during the second trimester) have a higher rate of complications. Abortions after 24 weeks are extremely rare and are usually limited to situations where the life of the mother is in danger.

Although it is safer to have an abortion during the first trimester, some second trimester abortions may be inevitable. The results of genetic testing are often not available until 16 weeks gestation. In addition, women, especially teens, may not have recognized the pregnancy or come to terms with it emotionally soon enough to have a first trimester abortion. Teens make up the largest group having second trimester abortions.

Very early abortions cost between \$200 and \$400. Later abortions cost more. The cost increases about \$100 per week between the thirteenth and sixteenth week. Second trimester abortions are much more costly because they often involve more risk, more services, anesthesia, and sometimes a hospital stay. Private insurance carriers may or may not cover the procedure. Federal law prohibits federal funds (including **Medicaid**) from being used to pay for an elective abortion.

### Medical abortions

Medical abortions are brought about by taking medications that end the pregnancy. The advantages of a first trimester medical abortion are:

- the procedure is non-invasive, so no surgical instruments are used;
- anesthesia is not required;
- drugs are administered either orally or by injection; and
- the outcome resembles a natural miscarriage.

Disadvantages of a medical abortion are:

- the effectiveness decreases after the seventh week;
- the procedure may require multiple visits to the doctor;
- bleeding after the abortion lasts longer than after a surgical abortion; and
- the woman may see the contents of her womb as it is expelled.

As of 2003, two drugs were available in the United States to induce abortion: methotrexate and mifepristone.

**METHOTREXATE.** Methotrexate (Rheumatrex) targets rapidly dividing fetal cells, thus preventing the fetus from further developing. It is used in conjunction with misoprostol (Cytotec), a prostaglandin that stimulates contractions of the uterus. Methotrexate may be taken up to 49 days after the first day of the last menstrual period.

On the first visit to the doctor, the woman receives an injection of methotrexate. On the second visit, about a week later, she is given misoprostol tablets vaginally to stimulate contractions of the uterus. Within two weeks, the woman will expel the contents of her uterus, ending the pregnancy. A follow-up visit to the doctor is necessary to assure that the abortion is complete.

With this procedure, a woman will feel cramping and may feel nauseated from the misoprostol. This combination of drugs is approximately 92–96% effective in ending pregnancy. Approximately 50% of women will experience the abortion soon after taking the misoprostol; 35–40% will have the abortion up to seven days later.

Methotrexate is not recommended for women with liver or kidney disease, inflammatory bowel disease, clotting disorders, documented immunodeficiency, or certain blood disorders.

**MIFEPRISTONE.** Mifepristone (RU-486), which goes by the brand name Mifeprex, works by blocking the action of progesterone, a hormone needed for pregnancy to continue. It was approved by the Food and Drug Administration (FDA) in September 2000 as an alternative to surgical abortion. Mifepristone can be taken up to 49 days after the first day of a woman's last period.

On the first visit to the doctor, a woman takes a mifepristone pill. Two days later she returns and, if the miscarriage has not occurred, takes two misoprostol pills, which causes the uterus to contract. Approximately 10% will experience the abortion before receiving the dose of misoprostol.

Within four days, 90% of women have expelled the contents of their uterus and completed the abortion. Within 14 days, 95–97% of women have completed the abortion. A third follow-up visit to the doctor is necessary to confirm through observation or **ultrasound** that the procedure is complete. In the event that it is not, a surgical abortion is performed. Studies show that 4.5–8% of women need surgery or a blood **transfusion** after taking mifepristone, and the pregnancy persists in about 1%. Surgical abortion is then recommended because the fetus may be damaged. Side effects include nausea, vaginal bleeding, and heavy cramping. The bleeding is typically heavier than a normal period and may last up to 16 days.

Mifepristone is not recommended for women with ectopic pregnancy or an intrauterine device (IUD), or those who have been taking long-term steroidal therapy, have bleeding abnormalities, or on blood-thinners such as Coumadin.

In 2005, 57% of abortion providers performed one or more medication induced abortions (a 70% increase from medication induced abortions during the first half of 2001). In 2005, 13% of all abortions were attributable to medication induced abortions and the incidence of medication induced abortions performed outside a traditional hospital setting was estimated to total about 161,100.

### *Surgical abortions*

**MANUAL VACUUM ASPIRATION.** Up to 10 weeks gestation, a pregnancy can be ended by a procedure called manual vacuum aspiration (MVA). This procedure is also called menstrual extraction, mini-suction, or early abortion. The contents of the uterus are suctioned out through a thin plastic tube that is inserted through the cervix; suction is applied by a syringe. The procedure generally lasts about 15 minutes.

A 1998 study of women undergoing MVA indicated that the procedure was 99.5% effective in terminating pregnancy and was associated with a very low risk of complications (less than 1%). Menstrual extractions are safe, but because the amount of fetal material is so small at this stage of development, it is easy to miss. This results in an incomplete abortion that means the pregnancy continues.

**DILATATION AND SUCTION CURETTAGE.** Dilation and suction curettage may also be called D & C, suction dilation, vacuum curettage, or suction curettage. The procedure involves gentle stretching of the cervix with a series of dilators or specific medications. The contents of the uterus are then removed with a tube attached to a suction machine, and walls of the uterus are cleaned using a narrow loop called a curette.

Advantages of an abortion of this type are:

- it is usually done as a one-day outpatient procedure;
- the procedure takes only 10–15 minutes;
- bleeding after the abortion lasts five days or less; and
- the woman does not see the contents of her womb being removed.

Disadvantages include:

- the procedure is invasive, so surgical instruments are used; and
- infection may occur.

The procedure is 97–99% effective. The amount of discomfort a woman feels varies considerably. **Local anesthesia** is often given to numb the cervix, but it does not mask uterine cramping. After a few hours of rest, the woman may return home.

**DILATATION AND EVACUATION.** Some second trimester abortions are performed as a dilatation and evacuation (D & E). The procedures are similar to those used in a D & C, but a larger suction tube must be used because more material must be removed. This increases the amount of cervical dilation necessary and increases the risk and discomfort of the procedure. A combination of suction and manual extraction using medical instruments is used to remove the contents of the uterus.

**OTHER SURGICAL OPTIONS.** Other surgical procedures are available for performing second trimester abortions, although are rarely used. These include:

- Dilatation and extraction (D & X)—the cervix is prepared by means similar to those used in a dilatation and evacuation; however, the fetus is removed mostly intact although the head must be collapsed to fit through the cervix. This procedure is sometimes called a partial-birth abortion. D & X accounted for only 0.17% of all abortions in 2000.
- Induction—in this procedure, an abortion occurs by means of inducing labor. Prior to induction, the patient may have rods inserted into her cervix to help dilate it or receive medications to soften the cervix and speed up labor. On the day of the abortion, drugs (usually prostaglandin or a salt solution) are injected into the uterus to induce contractions. The fetus is delivered within eight to 72 hours. Side effects of this procedure include nausea, vomiting, and diarrhea from the prostaglandin, and pain from uterine contractions. Anesthesia of the sort used in childbirth can be given to reduce pain. Many women are able to go home a few hours after the procedure.
- Hysterotomy—a surgical incision is made into the uterus and the contents of the uterus removed through the incision. This procedure is generally used if induction methods fail to deliver the fetus.

### Diagnosis/Preparation

The doctor must know accurately the stage of a woman's pregnancy before an abortion is performed. The doctor will ask the woman questions about her menstrual cycle and also do a **physical examination** to confirm the stage of pregnancy. This may be done at an office visit before the abortion or on the day of the abortion.

Pre-abortion counseling is important in helping a woman resolve any questions she may have about having the procedure. Some states require a waiting period (most often of 24 hours) following counseling before the abortion may be obtained. Most states require parental consent or notification if the patient is under the age of 18.

### Aftercare

Regardless of the method used to perform the abortion, a woman will be observed for a period of time to make sure her blood pressure is stable and that bleeding is controlled. The doctor may prescribe **antibiotics** to reduce the chance of infection. Women who are Rh negative (lacking genetically determined antigens in their red blood cells that produce immune responses) should be given an injection of human Rh immune globulin (RhoGAM) after the procedure unless the father of the fetus is also Rh negative. This prevents blood incompatibility complications in future pregnancies.

Bleeding will continue for about five days in a surgical abortion and longer in a medical abortion. To decrease the risk of infection, a woman should avoid intercourse, tampons, and douches for two weeks after the abortion.

A follow-up visit is a necessary part of the woman's aftercare. Contraception will be offered to women who wish to avoid future pregnancies, because menstrual periods normally resume within a few weeks.

### Risks

Complications from abortions can include:

- uncontrolled bleeding;
- infection;
- blood clots accumulating in the uterus;
- a tear in the cervix or uterus;
- missed abortion (the pregnancy is not terminated); and
- incomplete abortion where some material from the pregnancy remains in the uterus.

Women who experience any of the following symptoms of post-abortion complications should call the clinic or doctor who performed the abortion immediately:

- severe pain;
- fever over 100.4°F (38.2°C);
- heavy bleeding that soaks through more than one sanitary pad per hour;
- foul-smelling discharge from the vagina; and
- continuing symptoms of pregnancy.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

An induced abortion must be done under the supervision of a physician. Under normal circumstances, the abortion is performed by a licensed obstetrician or gynecologist. In some states, advanced clinicians such as nurse practitioners, certified nurse midwives, or physician assistants can perform an abortion under the direct supervision of a physician.

Most women are able to have abortions at clinics or outpatient facilities if the procedure is performed early in pregnancy and the woman is in relatively good health. Women with heart disease, previous endocarditis, asthma, lupus erythematosus, uterine fibroid tumors, blood clotting disorders, poorly controlled epilepsy, or some psychological disorders usually need to be hospitalized in order to receive special monitoring and medications during the procedure. In 2000, over 93% of abortions were performed in a clinic setting; clinics accounted for nearly half (46%) of all abortion providers. Hospitals were the site of 5% of abortions (accounting for 33% of abortion providers), while only 3% of abortions were performed at physician offices (21% of abortion providers).

### Normal results

Usually the pregnancy is ended without complication and without altering future fertility.

### Morbidity and mortality rates

Serious complications resulting from abortions performed before 13 weeks are rare. Of the 90% of women who have abortions in this time period, 2.5% have minor complications that can be handled without hospitalization. Less than 0.5% have complications that require a hospital stay. The rate of complications increases as the pregnancy progresses.

Only one maternal **death** occurs per 530,000 abortions performed at eight weeks gestation or less; this increases to one death per 17,000 abortions performed from 16 to 20 weeks, and one death per 6,000 abortions performed over 20 weeks.

### Alternatives

Adoption is an option for pregnant women who do not want to raise a child but are unwilling or unable

## QUESTIONS TO ASK THE DOCTOR

- What abortion options are available to me based on my stage of pregnancy?
- What are the short- and long-term complications of the procedure?
- What type of pain relief/anesthesia is available to me?
- Who can be in the procedure room with me?
- What will the abortion cost? What do the fees include?
- Is pre-abortion counseling offered?
- How is follow-up or emergency care provided?
- Does the doctor who will perform the abortion have admitting privileges at a hospital in case of a problem?

to have an abortion. Adoption agencies, crisis pregnancy centers, family service agencies, family planning clinics, or state social service agencies are available for women to contact for more information about the adoption process.

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- Alan Guttmacher Institute, 1301 Connecticut Ave., NW, Suite 700, Washington, DC, 20036, (202) 296 4012, <http://www.guttmacher.org>.
- Centers for Disease Control and Prevention, Division of Reproductive Health, 4770 Buford Highway, NE, Mail Stop K 20, Atlanta, GA, 30341 3717, (770) 488 5200, <http://www.cdc.gov/reproductivehealth/>.
- National Abortion Federation, 1660 L Street, NW, Suite 450, Washington, DC, 20036, (202) 667 5881, <http://www.prochoice.org>.
- Planned Parenthood Federation of America, 434 West 33rd St., New York, NY, 10001, (212) 541 7800, <http://www.plannedparenthood.org>.

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## Abscess incision and drainage

### Definition

An abscess is an infected skin nodule containing pus. It may need to be drained via an incision (cut) if the pus does not resolve with treatment by **antibiotics**. This allows the pus to escape, the infection to be treated, and the abscess to heal.

### Purpose

An abscess is a pus-filled sore, usually caused by a bacterial infection. The pus is comprised of both living and dead organisms. It also contains destroyed tissue due to the action of white blood cells that were carried to the area to fight the infection. Abscesses are often found in the soft tissue under the skin such as the armpit or the groin. However, they may develop in any organ, and are commonly found in the breast and gums. Abscesses are far more serious and call for more specific treatment if they are located in deep organs such as the lung, liver, or brain.

## KEY TERMS

**White blood cells**—Cells that protect the body against infection.

Because the lining of an abscess cavity tends to interfere with the amount of drug that can penetrate the source of infection from the blood, the cavity itself may require draining. Once an abscess has fully formed, it often does not respond to antibiotics. Even if the antibiotic does penetrate into the abscess, it does not function as well in that environment.

### Demographics

Abscess drainage is a minor and common surgical procedure that is often performed in a professional medical office. Accurate records concerning the number of procedures are kept in private medical office rather than hospital records. For these reasons, it is impossible to accurately tally the number of abscess incision and drainage procedures performed in a year. The procedure increases in frequency with increasing age.

### Description

A doctor will cut into the lining of an abscess, allowing the pus to escape either through a drainage tube or by leaving the cavity open to the skin. The size of the incision depends on the volume of the abscess and how quickly the pus is encountered.

Cells normally formed for the surface of the skin often migrate into an abscess. They line the abscess cavity. This process is called epithelialization. This lining prevents drugs from reaching an abscess. It also promotes recurrence of the abscess. The lining must be removed when an abscess is drained to prevent recurrence.

Once an abscess is opened, the pus drained, and the epithelial lining removed, the doctor will clean and irrigate the wound thoroughly with saline. If it is not too large or deep, the doctor may simply pack the abscess wound with gauze for 24–48 hours to absorb the pus and discharge.

If it is a deeper abscess, the doctor or surgeon may insert a drainage tube after cleaning out the wound. Once the tube is in place, the surgeon closes the incision with simple **stitches** and applies a sterile dressing. Drainage is maintained for several days to

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Abscesses are most commonly incised and drained by general surgeons. Occasionally, a family physician or dermatologist may drain a superficial abscess. These procedures may be performed in a professional office or in an outpatient facility. The skin and surrounding area may be numbed by a topical anesthetic.

Brain abscesses are usually drained by neurosurgeons. Thoracic surgeons drain abscesses in the lung. Otolaryngologists drain abscesses in the neck. These procedures are performed in a hospital operating room. General anesthesia is used.

help prevent the abscess from reforming. The tube is removed, and the abscess allowed to finish closing and healing.

### Diagnosis/Preparation

An abscess can usually be diagnosed visually, although an imaging technique such as a computed tomography (CT) scan or **ultrasound** may be used to confirm the extent of the abscess before drainage. Such procedures may also be needed to localize internal abscesses such as those in the abdominal cavity or brain.

Prior to incision, the skin over an abscess will be cleansed by swabbing gently with an antiseptic solution.

### Aftercare

Much of the pain around an abscess will be gone after the surgery. Healing is usually very rapid. After the drainage tube is removed, antibiotics may be continued for several days. Applying heat and keeping the affected area elevated may help relieve inflammation.

### Risks

Any scarring is likely to become much less noticeable as time goes on, and eventually become almost invisible. Occasionally, an abscess within a vital organ (such as the brain) damages enough surrounding tissue that there is some permanent loss of normal function.

Other risks include incomplete drainage and prolonged infection. Occasionally, an abscess may require

## QUESTIONS TO ASK THE DOCTOR

- How many abscess incision and drainage procedures has the physician performed?
- What is the physician's complication rate?

a second incision and drainage procedure. This is frequently due to retained epithelial cells that line the abscess cavity.

### Normal results

Most abscesses heal after drainage alone. Others may require more prolonged drainage and antibiotic drug treatment.

### Morbidity and mortality rates

Morbidity associated with an abscess incision and drainage is very uncommon. Post-surgical problems are usually associated with infection or an adverse reaction to antibiotic drugs prescribed. Mortality is virtually unknown.

### Alternatives

There is no reliable alternative to surgical incision and drainage of an abscess. Heat alone may cause small superficial abscesses to resolve. The degree of epithelialization usually determines if the abscess reappears.

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American College of Surgeons. 633 North St. Clair Street, Chicago, IL 60611 32311. (312) 202 5000; Fax: (312) 202 5001. Web site: <http://www.facs.org>. E mail: [postmaster@facs.org](mailto:postmaster@facs.org).

American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464 5000. <http://www.ama-assn.org>.

American Osteopathic College of Otolaryngology Head and Neck Surgery. 405 W. Grand Avenue, Dayton, OH 45405. (937) 222 8820 or (800) 455 9404; Fax (937) 222 8840. Email: [info@aocohns.org](mailto:info@aocohns.org).

American Society of Colon and Rectal Surgeons. 85 W. Algonquin Rd., Suite 550, Arlington Heights, IL 60005. (847) 290 9184; Fax: (847) 290 9203. <http://www.fascrs.org>. Email: [ascrs@fascrs.org](mailto:ascrs@fascrs.org).

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L. Fleming Fallon, Jr, MD, DrPH

# Acetaminophen

## Definition

Acetaminophen is a medicine used to relieve pain and reduce fever.

## Purpose

Acetaminophen is used to relieve many kinds of minor aches and pains, including headaches, muscle aches, backaches, toothaches, menstrual cramps, arthritis, and the aches and pains that often accompany colds. It is suitable for control of pain following minor surgery, or for **post-surgical pain** after the need for stronger pain relievers has been reduced. Acetaminophen is also used in combination with narcotic **analgesics** both to increase pain relief and reduce the risk that the narcotics will be abused.

## Description

This drug is available without a prescription. Acetaminophen (APAP) is sold under various brand names, including Tylenol, Panadol, Aspirin-Free Anacin, and Bayer Select Maximum Strength Headache Pain Relief Formula. Many multi-symptom cold, flu, and sinus medicines also contain acetaminophen. Persons are advised to check the ingredients listed on the container to see if acetaminophen is included in the product.

Acetaminophen is also included in some prescription-only combinations. These usually contain a narcotic in addition to acetaminophen; it is combined with oxycodone in Percocet, and is included in Tylenol with Codeine.

Studies have shown that acetaminophen relieves pain and reduces fever about as well as **aspirin**. But differences between these two common drugs exist. Acetaminophen is less likely than aspirin to irritate the stomach. However, unlike aspirin, acetaminophen does not reduce the redness, stiffness, or swelling that accompany arthritis.

## Recommended dosage

The usual dosage for adults and children age 12 and over is 325–650 mg every four to six hours as needed. No more than 4 g (4,000 mg) should be taken in 24 hours. Because the drug can potentially harm the liver, people who drink alcohol in large quantities should take considerably less acetaminophen and possibly should avoid the drug completely.

For children ages six to 11 years, the usual dose is 150–300 mg, three to four times a day. People are advised to check with a physician for dosages for children under six years of age.

## Precautions

A person should never take more than the recommended dosage of acetaminophen unless told to do so by a physician or dentist.

## KEY TERMS

**Arthritis**—Inflammation of the joints; the condition causes pain and swelling.

**Fatigue**—Physical or mental weariness.

**Inflammation**—A response to irritation, infection, or injury, resulting in pain, redness, and swelling.

Because acetaminophen is included in both prescription and non-prescription combinations, it is important to check the total amount of acetaminophen taken each day from all sources in order to avoid taking more than the recommended maximum dose.

Patients should not use acetaminophen for more than 10 days to relieve pain (five days for children) or for more than three days to reduce fever, unless directed to do so by a physician. If symptoms do not go away, or if they get worse, the patient should contact a physician. Anyone who drinks three or more alcoholic beverages a day should check with a physician before using this drug and should never take more than the recommended dosage. People who already have kidney or liver disease or liver infections should also consult with a physician before using the drug. Women who are pregnant or breastfeeding should also consult with a physician before using acetaminophen.

Smoking cigarettes may interfere with the effectiveness of acetaminophen. Smokers may need to take higher doses of the medicine, but should not take more than the recommended daily dosage unless told to do so by a physician.

Many drugs can interact with one another. People should consult a physician or pharmacist before combining acetaminophen with any other medicine, and they should not use two different acetaminophen-containing products at the same time, unless instructed by a physician or dentist.

Some products, such as Nyquil, contain acetaminophen in combination with alcohol. While these products are safe for people who do not drink alcoholic beverages, people who consume alcoholic drinks regularly, even in moderation, should use extra care before using acetaminophen-alcohol combinations.

Acetaminophen interferes with the results of some medical tests. Before having medical tests done, a person should check to see whether taking acetaminophen

would affect the results. Avoiding the drug for a few days before the tests may be necessary.

## Side effects

Acetaminophen causes few side effects. The most common one is lightheadedness. Some people may experience trembling and pain in the side or the lower back. Allergic reactions do occur in some people, but they are rare. Anyone who develops symptoms such as rash, swelling, or difficulty breathing after taking acetaminophen should stop taking the drug and get immediate medical attention. Other rare side effects include yellow skin or eyes, unusual bleeding or bruising, weakness, fatigue, bloody or black stools, bloody or cloudy urine, and a sudden decrease in the amount of urine.

Overdoses of acetaminophen may cause nausea, vomiting, sweating, and exhaustion. Very large overdoses can cause liver damage. In case of an overdose, a person is advised to get immediate medical attention.

## Interactions

Acetaminophen may interact with a variety of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Among the drugs that may interact with acetaminophen are alcohol, **nonsteroidal anti-inflammatory drugs** (NSAIDs) such as Motrin, oral contraceptives, the anti-seizure drug phenytoin (Dilantin), the blood-thinning drug warfarin (Coumadin), the cholesterol-lowering drug cholestyramine (Questran), the antibiotic Isoniazid, and zidovudine (Retrovir, AZT). People should check with a physician or pharmacist before combining acetaminophen with any other prescription or nonprescription (over-the-counter) medicine.

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Acid reducers see **Gastric acid inhibitors**

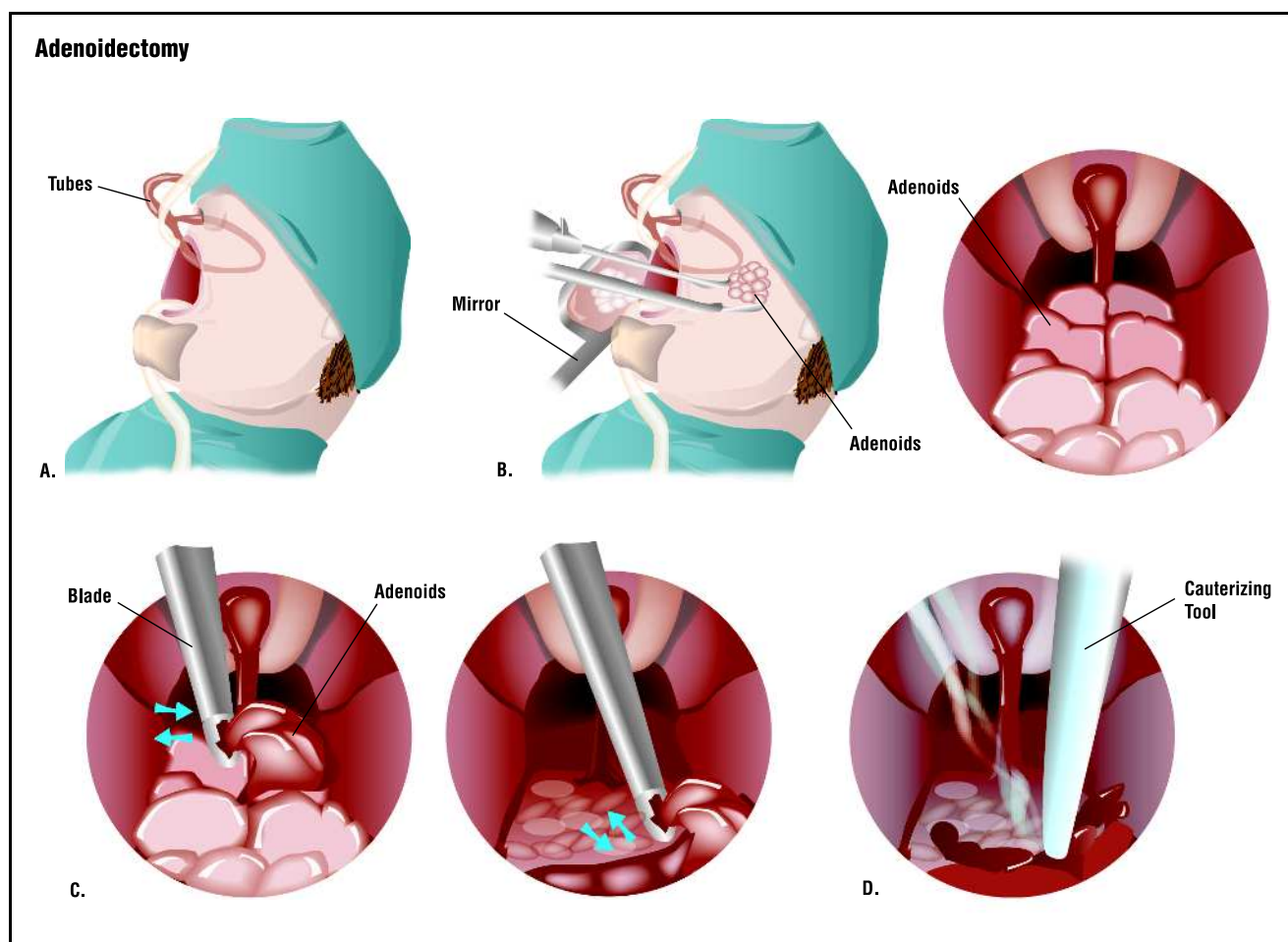
## Adenoidectomy

### Definition

An adenoidectomy is the surgical removal of the adenoids—small lumps of tissue that lie in the back of the throat behind the nose.

### Purpose

The adenoids are removed if they block breathing through the nose and if they cause chronic earaches or deafness. The adenoids consist of lymphoid tissue—white blood cells from the immune system. They are located near the tonsils, two other lumps of similar lymphoid tissue. In childhood, adenoids and tonsils are believed to play a role in fighting infections by producing antibodies that attack bacteria entering the body through the mouth and nose. In adulthood however, it is unlikely that the adenoids are involved in maintaining health, and they normally shrink and disappear. Between the ages of two and six, the adenoids can become chronically infected, swelling up and becoming inflamed. This can cause breathing difficulties, especially during sleep. The swelling can also block the eustachian tubes that connect the back



Patient's mouth is held open with tubes (A). A mirror is used to visualize the adenoids during the procedure (B). The adenoids are removed with a side-to-side or front-to-back motion (C). Bleeding is controlled with a cauterizing tool (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

of the throat to the ears, leading to hearing problems until the blockage is relieved. The purpose of an adenoidectomy is thus to remove infected adenoids. Since they are often associated with infected tonsils, they are often removed as part of a combined operation that also removes the tonsils, called a T&A (**tonsillectomy** and adenoidectomy).

## Demographics

Demographics information is difficult to provide because adenoidectomy is routinely performed in an outpatient setting, for which demographic data are not well recorded. Good information is available from the 1970s and 1980s when the surgery was performed in an inpatient setting. In the United States in 1971, more than one million combined T&As, tonsillectomies alone, or adenoidectomies alone were performed, with 50,000 of these procedures consisting of adenoidectomy alone. In 1987, 250,000 combined or single procedures were performed, with 15,000 consisting of adenoidectomy alone. Now, almost all adenoidectomies are performed on an outpatient basis unless other medical problems require hospital admission or an overnight stay. T&A is considered the most common major surgical procedure in the United States.

## Description

An adenoidectomy is performed under **general anesthesia**. The surgeon removes the adenoids from behind the palate. **Stitches** are usually not required.

### *Excision through the mouth*

The adenoids are most commonly removed through the mouth after placing an instrument to open the mouth and retract the palate. A mirror is used to see the adenoids behind the nasal cavity. Several instruments can then be used to remove the adenoids.

- **Curette removal.** The most common method of removal is using the adenoid curette, an instrument that has a sharp edge in a perpendicular position to its long handle. Various sizes of curettes are available.
- **Adenoid punch instrument.** An adenoid punch is a curved instrument with a chamber that is placed over the adenoids. The chamber has a knife blade sliding-door to section off the adenoids that are then housed in the chamber and removed with the instrument.

## KEY TERMS

**Adenoids**—Small lumps of lymphoid tissue near the tonsils on the walls of the upper throat behind the nose.

**Anesthesia**—A combination of drugs administered by a variety of techniques by trained professionals that provide sedation, amnesia, analgesia, and immobility adequate for the accomplishment of the surgical procedure with minimal discomfort, and without injury, to the patient.

**Antibodies**—Proteins that are produced normally by specialized white blood cells after stimulation by a foreign substance (antigen) and that act specifically against the antigen in an immune response.

**Electrocautery**—The cauterization of tissue using electric current to generate heat.

**Immune system**—Mechanism that protects the body from foreign substances, cells and pathogens by producing the immune response, a concerted defense involving the thymus, spleen, lymph nodes, white blood cells including the B cells and T cells, and antibodies.

**Lymphoid tissue**—Tissue that contains white blood cells of the immune system.

**Tonsillectomy**—Surgical removal of the tonsils.

**Tonsils**—Two lumps of lymphoid tissue located on either side of the back of the throat.

- **Magill forceps.** A Magill forceps is a curved instrument used to remove residual adenoid, usually located deeper in the posterior nasal cavity, after attempted removal with curettes or adenoid punches.
- **Electrocautery with a suction Bovie.** The adenoids can also be removed by electrocautery with a suction Bovie, an instrument with a hollow center to suction blood and a rim of metal to achieve coagulation.
- **Laser.** The Nd:YAG laser has also been used to remove the adenoids. However, this technique has caused scarring of tissue and is usually avoided.

### *Excision through the nose*

Adenoids may also be removed through the nasal cavity with a surgical suction instrument called a microdebrider. With this procedure, bleeding is controlled either with packing or suction cautery.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

An adenoidectomy is performed by an ENT (ear, nose, and throat) board-certified surgeon.

### Diagnosis/Preparation

The primary methods used to determine whether adenoids need removal are:

- medical history
- physical examination
- throat bacterial cultures
- x rays
- blood tests

When the patient arrives at the hospital or the day-surgery unit, a nurse or a doctor will ask questions concerning the patient's general health to make sure he or she is fit to undergo surgery. They will also check that the patient has not had anything to eat or drink and will record pulse and blood pressure. The doctor or nurse must be informed if the patient has had any allergic or unusual reactions to drugs in the past. The patient will be asked to put on a hospital gown and to remove any loose orthodontic braces, false teeth, and jewelry. In the past, an adenoidectomy usually called for an overnight stay in hospital. However, it is increasingly more common to have this operation on an outpatient basis, meaning that the patient goes home on the same day. The surgery is usually performed early in the morning to allow a sufficient observation period after the operation.

### Aftercare

After surgery, the patient wakes up in the recovery area and is given medication to reduce swelling and pain. When the patient has recovered from surgery, he or she is sent home and usually given a week's course of **antibiotics** to be taken by mouth. The patient may also develop a sore throat, especially when swallowing or speaking, or moderate pain at the back of the nose and throat, for which pain medication is prescribed. Normally, the pain goes away after a week. A child who has undergone an adenoidectomy should rest at home for at least one week to avoid possible infections at school. Swimming should not be allowed for at least 10 days after the operation. If there is any sign of bleeding or infection (fever, increased pain), the treating physician should be immediately contacted.

## QUESTIONS TO ASK THE DOCTOR

- What are the possible complications involved in this type of surgery?
- Should the tonsils be removed as well?
- Could my child outgrow the problem?
- How are adenoids removed in your clinic/hospital?
- Is there a special diet to be followed after the operation?
- How much adenoidectomies do you perform each year?

### Risks

Risks and complications include those generally associated with surgery and anesthesia. Very few complications are known to occur after this operation, except, very rarely, bleeding (which occurs in 0.4% of cases). Bleeding is more a concern with a very young child because he or she often will not notice. For this reason, a child is always kept in observation at the hospital or clinic for a few hours after the operation. If bleeding does occur, the surgeon may insert a pack of gauze into the nose to stop the blood flow for subsequent removal after a day or two. The other possible complications are those associated with any operation, including infection of the operated area, which may result in light bleeding, increased pain, and fever. Infection is usually treated with antibiotics and bed rest.

### Normal results

Adenoidectomy is an operation that has very good outcomes, and patients are expected to make a full and quick recovery once the initial pain has subsided. Adenoid tissue rarely regrows, but some instances have been reported. The exact mechanism is unknown but may be related to incomplete removal.

### Alternatives

There is no good evidence supporting any curative non-surgical therapy for chronic infection of the adenoid. Antibiotics have been used for as long as six weeks in lymphoid tissue infection, but with failure to eradicate the bacteria. With reported incidences of drug-resistant bacteria, use of long-term antibiotics is not a recommended alternative to surgical removal of infected adenoids.

Some studies indicate some benefit from using topical nasal steroids. Studies show that while using the medication, the adenoids may shrink up to 10% and help relieve nasal blockage. However, once the steroid medication is stopped, the adenoids can again enlarge and continue to cause symptoms. In a child with nasal obstructive symptoms, a trial of topical nasal steroid spray and saline spray may be attempted for controlling symptoms.

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## Admission to the hospital

### Definition

Hospital admission involves staying at a hospital for at least one night or more.

### Purpose

Staying in the hospital overnight is done because the individual is too sick to stay at home, requires 24-hour nursing care, and/or is receiving medications and undergoing tests and/or surgery that can be performed only in a hospital setting.

### Description

An individual may be admitted to the hospital for a positive experience, such as having a baby, or because of undergoing an **elective surgery** or procedure, or because of being admitted through the emergency department. Being admitted through the emergency department is the most stressful of these circumstances because the event is unexpected and may be a major life crisis.

Before the person is taken to a patient room, admitting procedures are performed. The person's personal data is recorded and entered into the hospital's computer database. This data may include:

- name
- address
- home and work telephone numbers
- date of birth
- place of employment
- occupation
- emergency contact information, or the names and telephone numbers of those individuals the hospital should contact if the person being admitted needs emergency care or his or her condition worsens significantly
- insurance coverage



- reason for hospitalization
- allergies to medications or foods
- religious preference, including whether the patient wishes a visit from a clergy member

There may be several forms to fill out. One form may be a detailed medical and medication history. This history will include past hospitalizations and surgeries. Having this information readily available will help the admission process move faster and can allow a family member or friend who is accompanying the person to help fill out the forms more easily. The hospital may ask if there are any advance directives. This refers to forms that have been filled out indicating what medical decisions the patient wants others to make on his or her behalf. One form is called a **living will** and clearly tells which specific resuscitation efforts the person does or does not want to have performed in order to save or extend his or her life. Another form may be a durable **power of attorney**. This is a form stating whom the patient wishes to make medical decisions for him or her if the patient becomes unable to do so, such as if the patient falls into a coma. Some hospitals have blank forms that the individual can use to make these designations; others may just ask if the forms have been filled out, and, if so, to add copies of them into the person's medical record. These forms are considered legally binding, and an attorney can assist in filling them out. During the time spent in the admitting department, a plastic bracelet will be placed on the person's wrist that details name, age, date of birth, room number, and medical record number. A separate bracelet is added that lists allergies. Forms are completed and signed, so that the patient is giving full consent to have the hospital personnel take care of him or her while in the hospital during that particular hospital stay. Subsequent hospital stays require new consent forms.

Once all the admitting forms have been completed, the person is taken to a patient room. Most people stay in a semi-private room, which means that there are two people in the room. In some circumstances, a person's medical condition may require staying in a private room. If there are private rooms available, and the individual is willing to pay the extra cost (insurance companies generally only cover the cost of a semi-private room), it may be possible to have a private room. Once the patient is taken to a room, the nurse will go over the medical and medication history, and orient the patient to the room by explaining how to adjust bed height, how to use the nurse call button, where the bathroom is located, and

## KEY TERMS

**Elective surgery**—Surgery that is planned and anticipated. For example, a person may have a medical condition that requires surgery to fix an ongoing problem. The person's condition may have developed over weeks or months, and the person and his or her doctor decide that the time is right to take care of the condition. The surgery is scheduled, and the person knows that he or she will be spending some time in the hospital.

how to use the bedside telephone and television. The cost for the telephone and television are not usually covered by insurance. There may be limitations on using the bathroom, for example, if the patient's doctor feels that the patient should not get out of bed. These decisions are made with the patient's safety and medical condition in mind. Another safety practice is raising the side rails of the bed to prevent the patient from falling out of bed. The nurse will review the doctor's orders, such as what tests have been scheduled, whether the patient can get out of bed to use the bathroom or to walk around the unit, what medications the patient will be getting, and whether there are food restrictions. The hospital will supply towels, sheets, and blankets, but some people like to bring something personal with them from home. If a person does choose to bring in a personal item, the item should be washed with warm or hot water and soap upon returning home to ensure that germs are not brought home from the hospital.

Sometimes a person needs extremely close observation that can only be provided with specialized care in an **intensive care unit (ICU)**. Because of the patient's medical condition, visiting hours are more restricted than in the regular rooms. It may be that only one or two people can visit at a time, and only for a few minutes at a time. Once the person's condition improves, he or she may then be transferred to a room with a less rigid visitation policy. If an individual has a surgical procedure performed, he or she will spend a few hours in a recovery area. This is to make sure that the person's condition is stable before returning to the regular room. Visiting is limited in the recovery area, and the person may spend most of the time sleeping, as the effects of the surgical anesthesia wear off.

If the person entering the hospital is a child, the parents or guardian will fill out the hospital forms.

Most hospitals allow parents and guardians to stay overnight in the hospital with the child, and to be with him or her 24 hours a day. Many hospitals have special areas for children to play in.

### Preparation

If the hospitalization is prearranged, there are preparations that will make the process go more smoothly. For example, a list of all medications currently being taken, the dosages, how often they are taken, and why they are taken is helpful. The list should also include any allergies to food and medications, including a description of the reaction, and when the food or medication was last taken. The list should include over-the-counter (OTC) and prescription medications, vitamins, supplements, and herbal and home remedies.

If the hospital stay involves surgery in which there is the potential for significant blood loss, it may be possible to arrange to have blood drawn and stored so that, in the event of a **transfusion**, the individual receives his or her own blood.

If the hospital stay is an extended one, a list of family and friends, with their telephone numbers, can make it easier to stay in touch with people who can come and visit, or offer support by telephone. It is not a good idea to bring anything of value to the hospital as there are many times when the patient could be out of the room. However, it may be helpful to have some pocket change available to make some small purchases at the hospital gift shop, such as a newspaper.

A small bag can be brought into the hospital that contains:

- night clothes (the hospital supplies gowns, but some people like to wear familiar clothing)
- a robe
- slippers
- clothes for the return trip home
- reading material
- hobby materials, such as knitting or a book of crossword puzzles
- reading glasses
- personal care items such as comb, brush, and toothbrush (most hospitals supply these items, but many individuals prefer to have their own from home)

It is best not to bring in any medication from home unless it has been prearranged with the physician and hospital staff prior to hospitalization. This is to prevent an error from occurring by having the

person taking one dose from his or her own medicine and then being given another dose from the hospital pharmacy.

### Resources

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Fran Hodgkins

Adrenal gland removal *see* **Adrenalectomy**

## Adrenalectomy

### Definition

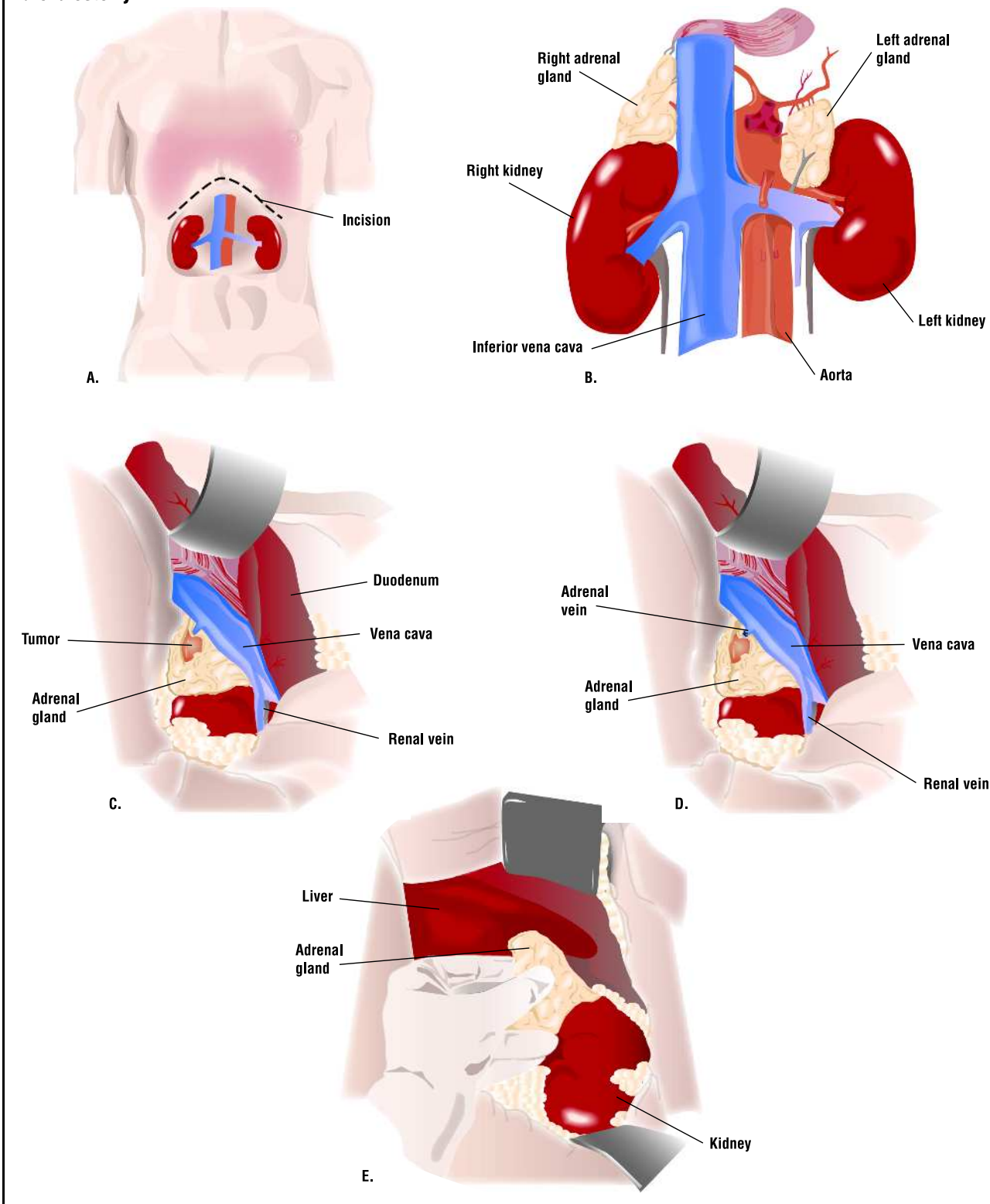
Adrenalectomy is the surgical removal of one or both adrenal glands. The adrenal glands are paired endocrine glands—one located above each kidney—that produce hormones such as epinephrine, norepinephrine, androgens, estrogens, aldosterone, and cortisol. Adrenalectomy is usually performed by conventional (open) surgery; however, in selected patients, surgeons may use **laparoscopy**. With laparoscopy, adrenalectomy can be accomplished through four very small incisions.

### Purpose

Adrenalectomy is usually advised for patients with tumors of the adrenal glands. Adrenal gland tumors may be malignant or benign, but all typically excrete excessive amounts of one or more hormones. When malignant, they are usually neuroblastoma cancers. A successful procedure will aid in correcting hormone imbalances, and may also remove cancerous tumors before they invade other parts of the body. Occasionally, adrenalectomy may be recommended when hormones produced by the adrenal glands aggravate another condition such as breast cancer.

### Demographics

Neuroblastoma is one of the few cancer types known to secrete hormones. It occurs most often in

**Adrenalectomy**

To remove the adrenal glands, an incision is made below the patient's ribcage (A). The adrenal gland, which sits on top of the kidney (B), is visualized (C). The vein emerging from the gland is tied off and cut (D), and the adrenal is removed (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

children, and it is the third most common cancer that occurs in children. In the United States, approximately 7.5% of the childhood cancers diagnosed in 2001 were neuroblastomas, affecting one in 80,000 to 100,000 children. Close to 50% of cases of neuroblastoma occur in children younger than two years old. The disease is sometimes present at birth, but is usually not noticed until later. Approximately one-third of neuroblastomas start in the adrenal glands. According to some reports, African-American children develop the disease at a slightly higher rate than Caucasian children (8.7 per million compared to 8.0 per million cases diagnosed).

## Description

### *Open adrenalectomy*

The surgeon may operate from any of four directions, depending on the exact problem and the patient's body type.

In the anterior approach, the surgeon cuts into the abdominal wall. Usually the incision will be horizontal, just under the rib cage. If the surgeon intends to operate on only one of the adrenal glands, the incision will run under just the right or the left side of the rib cage. Sometimes a vertical incision in the middle of the abdomen provides a better approach, especially if both adrenal glands are involved.

In the posterior approach, the surgeon cuts into the back, just beneath the rib cage. If both glands are to be removed, an incision is made on each side of the body. This approach is the most direct route to the adrenal glands, but it does not provide quite as clear a view of the surrounding structures as the anterior approach.

In the flank approach, the surgeon cuts into the patient's side. This is particularly useful in massively obese patients. If both glands need to be removed, the surgeon must remove one gland, repair the surgical wound, turn the patient onto the other side, and repeat the entire process.

The last approach involves an incision into the chest cavity, either with or without part of the incision into the abdominal cavity. It is used when the surgeon anticipates a very large tumor, or if the surgeon needs to examine or remove nearby structures as well.

### *Laparoscopic adrenalectomy*

This technique does not require the surgeon to open the body cavity. Instead, four small incisions (about 0.5

## KEY TERMS

**Hyperaldosteronism**—A disorder of excessive aldosterone secretion.

**Laparoscope**—An instrument that enables the surgeon to see inside the abdominal cavity by means of a thin tube that carries an image to a television monitor.

**Pancreas**—An organ that secretes a number of digestive hormones and also secretes insulin to regulate blood sugar.

**Pheochromocytoma**—A tumor of specialized cells of the adrenal gland.

**Spleen**—An organ that traps and breaks down red blood cells at the end of their useful life and manufactures some key substances used by the immune system.

**Vena cava**—The large vein that drains directly into the heart after gathering incoming blood from the entire body.

in [1.27 cm] diameter each) are made into a patient's flank, just under the rib cage. A laparoscope enabling the surgeon to visualize the inside of the abdominal cavity on a television monitor is placed through one of the incisions. The other incisions are for tubes that carry miniaturized versions of surgical tools. These tools are designed to be operated by manipulations that the surgeon makes outside the body.

## Diagnosis/Preparation

Most aspects of preparation are the same as in other major operations. In addition, hormone imbalances are often a major challenge. Whenever possible, physicians will try to correct hormone imbalances through medication in the days or weeks before surgery. Adrenal tumors may cause other problems such as hypertension or inadequate potassium in the blood, and these problems also should be resolved if possible before surgery is performed. Therefore, a patient may take specific medicines for days or weeks before surgery.

Most adrenal tumors can be imaged very well with a **CT scan** or **MRI**, and benign tumors tend to look different on these tests than do cancerous tumors. Surgeons may order a CT scan, MRI, or scintigraphy (viewing of the location of a tiny amount



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Adrenalectomies are performed by general or endocrine surgeons. Surgeons work closely with their medical colleagues (endocrinologists) who are often the doctors who are responsible for both the initial diagnosis and investigation of endocrine disorders. Endocrinologists may also be involved in long-term follow-up care after the adrenalectomy. Endocrine surgeons also work with nuclear medicine physicians, radiologists, pathologists, geneticists, and anesthesiologists to provide the best possible patient care.

of radioactive agent) to help locate exactly where the tumor is located.

The day before surgery, patients will probably have an enema to clear the bowels. In patients with lung problems or clotting problems, physicians may advise special preparations.

### Aftercare

Patients stay in the hospital for various lengths of time after adrenalectomy. The longest hospital stays are required for open surgery using an anterior approach; hospital stays of about three days are indicated for open surgery using the posterior approach or for laparoscopic adrenalectomy.

The special concern after adrenalectomy is the patient's hormone balance. There may be several sets of required lab tests to define hormone problems and monitor the results of drug treatment. In addition, blood pressure problems and infections are more common after removal of certain types of adrenal tumors.

As with most open surgery, surgeons are also concerned about blood clots forming in the legs and traveling to the lungs (venous thromboembolism), bowel problems, and postoperative pain. With laparoscopic adrenalectomy, these problems are somewhat less prevalent, but they are still present.

### Risks

The risks of adrenalectomy include major hormone imbalances, caused by the underlying disease, the surgery, or both. These can include problems with

## QUESTIONS TO ASK THE DOCTOR

- What procedure do you intend to use for my adrenalectomy?
- What do I need to know about my adrenalectomy?
- How long is the procedure?
- How long will it take to recover from the surgery?
- What are the major risks of the surgery?
- Why must my adrenal gland(s) be removed?
- What restrictions can I expect on my physical activity after the surgery?
- How many adrenalectomies do you perform each year?

healing, blood pressure fluctuations, and other metabolic problems.

Other risks are typical of many operations. These include:

- bleeding
- damage to adjacent organs (spleen, pancreas)
- loss of bowel function
- blood clots in the lungs
- lung problems
- surgical infections
- pain
- scarring

### Normal results

The outcome of an adrenalectomy depends on the condition for which it was performed. For example, in the case of hyperaldosteronism, the surgical removal of the adrenal glands provides excellent results, with the majority of patients being cured. In the case of patients diagnosed with pheochromocytoma, long-term cures are rare in cases of malignant pheochromocytomas. In cases of metastatic disease, five-year survival rates as high as 36% have been reported.

### Morbidity and mortality rates

There is wide agreement that laparoscopic approaches decrease operative morbidity. The laparoscopic approach is commonly used to treat smaller adrenal tumors. At many laparoscopic centers, the laparoscopic adrenalectomy has become the standard practice. Several centers recommend a particular

approach or laparoscopic method, but regardless of which approach is preferred, the cure and morbidity rates are similar for laparoscopic and open adrenalectomy (in the case of small tumors). No method is suitable for all patients. In general, selecting the approach based on patient and tumor characteristics while considering the familiarity of the surgeon yields the best results.

## Alternatives

Alternatives to adrenalectomy depend on the medical condition underlying the decision to perform the surgery. In some cases, drug therapy may be considered as an alternative when the condition being treated is benign.

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American College of Surgeons. 633 N. Saint Clair St., Chicago, IL 60611-3211. (312) 202-5000. <http://www.facs.org>.

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## Adrenergic drugs

### Definition

Adrenergic amines are drugs that stimulate the sympathetic nervous system, also called the adrenergic nervous system. These compounds are known as sympathomimetic drugs. The sympathetic nervous system is the part of the autonomic nervous system that originates in the thoracic, or chest, and lumbar, or lower back regions of the spinal cord and regulates involuntary reactions to stress. It stimulates the heartbeat, sweating, breathing rate, and other stress-related body processes.

### Purpose

Adrenergic drugs have many uses. They are used to increase the output of the heart, to raise blood pressure, and to increase urine flow as part of the treatment of shock. Adrenergics are also used as heart stimulants. They may be given to a patient to reverse the drop in blood pressure that is sometimes caused by **general anesthesia**. They may be used to stop bleeding by causing the blood vessels to constrict, and to keep local anesthetics in a small area of the body by closing off the nearby blood vessels that would otherwise spread the anesthetic to other parts of the body. This ability to make blood vessels constrict makes adrenergics useful in reducing nasal stuffiness associated with colds and allergies. They may also be given to open the bronchi, the tubes leading to the lungs, for treatment of asthma and chronic obstructive pulmonary disease (COPD).



(Medical-on-Line / Alamy)

## Description

There are several types of adrenergic receptors in the human body. Although all types of adrenergic receptors, or nerve endings, respond to the same drugs, the effects depend on which specific receptors are stimulated. The alpha receptors make the heart beat faster, the pupils of the eyes dilate, and the muscles contract. The beta receptors have similar effects and also cause the bronchi in the lungs to open up. Both alpha and beta receptors are divided into subgroups—alpha-1, alpha-2, beta-1, and beta-2—each with its own specific effects. A hormone called norepinephrine that is secreted in the body affects all types of adrenergic receptors; the drugs used in medicine and surgery, however, have been developed to affect only specific types of receptors.

There are several adrenergic amines in common use:

- Albuterol (Alupent, Ventolin, others)—given by mouth or as a nasal spray to improve breathing;

- Dobutamine (Dobutrex and generic forms)—used to stimulate the heart during surgery or after a heart attack or cardiac arrest;
- Dopamine (Intropin)—used to increase cardiac output, blood pressure, and urine flow in treating patients with shock;
- Epinephrine (Adrenalin)—used locally to control bleeding from arterioles and capillaries during surgery. It is used to treat shock, as a heart stimulant, and as a decongestant. Epinephrine may be added to local anesthetics to keep the anesthetic in the area where it is applied. Epinephrine may also be applied to the eye to reduce the symptoms of conjunctivitis (red eye);
- Isoproterenol—most widely used to ease breathing problems in asthma and COPD, but also used to control several types of irregular heartbeat until a pacemaker can be implanted;
- Metaraminol (Aramine)—used to raise the blood pressure and stimulate the heart in treating patients with shock;
- Norepinephrine (Levophed)—used to increase the output of the heart and raise blood pressure as part of the treatment of shock; and
- Phenylephrine (Neo-Synephrine)—used to treat shock and low blood pressure; also used in the form of nose drops or spray to relieve nasal congestion from colds and allergies.

## Recommended dosage

The recommended dosage of an adrenergic drug depends on the specific compound, the purpose for which it is given, and the route of administration (oral or intravenous).

People who use adrenergic amines to treat breathing problems or conjunctivitis (red eye) should not use over-the-counter preparations of these drugs as an alternative to seeking professional care. These medications may temporarily relieve the symptoms of some disorders but will not cure the underlying problems, which may be serious.

## Precautions

When adrenergic amines are given during surgery, they will be administered by an anesthesiologist or other health care professional skilled in their use. It is the anesthesiologist's responsibility to **exercise** appropriate care when these drugs are used during an operation.

## KEY TERMS

**Adrenergic**—Characteristic of or releasing epinephrine or related substances. The term often refers to the nerve fibers in the sympathetic nervous system that release norepinephrine as a neurotransmitter.

**Amine**—A chemical compound that contains  $\text{NH}_3$  (a nitrogen-hydrogen combination) as part of its structure.

**Autonomic nervous system**—The part of the nervous system that regulates the activity of heart muscle, smooth muscle, and glands.

**Bronchi**—The large air tubes leading from the trachea to the lungs that convey air to and from the lungs.

**Conjunctivitis**—Inflammation of the conjunctiva, the membrane on the inner part of the eyelids and the covering of the white of the eye.

**Norepinephrine**—A naturally occurring hormone that acts as a neurotransmitter and affects both alpha- and beta-adrenergic receptors. It is also known as noradrenaline.

**Receptor**—A sensory nerve ending that responds to chemical or other stimuli of various kinds.

**Shock**—A serious condition in which the body's blood circulation and metabolism is severely impaired by injury, pain, blood loss, or certain diseases. The symptoms of shock include a pale complexion, very low blood pressure, and a weak pulse.

**Sympathetic nervous system**—The part of the nervous system stimulated by adrenergic drugs. It regulates such involuntary reactions to stress as changes in the heartbeat and breathing rate, sweating, and changes in digestive secretions.

**Sympathomimetic drugs**—Another name for adrenergic drugs.

The following are some of the hazards associated with the use of adrenergic amines. Patients under anesthesia may not be aware of these side effects:

- nervousness;
- rapid heart beat;
- high blood pressure;
- irregular heart beat;
- rapid heartbeat;
- chest pain;
- dizziness;
- dry mouth;

- headache;
- flushing;
- nausea;
- vomiting; and
- weakness.

Before undergoing procedures that may involve the use of an adrenergic amine, people with any of these medical problems should make sure their physicians know about them:

- narrow-angle glaucoma;
- liver disease;
- enlarged heart;
- disorders affecting the arteries and veins; and
- diseases and disorders affecting the blood supply to the brain.

## Side effects

The most common side effects of adrenergic amines are nervousness, agitation, and wakefulness. These side effects do not usually cause problems when the drugs are given during surgery or in combination with local anesthetics.

The following side effects sometimes occur when adrenergic amines are used to treat nasal congestion due to allergies or infections:

- rapid heartbeat;
- increased sweating;
- nervousness;
- hallucinations;
- sleep disturbances; and
- paleness.

Other rare side effects may occur. Anyone who has unusual symptoms after taking adrenergic amines should contact his or her physician right away.

## Interactions

Adrenergic amines may interact with many different types of drugs. People should discuss the use of these drugs with their pharmacist or physician before using over-the-counter preparations that contain them for colds or allergies. Patients scheduled for surgery should be sure to give the surgeon and anesthesiologist a list of all the drugs they take, including nonprescription, herbal, and alternative preparations. Some drugs that interact with adrenergic amines should be discontinued several days before surgery, since they last for a long time after the last dose.

Drugs that may interact with adrenergic amines include:



- furazolidone (Furoxone);
- tricyclic antidepressants (Adapin, Asendin, Aventyl, Elavil, Endep, Norpramin, Pamelor, Sinequan, Surmontil, Tofranil, Vivactil);
- guanethidine (Ismelin); and
- methyldopa (Aldomet).

Herbs that have been reported to interact with adrenergic amines include ephedra (ma huang), often sold in over-the-counter weight loss formulas; St. John's wort, a popular remedy for anxiety or depression; alfalfa; hibiscus; ginseng; angelica (dong quai); and yohimbe.

The list above does not include every drug or herb that may interact with adrenergic amines. People should consult their physician or pharmacist before combining adrenergic amines with any other prescription or nonprescription (over-the-counter) medicine.

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- American Herbal Products Association, 8484 Georgia Avenue, Suite 370, Silver Spring, MD, 20910, (301) 588-1171, <http://www.ahpa.org>.
- American Society of Health System Pharmacists, 7272 Wisconsin Avenue, Bethesda, MD, 20814, (301) 657-3000, <http://www.ashp.org>.
- U.S. Food and Drug Administration, 5600 Fishers Lane, Rockville, MD, 20857-0001, (888) INFO FDA, <http://www.fda.gov>.

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## Adult day care

### Definition

Adult day care includes programs, services, and facilities designed to assist physically or mentally impaired adults remain in their homes and communities. These are persons who might otherwise require institutional or long-term care and rehabilitation.

### Purpose

There are two general purposes for adult day-care. The first is to provide an alternative to placement in a residential institution. The second is to create a respite for care-givers, often the children of the persons for whom the care is being provided.

### Description

There are two general types of adult day care programs. One is based on a medical model and the other on a social model. The medical model provides comprehensive medical, therapeutic, and rehabilitation treatment, usually during normal working hours. The social model offers supervised activities, peer support, companionship, and recreation. Both models assist older adults and those with chronic conditions to remain as independent as possible, for as long as possible.

Programs organized along medical model lines are often called adult day health care to distinguish them from social programs. Adult day health care programs offer health services such as physician visits, nursing care, and podiatry, as well as rehabilitation services such as physical, occupational, and speech therapy in a secure environment. This model of adult day care is offered to persons with a variety of chronic medical conditions including the following:

- adults with Alzheimer's disease, other forms of dementia, or depression;
- persons recovering from strokes or head or spinal cord injuries;
- people with chronic conditions such as diabetes or cardiovascular disease;
- adults with developmental disabilities such as Down syndrome;
- adults suffering from mental illnesses; and
- weak or frail older adults requiring nursing care or assistance with daily living activities.

The social model of adult day care emphasizes supervised group activities such as crafts, gardening, music, and **exercise**. Participants in this model may require some assistance with the activities of daily

## KEY TERMS

**Alzheimer's disease**—Progressive dementia characterized by worsening memory and other cognitive impairment.

**Geriatrician**—Physician specializing in the care and treatment of older adults.

living (e.g., eating, bathing, dressing) but they generally do not require skilled nursing care. Like adult day health care facilities, these social programs generally provide transportation and a midday meal for participants, as well as caregiver support groups, information and referral services, and community outreach programs.

In 2008, an estimated 37 million Americans will be aged 65 or older. According to statistics from the U.S. Department of Labor, the fastest growing segment of older adults is the population aged 85 and older. Historically, approximately 80% of the frail elderly remain in their communities and are cared for by relatives, most commonly by adult daughters; however, as of the early twenty-first century, an increasing number of women aged 35–54 are in the workforce and unable to care for aging parents or disabled adult children living at home.

Although the participants of adult day care are adults who attend the programs daily or several times each week, adult day care also meets the needs of families and other caregivers. Before women entered the workforce, they were available to care for relatives at home. In the early 2000s, adult day care provides a secure, alternative source of care for women who work outside the home. It also offers respite, or much needed breaks, for caregivers. Older adults caring for spouses, or children caring for aging parents find that adult day care helps ease the burden of caring for ill, confused, or disabled family members.

The first adult day care centers opened in England during the 1940s and 1950s. Established by psychiatric hospitals, these centers were designed to reduce the frequency of hospital admissions. The first adult day care centers in the United States appeared during the early 1970s. Today, there are more than 4,500 services and centers. Most centers and programs operate during normal business hours, Monday through Friday, but some offer weekend and evening care.

As of 2007, 35 states offer licensure of adult day care, but only 26 require such licensure. Adult day care services or programs may be affiliated with hospitals,

nursing homes, home health agencies, or senior centers, but many are unaffiliated, independent programs. They may be located in storefronts, senior centers, community health and medical centers, and nursing homes.

Among centers responding to a 1997 National Adult Day Services Association (NADSA) survey, the average number of persons in an adult day care facility was approximately 40 and the average age of persons served was 76. About three out of four persons receiving adult day care services lived with family. Nearly 80% of adult day centers offered nursing services, and approximately 90% were not-for-profit. Fees ranged from \$1 to \$200 per day, with an average of \$28 to \$43 dollars per day. As of 2003, **Medicare** does not pay for any type of adult day care; however, in 35 states, **Medicaid** can be used to pay for adult day care services for individuals that meet financial criteria.

Though fees for adult day care vary widely, the service is generally considered to be cost effective when compared with the cost of institutional care, such as skilled nursing facilities or even home health care. More importantly, adult day care enables older adults, persons with physical disabilities, and those with cognitive impairments to maintain their independence. Research has demonstrated that adult day care also reduces the risks and frequency of hospitalization for older adults. Adult day care satisfies two requirements of care. It provides a secure, protected environment and is often the least restrictive setting in which care may be delivered.

Quality and standards of care vary from state to state and from one center or program to another. NADSA and the National Council on the Aging have developed standards and benchmarks for care, but adherence to these standards is voluntary. NADSA is developing a certification program for adult day center administrators and directors. A certification process for program assistants also exists. Since no uniform national standards exist, it is difficult for consumers to know whether a program or center is staffed by qualified personnel or provides appropriate services.

Generally, quality adult day care centers or programs conduct thorough assessments of each person and develop individualized plans of care and activities to meet the needs of impaired, disabled, or frail older adults. The plans for each individual describe objectives in terms of improvement or maintenance of health status, functional capabilities, and emotional well being. Centers must have sufficient staff to ensure safety, supervision, and close attention. Further, all personnel and volunteers should be qualified, trained,



and sensitive to the special needs of older adults. For example, centers and services for persons with Alzheimer's disease or other dementias must take special precautions to ensure that people do not wander away from the facility.

## Results

The aging population in the United States, the increasing incidence of Alzheimer's disease, and rising popularity of adult day care have created new and additional opportunities for health professionals and other care-giving and service personnel.

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## ORGANIZATIONS

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- California Association for Adult Day Services, 921 11th Street Suite 1101, Sacramento, CA, 95814, (916) 552 7400, (916) 552 7404, [caads@caads.org](mailto:caads@caads.org), <http://www.caads.org>.
- National Adult Day Services Association, 85 South Washington, Suite 316, Seattle, WA, 98104, (877) 745 1440, (206) 461 3218, [info@nadsa.org](mailto:info@nadsa.org), <http://www.nadsa.org>.
- U.S. Administration on Aging, One Massachusetts Ave., Washington, DC, 20201, (202) 619 0724, [AoAInfo@aoa.hhs.gov](mailto:AoAInfo@aoa.hhs.gov), <http://www.aoa.gov>.

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AICD see **Implantable cardioverter-defibrillator**

## Alanine aminotransferase test

### Definition

The alanine aminotransferase test, also known as ALT, is one of a group of tests known as **liver function tests** (or LFTs) and is used to monitor damage to the liver.

### Purpose

ALT levels are used to detect liver abnormalities. Since the alanine aminotransferase enzyme is also found in muscle, tests indicating elevated ALT levels may indicate muscle damage; however, other tests, such as the levels of the MB fraction of creatine kinase should indicate whether the abnormal test levels are because of muscle or liver damage.

### Demographics

The number of ALT tests administered each year can only be estimated. Since statins are the most prescribed drugs in the United States and standards of care call for quarterly liver function tests, the number of ALTs can easily exceed 500 million per year.

## Description

The alanine aminotransferase test (ALT) can reveal liver damage. It is probably the most specific test for liver damage; however, the severity of the liver damage is not necessarily shown by the ALT test since the amount of dead liver tissue does not correspond to higher ALT levels. Also, persons with normal, or declining, ALT levels may experience serious liver damage without an increase in ALT.

Nevertheless, ALT is widely used, and useful, because ALT levels are elevated in most patients with liver disease. Although ALT levels do not necessarily indicate the severity of the damage to the liver, they may indicate how much of the liver has been damaged. ALT levels, when compared to the levels of a similar enzyme, aspartate aminotransferase (AST), may provide important clues to the nature of the liver disease. For example, within a certain range of values, a ratio of 2:1 or greater for AST:ALT might indicate that a person suffers from alcoholic liver disease. Other diagnostic data may be gleaned from ALT tests to indicate abnormal results.

## Preparation

No special preparations are necessary for this test.

## Aftercare

This test involves blood being drawn, usually from a vein in the person's elbow. The person being tested should keep the wound from the needle puncture covered with a bandage until the bleeding stops. Individuals should report any unusual symptoms to their physician.

## Risks

The greatest risk associated with an ALT test is bleeding. The odds of experiencing uncontrolled bleeding are fewer than one in a million.

## Normal results

Normal values vary from laboratory to laboratory, and should be available to physicians at the time of the test. An informal survey of some laboratories indicates many laboratories find values from approximately 7 to 50 IU/L (international units per liter) to be normal.

## Abnormal results

Mildly elevated levels of ALT (generally below 300 IU/L) may indicate any kind of liver disease. Levels above 1,000 IU/L generally indicate extensive

liver damage from toxins or drugs, viral hepatitis, or a lack of oxygen (usually resulting from very low blood pressure or a heart attack). A briefly elevated ALT above 1,000 IU/L that resolves in 24–48 hours may indicate a blockage of the bile duct. More moderate levels of ALT (300–1,000 IU/L) may support a diagnosis of acute or chronic hepatitis.

It is important to note that persons with normal livers may have slightly elevated levels of ALT. This is a normal finding.

## Morbidity and mortality rates

Morbidity rates are excessively miniscule. The most common problems are minor bleeding and bruising. Since neither are reportable events, morbidity can only be estimated. Mortality is essentially zero.

## Alternatives Resources

There are no alternatives to an alanine aminotransferase test.

## Precautions

The only precaution needed is to clean the venipuncture site with alcohol.

## Side effects

The most common side effects of an alanine aminotransferase test are minor bleeding and bruising.

## Interactions

There are no known interactions with an alanine aminotransferase test.

## Resources

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#### ORGANIZATIONS

- American Association for Clinical Chemistry, 1850 K Street, NW, Suite 625, Washington, DC, 20006, (800) 892 1400, <http://www.aacc.org/AACC/>.
- American Society for Clinical Laboratory Science, 6701 Democracy Blvd., Suite 300, Bethesda, MD, 20817, (301) 657 2768, <http://www.ascls.org/>.
- American Society for Clinical Pathology, 1225 New York Ave., NW, Suite 250, Washington, DC, 20005, (202) 347 4450, <http://www.ascp.org/>.
- College of American Pathologists, 325 Waukegan Rd., Northfield, IL, 60093 2750, (800) 323 4040, <http://www.cap.org/apps/cap.portal>.

L. Fleming Fallon, Jr., M.D., Dr.P.H.

Albumin test see **Liver function tests**

## Albumin Test, Blood

### Definition

Albumin is a type of protein found in the plasma (liquid) portion of the blood. Of all the types of protein in plasma, albumin is found in the highest concentrations, constituting about two-thirds of total plasma protein.



**Vials of blood serum.** (AJP / Hop American / Photo Researchers, Inc.)

Albumin serves a number of important purposes. It transports a variety of other important chemicals in the blood, allowing them to be delivered to various organs and tissues. Chemicals that bind to albumin include thyroxine, bilirubin, penicillin, cortisol, estrogen, free fatty acids, warfarin, calcium, magnesium, and heme. Appropriate levels of albumin are also necessary in order to maintain sufficient quantities of fluid within the blood vessels. When the correct concentration of albumin is present in the blood's serum, fluid remains in the blood vessels in order to reach a chemical equilibrium of protein concentrations in and outside of the blood vessels. When there is an insufficient amount of albumin in the serum, fluid will leak out of the blood vessels in response to the considerably higher concentration of protein in the surrounding tissues. This can result in visible swelling of the lower legs (referred to as edema), or in ascites (an abnormal collection of fluid in the abdomen).

## Purpose

Albumin levels are tested in order to monitor liver and kidney functioning, and in order to ascertain an individual's nutritional status. Albumin levels may be checked if there is new edema or ascites. Albumin is manufactured in the liver, therefore, low albumin levels may indicate liver damage. Under normal circumstances, no albumin leaves the body in urine; however, when the kidneys are damaged, they may become leaky, allowing albumin to be excreted in the urine. This happens, for example, in nephrotic syndrome, and in pregnant women with pre-eclampsia and eclampsia. Individuals who have poor diets, with an extremely low dietary intake of protein, may also have low serum albumin.

An increased concentration of albumin may suggest that an individual has become dehydrated. High albumin levels may also occur when an individual is using insulin, growth hormones, androgens, or anabolic steroids.

## Precautions

Individuals who have been on intravenous fluids may not have an accurate serum albumin reading. Additionally, it's important to remember that women have lower-than-normal serum albumin levels during pregnancy. Individuals using certain medications, such as insulin, growth hormones, androgens, or anabolic steroids, may also have an abnormal serum albumin level.

## Description

This test is usually performed as part of a panel of blood tests, in which a single sample of blood is tested for a variety of chemical elements. Serum albumin levels are often tested along with total protein levels. A blood test for serum albumin requires vein puncture with a needle, and is usually performed by a nurse or phlebotomist (an individual who has been trained to draw blood).

## Preparation

There are no restrictions on diet or physical activity, either before or after the blood test.

## Aftercare

As with any blood tests, discomfort, bruising, and/or a very small amount of bleeding is common at the puncture site. Immediately after the needle is withdrawn, it is helpful to put pressure on the puncture site until the bleeding has stopped. This decreases

## KEY TERMS

**Ascites**—An abnormal collection of fluid within the abdomen, often suggests liver disease such as cirrhosis.

**Cirrhosis**—Liver disease that results in damage and scarring to the liver.

**Dehydration**—Low overall levels of body fluid. May occur due to increased loss of fluids through sweating, vomiting, or diarrhea.

**Eclampsia**—A serious, life-threatening complication of pregnancy, in which high blood pressure results in a variety of problems, including seizures.

**Nephrotic syndrome**—A kidney disorder which causes a cluster of symptoms, including low serum protein, loss of protein in the urine, and body swelling.

**Plasma**—The fluid component of blood which contains such substances as proteins, vitamins, minerals, enzymes, and sugars.

**Pre-eclampsia**—High blood pressure in pregnancy, which can result in protein in the urine; untreated, pre-eclampsia may lead to the life-threatening condition known as eclampsia, which is characterized by seizures.

the chance of significant bruising. Warm packs may relieve minor discomfort. Some individuals may feel briefly woozy after a blood test, and they should be encouraged to lie down and rest until they feel better.

## Risks

Basic blood tests, such as serum albumin levels, do not carry any significant risks, other than slight bruising and the chance of brief dizziness.

## Normal results

In general, the normal range of serum albumin is 3.4 to 5.4 g/dL (grams per deciliter). Different labs may have slightly different values listed for the normal range of serum albumin. If total serum proteins are also being tested, the fraction that is made up of albumin should be about 60%.

## Abnormal results

Low albumin may indicate:

- liver disease, such as cirrhosis, hepatitis, or hepatocellular necrosis (death of liver cells);



- kidney disease, such as nephritic syndrome or glomerulonephritis;
- severe malnutrition, as occurs in developing countries where protein deficiencies are common. This type of malnutrition is referred to as kwashiorkor, and results in the stereotypical “potbelly” often associated with malnourished children;
- malnourishment due to chronic diseases such as HIV or cancer, or due to the effects of an eating disorder such as anorexia nervosa;
- inability to absorb and digest protein, as occurs in Crohn’s disease, Whipple’s disease, or sprue;
- loss of protein from severe or chronic diarrhea;
- inflammation;
- severe burns; or
- shock.

High albumin levels can result from dehydration or the presence of certain medications.

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### ORGANIZATIONS

American Association for Clinical Chemistry, 1850 K Street, NW, Suite 625, Washington, DC, 20006, (800) 892 1400, <http://www.aacc.org>.

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Allogenic transplant see **Bone marrow transplantation**

## Ambulatory surgery centers

### Definition

Ambulatory surgery centers (ASCs) are medical facilities that specialize in elective same-day or outpatient surgical procedures. They do not offer emergency care.

The word ambulatory comes from the Latin verb *ambulare*, which means “to walk.” It means that the patients treated in these surgical centers do not require admission to a hospital and are well enough to go home after the procedure. Ambulatory surgical centers are also known as surgicenters.

### Demographics

As of 2008, there were more than 5,300 ambulatory surgical centers in the United States, up from about 3,700 in 2003. In 1980, only 275 such centers existed. This rapid increase reflects a general trend toward surgeries performed on an outpatient basis. According to *American Medical News*, 70% of all surgical procedures performed in the United States in 2000 were done in outpatient facilities, compared to 15% in 1980. As of 2003, over seven million surgeries are performed annually in American ASCs. Between 1990 and 2000, the number of operations performed annually in these centers rose 191%, from 2.3 million procedures in 1990 to 6.7 million in 2000.

The types of surgical procedures performed in ASCs have also undergone significant changes in recent years. Many of the early ASCs were outpatient centers for **plastic surgery**. Advances in minimally invasive surgical techniques in other specialties, however, led to the establishment of ASCs for orthopedic, dental, and ophthalmologic procedures. According to the Federated Ambulatory Surgery Association (FASA), gastroenterology accounted for only 10% of all procedures performed in ASCs in 1995, while plastic surgery still represented 20%. These proportions changed rapidly. By 1998, only three years later, ophthalmology accounted for more procedures performed in ASCs than any other surgical specialty (26.8%), followed by gastroenterology (18.8%), **orthopedic surgery** (9.8%), gynecology (9.5%), plastic surgery (7.7%), and otolaryngology (6.9%). The remaining 20.6% included dental, urological, neurological, podiatric, and pain block procedures.

As of 2003, ASCs are not distributed evenly across the United States; they tend to be concentrated in urban areas, particularly those with a high ratio of physicians to the general population.

### Description

Ambulatory surgical centers are sometimes classified as either hospital-associated or freestanding. The term freestanding is somewhat confusing because some hospital-associated ASCs are located in buildings that may be several blocks away from the main hospital. As

## KEY TERMS

**Ambulatory**—Referring to a condition that is treatable without admission to a hospital, or to a surgical procedure performed on an outpatient basis.

**Dedicated**—Reserved for a specific purpose. An ambulatory surgical center must have at least one dedicated operating room in order to qualify for accreditation.

**Elective**—Referring to a surgical procedure that is a matter of choice; an elective operation may be beneficial to the patient but is not urgently needed.

**Podiatry**—The surgical specialty that treats disorders of the foot.

**Surgicenter**—Another term for ambulatory surgical center.

a result, some states have defined an ASC for legal purposes as “a facility primarily organized or established for the purpose of performing surgery for outpatients and...a separate identifiable legal entity from any other health care facility.” More recently, some ASCs have sought institutional relationships with academic medical centers, hoping to benefit from the prestige associated with teaching and research.

Ambulatory surgery centers should not be confused with office-based surgery practices or with other outpatient centers that provide diagnostic services or primary health care, such as urgent care centers, community health centers, mobile diagnostic units, or rural health clinics. ASCs are distinguished from these other health care facilities by their use of a referral system for accepting patients and their maintenance of a dedicated **operating room**. The first characteristic means that any patient who wants to be treated in an ambulatory surgery center must first consult their primary health care provider, or PCP, and choose to have their condition treated by surgery rather than an alternative approach. The second feature means that the surgical facility must have at least one room that is used only for operations.

### *Accreditation and ownership*

The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) lists nine types of ASCs that it presently accredits:

- cosmetic and facial surgery centers
- endoscopy centers
- ophthalmology practices

- laser eye surgery centers
- centers for oral and maxillofacial surgery
- orthopedic surgery centers
- plastic surgery centers
- podiatry clinics
- multi-specialty surgery centers

**Medicare** inspection and certification of ambulatory surgery centers is a separate process from professional accreditation. An ASC does not have to be certified by Medicare in order to be accredited by JCAHO. Office-based surgical practices are accredited by JCAHO under a specialized Office-Based Surgery Accreditation program.

ASCs are sometimes categorized on the basis of ownership. Some are owned by hospitals and others are owned by the physicians who treat patients in them; about half, however, are operated by investor-owned businesses. The rapid growth of ASCs is in part a reflection of the general commercialization of health care in the United States over the past two decades.

### *Patient care*

A patient in an ambulatory surgical center is asked to observe some of the same precautions and preparations that hospital patients undergo, including routine blood tests and a thorough medical history to make certain that they will not have an adverse reaction to anesthesia. In most cases the patient will be told to avoid eating and drinking before the procedure. Patients are asked to have a friend or family member drive them home after surgery; some ASCs request that the friend or relative come with the patient in the morning and stay at the center in a waiting area until the patient feels well enough to leave.

On average, patients leave the ASC within two hours after their surgery. If the patient needs overnight care or has a serious complication, he or she is transferred to an acute care hospital. Most ASCs that are not hospital-owned have arrangements with nearby hospitals to cover emergency situations.

## Historical background

The first ambulatory surgical center was opened in 1970 by a group of anesthesiologists in Phoenix, Arizona. Relatively few ASCs were built, however, until the mid-1980s. Two factors that encouraged the rapid spread of ASCs after that point were the development of accreditation programs and standards on the one hand and government approval on the other. In 1980 the American Society of Plastic and Reconstructive Surgeons (ASPRS) established the American



Association for Accreditation of Ambulatory Plastic Surgery Facilities, or AAAAPSF, in order to guarantee the quality of outpatient surgical facilities. The AAAAPSF then formed the American Association for Accreditation of Ambulatory Surgical Facilities, or AAAASF, to establish standards for single-specialty and multi-specialty ASCs owned or operated by surgeons who are board-certified in other types of surgery. In 1982 procedures performed at ASCs were made eligible for Medicare payments on the grounds that they were low-risk surgeries provided in less expensive settings. As of 2003, 85% of the ASCs in the United States are certified by Medicare.

Other factors involved in the expansion of ASCs include:

- **Advances in medical technology.** The development of instruments that made minimally invasive procedures possible made certain types of surgery less complicated to perform and less painful for the patient. The most important single development that made outpatient surgery increasingly safe, however, is the discovery of new anesthetic agents combined with better techniques for administering anesthesia. The number of anesthesia-related deaths has dropped sharply since the 1980s, from 1:10,000 operations in 1982 to 1:400,000 in 2002.
- **Demographic changes.** Instead of a shortage, by the late 1990s there was an oversupply of physicians as well as hospital beds in the United States. This situation has led to increasing competition for patients among both doctors and hospital managers.
- **The increasing commercialization of health care.** The rise of investor-owned hospitals and ambulatory surgery centers encouraged many doctors to invest money in these facilities, particularly the ASCs. Since ambulatory surgery centers accept patients only on a referral basis, questions have been raised about the legitimacy of doctors referring patients to facilities in which they have a financial interest. The former editor of the *New England Journal of Medicine* cites a Florida study revealing that almost 40% of the doctors practicing in that state had money invested in the ASCs to which they sent their patients.

### Advantages of ASCs

Surgeons as well as patients tend to prefer ambulatory surgery centers for outpatient procedures for several reasons:

- **Cost.** In many cases, an outpatient procedure done in an ASC costs between one-half and one-third as much as the same procedure done in a hospital. It is important, however, for patients to compare costs

carefully, because some ASC procedures may cost as much as or even more than hospital-based procedures. For example, the Medicare Payment Advisory Commission found that whereas a cataract operation cost only \$942 at an ambulatory surgery center in 2001 as opposed to \$1334 at a hospital, after-cataract laser surgery cost \$429 at the ASC versus \$246 at a hospital. Figures for an endoscopy and biopsy of the upper digestive tract were \$429 and \$359 respectively; for a diagnostic colonoscopy, \$429 and \$401; and for epidural anesthesia, \$320 and \$183.

- **Convenience.** There is much less administrative paperwork and “red tape” at an ambulatory surgical center compared to the admissions process at most hospitals. Patients also like the fact that they can leave an ASC relatively quickly after their surgery, which translates into less time lost from work.
- **Presence of family and friends.** Whereas most hospitals keep patients recovering from a surgical procedure in separate rooms, in an ASC the patient can usually spend the recovery period after surgery with their loved ones.
- **Greater efficiency.** This advantage is particularly important to surgeons. It takes much less time to prepare an operating room in a specialized ASC for the next patient than in a standard hospital. Improved efficiency allows the surgeon to treat more patients in the same amount of time than he or she would be able to do in a hospital; some surgeons maintain that they can do three times the number of procedures in an ASC as they could in a hospital setting.
- **Greater control over procedures and standards.** Many doctors prefer working in an ASC because they can set the standards for staffing, safety precautions, postoperative care, etc., rather than having these things decided for them by a hospital manager.

### ASCs within the American health care system

As of 2003, there are several areas of tension in the health care system related to ambulatory surgical centers. One is opposition from hospitals. Most hospitals have relied on income from surgical procedures to make up for losses incurred by treating other patients who cannot afford to pay. The movement toward freestanding ambulatory surgery centers means a considerable loss of income for many hospitals.

On the other hand, there is also increasing competition between ASCs and office-based surgical practices. The same improvements in anesthesia and surgical equipment that made **outpatient surgery** in an ASC safe to perform have also made it safe to do a

growing number of fairly complex procedures in a doctor's office. Such procedures as hernia repair, arthroscopic joint repair, and **liposuction** are now being performed in office-based facilities. It is estimated that by 2005, 10 million surgical procedures will be performed annually in American doctors' offices, or twice as many as were done in 1995. The American Society of Anesthesiologists predicts that office-based surgical procedures will account for a steadily growing proportion of outpatient surgeries. The ASA has stated that "... the trend toward office-based surgery is growing at least as fast [as of 2003] as the trend toward ambulatory surgery grew a few years ago."

### Legal and regulatory issues

The growing number of for-profit ASCs as well as government involvement with outpatient facilities through the Medicare program has led to a number of legal and regulatory questions. One issue concerns the level of Medicare reimbursement for procedures performed in ASCs. The present Medicare fee schedule is based on data from 1986, when the operating costs of many ambulatory surgical centers were higher than they are in 2003, due to advances in technology. As a result, some observers think that ASCs are being overpaid for services to Medicare patients. Another issue is a proposal to add more procedures to the list approved by Medicare for ASC patients. The present list has not been updated since 1995. The proposed additions would increase ASC services available to Medicare patients by 20%.

The major legal question facing surgeons who own or have investments in ambulatory surgical centers is whether they are breaking the law by referring patients to ASCs in which they have invested or in which they perform surgery. The existing laws are not entirely clear on this point, but experts in health law do not expect the confusion to be resolved in the near future.

### Resources

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#### ORGANIZATIONS

- Accreditation Association for Ambulatory Health Care (AAAHC). 3201 Old Glenview Road, Suite 300, Wilmette, IL 60091-2992. (847) 853-6060. <http://www.aahc.org>.
- American Association for Accreditation of Ambulatory Surgery Facilities (AAAASF). 1202 Allanson Road, Mundelein, IL 60060. (888) 545-5222.
- American Association of Ambulatory Surgical Centers (AAASC). P. O. Box 23220, San Diego, CA 92193. (800) 237-3768. <http://www.aaasc.org>.
- American Health Lawyers Association. Suite 600, 1025 Connecticut Avenue NW, Washington, DC 20036-5405. (202) 833-1100. <http://www.healthlawyers.org>.
- American Society of Anesthesiologists (ASA). 520 N. Northwest Highway, Park Ridge, IL 60068-2573. (847) 825-5586. <http://www.asahq.org>.
- Federated Ambulatory Surgery Association (FASA). 700 North Fairfax Street, #306, Alexandria, VA 22314. (703) 836-8808. <http://www.fasa.org>.
- Joint Commission on Accreditation of Healthcare Organizations (JCAHO). One Renaissance Boulevard, Oakbrook Terrace, IL 60181. (630) 792-5000. <http://www.jcaho.org>.

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Ammonia (blood) test see **Liver function tests**

## Amniocentesis

### Definition

Amniocentesis is a procedure used to diagnose fetal defects in the early second trimester of pregnancy. A sample of the amniotic fluid, which surrounds a fetus in the womb, is collected through a pregnant woman's abdomen using a needle and syringe. Tests performed on fetal cells found in the amniotic fluid can reveal the presence of many types of genetic disorders. Early diagnosis allows doctors and prospective parents to make important decisions about treatment and intervention prior to birth.

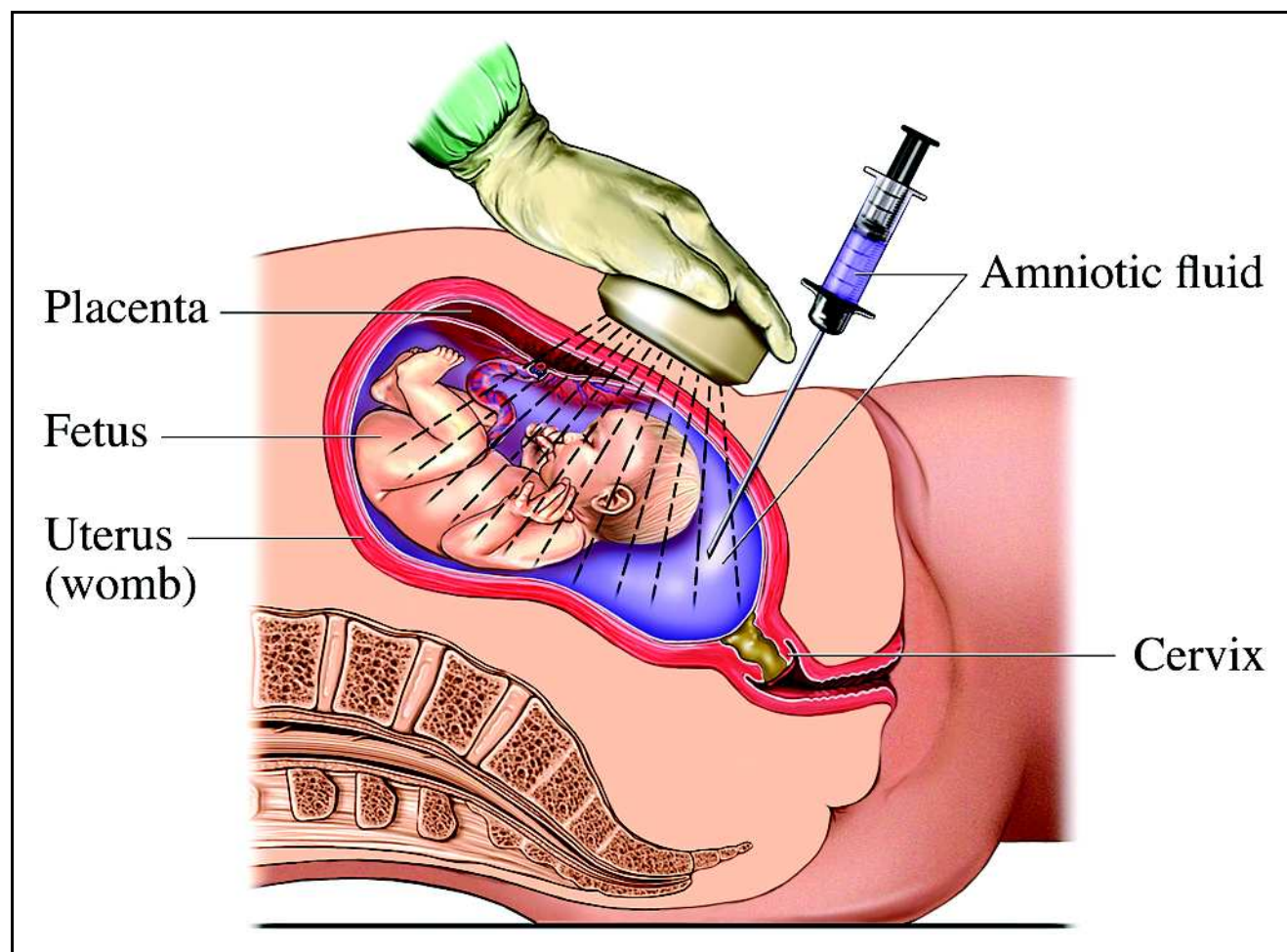
### Purpose

Since the mid-1970s, amniocentesis has been used routinely to test for Down syndrome, by far the most common, nonhereditary, genetic birth defect, afflicting

about one in every 1,000 babies. By 1997, approximately 800 different diagnostic tests were available, most of them for hereditary genetic disorders such as Tay-Sachs disease, sickle cell disease, hemophilia, muscular dystrophy, and cystic fibrosis.

Amniocentesis, often called amnio, is recommended for women who will be older than 35 on their due date. It is also recommended for women who have already borne children with birth defects, or when either of the parents has a family history of a birth defect for which a diagnostic test is available. Another reason for the procedure is to confirm indications of Down syndrome and certain other defects that may have shown up previously during routine maternal blood screening.

The risk of bearing a child with a nonhereditary genetic defect such as Down syndrome is directly related to a woman's age—the older the woman, the greater the risk. Thirty-five is the recommended age to



(Nucleus Medical Art, Inc./Alamy)

## KEY TERMS

**Alpha-fetoprotein (AFP)**—A protein normally produced by the liver of a fetus and detectable in maternal blood samples. AFP screening measures the amount of alpha-fetoprotein in the blood. Levels outside the norm may indicate fetal defects.

**Anencephaly**—A hereditary defect resulting in the partial to complete absence of a brain and spinal cord. It is fatal.

**Chorionic villus sampling (CVS)**—A procedure similar to amniocentesis, except that cells are taken from the chorionic membrane for testing. These cells, called chorionic villus cells, eventually become the placenta. The samples are collected either through the abdomen, as in amnio, or through the vagina. CVS can be done earlier in the pregnancy than amnio, but carries a somewhat higher risk.

**Chromosomes**—Chromosomes are the strands of genetic material in a cell that occur in nearly identical pairs. Normal human cells contain 23 chromosome pairs—one in each pair inherited from the mother, and one from the father. Every human cell contains the exact same set of chromosomes.

**Down syndrome**—The most prevalent of a class of genetic defects known as trisomies, in which cells contain three copies of certain chromosomes rather than the usual two. Down syndrome, or

trisomy 21, usually results from three copies of chromosome 21.

**Genetic**—The term refers to genes, the basic units of biological heredity, which are contained on the chromosomes, and contain chemical instructions that direct the development and functioning of an individual.

**Hereditary**—Something that is inherited or passed down from parents to offspring. In biology and medicine, the word pertains to inherited genetic characteristics.

**Maternal blood screening**—Maternal blood screening is normally done early in pregnancy to test for a variety of conditions. Abnormal amounts of certain proteins in a pregnant woman's blood raise the probability of fetal defects. Amniocentesis is recommended if such a probability occurs.

**Tay-Sachs disease**—An inherited disease prevalent among the Ashkenazi Jewish population of the United States. Infants with the disease are unable to process a certain type of fat that accumulates in nerve and brain cells, causing mental and physical retardation, and death by age four.

**Ultrasound**—A technique that uses high-frequency sound waves to create a visual image (a sonogram) of soft tissues. The technique is routinely used in prenatal care and diagnosis.

begin amnio testing because that is the age at which the risk of carrying a fetus with such a defect roughly equals the risk of miscarriage caused by the procedure, which is about one in 200. At age 25, the risk of giving birth to a child with this type of defect is about one in 1,400; by age 45, it increases to about one in 20. Nearly half of all pregnant women over 35 in the United States undergo amniocentesis, and many younger women also decide to have the procedure. Notably, some 75% of all Down syndrome infants born in the United States each year are to women younger than 35. In January 2007, the American College of Obstetricians and Gynecologists issued a recommendation that all pregnant patients be offered the option of amniocentesis testing, regardless of maternal age.

One of the most common reasons for performing amniocentesis is an abnormal alpha-fetoprotein (AFP) test. Alpha-fetoprotein is a protein produced by the fetus and present in the mother's blood. A

simple blood screening, usually conducted around the fifteenth week of pregnancy, can determine the AFP levels in the mother's blood. Levels that are too high or too low may signal possible fetal defects. Because this test has a high false-positive rate, another test such as amniocentesis is recommended whenever the AFP levels fall outside the normal range.

Amniocentesis is generally performed during the sixteenth week of pregnancy, with results usually available within three weeks. It is possible to perform amnio as early as the eleventh week, but this is not usually recommended because there appears to be an increased risk of miscarriage when done at this time. The advantage of early amnio and speedy results lies in the extra time for decision making if a problem is detected. Potential treatment of the fetus can begin earlier. Important, also, is the fact that elective abortions are safer and less controversial the earlier they are performed.



## Precautions

As an invasive surgical procedure, amniocentesis poses a real, although small, risk to the health of a fetus. Parents must weigh the potential value of the knowledge gained, or indeed the reassurance that all is well, against the small risk of miscarriage. The serious emotional and ethical dilemmas that adverse test results can bring must also be considered. The decision to undergo amnio is always a matter of personal choice.

## Description

The word amniocentesis literally means “puncture of the amnion,” the thin-walled sac of fluid in which a developing fetus is suspended during pregnancy. During the procedure, the obstetrician inserts a very fine needle through the woman’s abdomen into the uterus and the amniotic sac and withdraws approximately 1 oz (28.3 g) of amniotic fluid for testing. The relatively painless procedure is performed on an outpatient basis, sometimes using **local anesthesia**.

The physician uses **ultrasound** images to guide needle placement and collect the sample, thereby minimizing the risk of fetal injury and the need for repeated needle insertions. Once the sample is collected, the woman can return home after a brief observation period. She may be instructed to rest for the first 24 hours and to avoid heavy lifting for two days.

The sample of amniotic fluid is sent to a laboratory where fetal cells contained in the fluid are isolated and grown in order to provide enough genetic material for testing. This takes about seven to 14 days. The material is then extracted and treated so that visual examination for defects can be made. For some disorders, like Tay-Sachs, the simple presence of a telltale chemical compound in the amniotic fluid is enough to confirm a diagnosis. Depending on the specific tests ordered, and the skill of the lab conducting them, all the results are available one to four weeks after the sample is taken.

Cost of the procedure depends on the doctor, the lab, and the tests ordered. Most insurers provide coverage for women over 35, as a follow-up to positive maternal blood screening results, and when genetic disorders run in the family.

An alternative to amnio, now in general use, is chorionic villus sampling (CVS), which can be performed as early as the eighth week of pregnancy. While this allows for the possibility of a first-trimester abortion, if warranted, CVS is apparently also riskier and is more expensive. The most promising area of new research in prenatal testing involves expanding

the scope and accuracy of maternal blood screening as this poses no risk to the fetus.

## Preparation

It is important for a woman to fully understand the procedure and to feel confident in the obstetrician performing it. Evidence suggests that a physician’s experience with the procedure reduces the chance of mishap. Almost all obstetricians are experienced in performing amniocentesis. The patient should feel free to ask questions and seek emotional support before, during, and after amniocentesis is performed.

## Aftercare

Necessary aftercare falls into two categories, physical and emotional.

### *Physical aftercare*

During and immediately following the sampling procedure, a woman may experience dizziness, nausea, a rapid heartbeat, and cramping. Once past these immediate hurdles, the physician will send the woman home with instructions to rest and to report any complications requiring immediate treatment, including:

- Vaginal bleeding. The appearance of blood could signal a problem.
- Premature labor. Unusual abdominal pain and/or cramping may indicate the onset of premature labor. Mild cramping for the first day or two following the procedure is normal.
- Signs of infection. Leaking of amniotic fluid or unusual vaginal discharge, and fever could signal the onset of infection.

### *Emotional aftercare*

Once the procedure has been safely completed, the anxiety of waiting for the test results can prove to be the worst part of the process. A woman should seek and receive emotional support from family and friends, as well as from her obstetrician and family doctor. Professional counseling may also prove necessary, particularly if a fetal defect is detected.

## Risks

Most of the risks and short-term side effects associated with amniocentesis relate to the sampling procedure. A successful amnio sampling results in no long-term side effects. Risks include:

- Maternal/fetal hemorrhaging. While spotting in pregnancy is fairly common, bleeding following amnio should always be investigated.
- Infection. Infection, although rare, can occur after amniocentesis. An unchecked infection can lead to severe complications.
- Fetal injury. A very slight risk of injury to the fetus resulting from contact with the amnio needle does exist.
- Miscarriage. The rate of miscarriage occurring during standard, second-trimester amnio is approximately 0.5%. This compares to a miscarriage rate of 1% for CVS. Many fetuses with severe genetic defects miscarry naturally during the first trimester.
- The trauma of difficult family-planning decisions. The threat posed to parental and family mental health from the trauma accompanying an abnormal test result can not be underestimated.

### Normal results

Negative results from an amnio analysis indicate that everything about the fetus appears normal and the pregnancy can continue without undue concern. A negative result for Down syndrome means that it is 99% certain that the disease does not exist.

An overall “normal” result does not, however, guarantee that the pregnancy will come to term, or that the fetus does not suffer from some other defect. Laboratory tests are not 100% accurate at detecting targeted conditions, nor can there be a test for every possible fetal condition.

### Abnormal results

Positive results on an amnio analysis indicate the presence of a fetal defect, with an accuracy approaching 100%. With such a diagnosis, prospective parents face emotionally and ethically difficult choices regarding prenatal treatment options, the prospect of treating the defect at birth, and the option of elective abortion. At this point, the parents need expert medical advice and counseling.

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Amniotic fluid analysis see **Amniocentesis**

## Amputation

### Definition

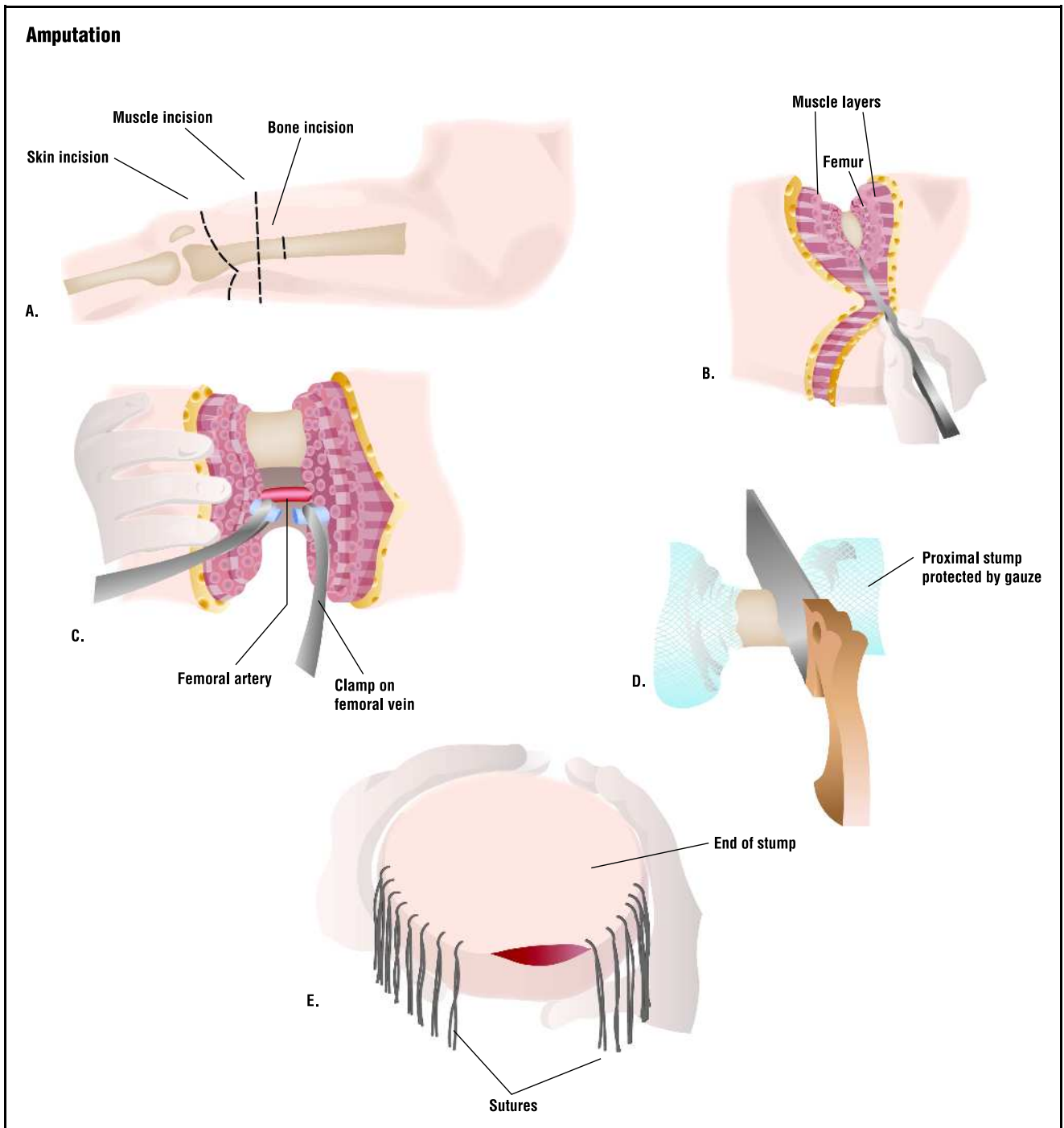
Amputation is the surgical removal of a limb or body part. It is performed to remove diseased tissue or relieve pain.

### Purpose

Arms, legs, hands, feet, fingers, and toes can all be amputated. In the United States, there are approximately 350,000 amputees, with some 135,000 new amputations occurring each year. The number of amputees worldwide is not currently known.

Here in the United States, the most common causes of amputation of the lower extremity are: disease (70%), trauma (22%), congenital or birth defects (4%), and tumors (4%). As for upper extremity amputation, it is usually performed because of trauma or birth defect. Seldom is disease as great a contributing factor. The causes of amputation differ significantly in various countries. For example, countries with a recent history of warfare and civil unrest will have a higher incidence of amputations, due to war itself or its technology (landmines, uncontrolled ordnance, etc).





In an above-the-knee amputation, three incisions are made (A). First the skin and muscle layers are cut (B). The major blood vessels are clamped and severed (C). The bone is cut with a special saw (D). Finally, the muscles are stitched over the bone, and the skin is closed over the wound (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

Among the diseases and conditions that may lead to amputation of an extremity, the most prevalent are:

- hardening of the arteries
- arterial embolism
- impaired circulation as a complication of diabetes mellitus
- gangrene
- severe frostbite

## KEY TERMS

**Arterial embolism**—A blood clot arising from another location that blocks an artery.

**Buerger's disease**—An episodic disease that causes inflammation and blockage of the veins and arteries of the limbs. It tends to be present almost exclusively in men under age 40 who smoke, and may require amputation of the hand or foot.

**Diabetes mellitus**—A disease in which insufficient insulin is made by the body to metabolize sugars.

**Raynaud's disease**—A disease found mainly in young women that causes decreased circulation to the hands and feet. Its cause is unknown.

- Raynaud's disease
- Buerger's disease

More than 90% of amputations performed in the United States are due to circulatory complications of diabetes. Sixty to eighty percent of these operations involve the legs.

## Demographics

Most amputations involve small body parts such as a finger, rather than an entire limb. About 65,000 amputations are performed in the United States each year.

In the United States, there are approximately 350,000 amputees, with some 135,000 new amputations occurring each year. The number of amputees worldwide is not currently known.

## Description

Amputations can be either planned or emergency procedures. Injury and arterial embolisms are the main reasons for emergency amputations. The operation is performed under regional or **general anesthesia** by a general or orthopedic surgeon in a hospital **operating room**.

Details of the operation vary slightly depending on what part is to be removed. All amputations consist of a two-fold surgical procedure: to remove diseased tissue so that the wound will heal cleanly, and to construct a stump that will allow the attachment of a prosthesis or artificial replacement part.

The surgeon makes an incision around the part to be amputated. The part is removed, and the bone is smoothed. A flap is constructed of muscle, connective tissue, and skin to cover the raw end of the bone. The

flap is closed over the bone with sutures (surgical **stitches**) that remain in place for about one month. Often, a rigid dressing or cast is applied that stays in place for about two weeks.

## Diagnosis/Preparation

Before an amputation is performed, extensive testing is done to determine the proper level of amputation. The goal of the surgeon is to find the place where healing is most likely to be complete, while allowing the maximum amount of limb to remain for effective rehabilitation.

The greater the blood flow through an area, the more likely healing is to occur. These tests are designed to measure blood flow through the limb. Several or all of them can be done to help choose the proper level of amputation.

- measurement of blood pressure in different parts of the limb
- xenon 133 studies, which use a radiopharmaceutical to measure blood flow
- oxygen tension measurements in which an oxygen electrode is used to measure oxygen pressure under the skin (If the pressure is 0, the healing will not occur. If the pressure reads higher than 40mm Hg [40 milliliters of mercury], healing of the area is likely to be satisfactory.)
- laser doppler measurements of the microcirculation of the skin
- skin fluorescent studies that also measure skin microcirculation
- skin perfusion measurements using a blood pressure cuff and photoelectric detector
- infrared measurements of skin temperature

No one test is highly predictive of healing, but taken together, the results give the surgeon an excellent idea of the best place to amputate.

## Aftercare

After amputation, medication is prescribed for pain, and patients are treated with **antibiotics** to discourage infection. The stump is moved often to encourage good circulation. Physical therapy and rehabilitation are started as soon as possible, usually within 48 hours. Studies have shown that there is a positive relationship between early rehabilitation and effective functioning of the stump and prosthesis. Length of stay in the hospital depends on the severity of the amputation and the general health of the amputee, but ranges from several days to two weeks.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Amputations are performed in a hospital, usually by an orthopedic surgeon. Orthopedics is a medical specialty that focuses on the diagnosis, care and treatment of patients with disorders of the bones, joints, muscles, ligaments, tendons, nerves, and skin. These elements make up the musculoskeletal system. The physicians who specialize in this area are called orthopedic surgeons or orthopedists. Orthopedic surgery is a specialty of immense variety, and includes amputation surgery.

Rehabilitation is a long, arduous process, especially for above the knee amputees. Twice daily physical therapy is not uncommon. In addition, psychological counseling is an important part of rehabilitation. Many people feel a sense of loss and grief when they lose a body part. Others are bothered by phantom limb syndrome, where they feel as if the amputated part is still in place. They may even feel pain in this limb that does not exist. Many amputees benefit from joining self-help groups and meeting others who are also living with amputation. Addressing the emotional aspects of amputation often speeds the physical rehabilitation process.

### Risks

Amputation is major surgery. All the risks associated with the administration of anesthesia exist, along with the possibility of heavy blood loss and the development of blood clots. Infection is of special concern to amputees. Infection rates in amputations average 15%. If the stump becomes infected, it is necessary to remove the prosthesis and sometimes to amputate a second time at a higher level.

Failure of the stump to heal is another major complication. Nonhealing is usually due to an inadequate blood supply. The rate of nonhealing varies from 5–30% depending on the facility. Centers that specialize in amputation usually have the lowest rates of complication.

Persistent pain in the stump or pain in the phantom limb is experienced by most amputees to some degree. Treatment of phantom limb pain is difficult. One final complication is that many amputees give up on the rehabilitation process and discard their prosthesis.

## QUESTIONS TO ASK THE DOCTOR

- Is amputation the best solution?
- How long is the procedure?
- How long will it take to recover from the amputation?
- What are the major risks of the surgery?
- What kind of pain will I have after the amputation and for how long?
- What steps will you take to minimize those risks?
- How long will I have to remain in bed?
- When will I be fitted with my first prosthesis?

Better fitting prosthetics and earlier rehabilitation have decreased the incidence of this problem.

### Normal results

The five year survival rate for all lower extremity amputees is less than 50%. For diabetic amputees, the rate is less than 40%. Up to 50% of people who have one leg amputated because of diabetes will lose the other within five years. Amputees who walk using a prosthesis have a less stable gait. Three to five percent of these people fall and break bones because of this instability. Although the fractures can be treated, about half the amputees who suffer them then remain wheelchair bound.

### Alternatives

Alternatives to amputation depend on the medical cause underlying the decision to amputate and the degree of medical urgency. In some cases, drug therapy may be considered as an alternative.

For example, one serious complication of diabetes is the development of foot ulcers that often lead to amputation. Some studies have suggested non-surgical treatment of diabetic foot ulcers with a new, recombinant drug (Becaplermin/Regranex). Combined with competent ulcer nursing, the drug leads to fewer amputations compared to the alternative of ulcer nursing on its own.

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American Diabetes Association. 1701 North Beauregard Street, Alexandria, VA 22311. (800) 342-2383. [www.diabetes.org](http://www.diabetes.org).

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# Anaerobic bacteria culture

## Definition

An anaerobic bacteria culture is a method used to grow anaerobes from a clinical specimen. Obligate anaerobes are bacteria that can live only in the absence of oxygen. Obligate anaerobes are destroyed when exposed to the atmosphere for as briefly as 10 minutes. Some anaerobes are tolerant to small amounts of oxygen. Facultative anaerobes are those organisms that will grow with or without oxygen. The methods of obtaining specimens for anaerobic culture and the culturing procedure are performed to ensure that the organisms are protected from oxygen.

## Purpose

Anaerobic bacterial cultures are performed to identify bacteria that grow only in the absence of oxygen and which may cause human infection. If overlooked or killed by exposure to oxygen, anaerobic infections result in such serious consequences as **amputation**, organ failure, sepsis, meningitis, and **death**. Culture is required to correctly identify anaerobic pathogens and institute effective antibiotic treatment.

## Precautions

It is crucial that the health care provider obtain the sample for culture via **aseptic technique**. Anaerobes are commonly found on mucous membranes and other sites such as the vagina and oral cavity. Therefore, specimens likely to be contaminated with these organisms should not be submitted for culture (e.g., a throat or vaginal swab). Some types of specimens should always be cultured for anaerobes if an infection is suspected. These include abscesses, bites, blood, cerebrospinal fluid and exudative body fluids, deep wounds, and dead tissues. The specimen must be protected from oxygen during collection and transport, and must be transported to the laboratory immediately.

## Description

Anaerobes are normally found within certain areas of the body but result in serious infection when they have access to a normally sterile body fluid or deep tissue that is poorly oxygenated. Some anaerobes normally live in the crevices of the skin, in the nose, mouth, throat, intestine, and vagina. Injury to these tissues (i.e., cuts, puncture wounds, or trauma) especially at or adjacent to the mucous membranes allows anaerobes entry into otherwise sterile areas of the body and is the primary cause of anaerobic infection. A second source of anaerobic infection occurs from the

## KEY TERMS

**Aerobic bacteria**—Bacteria that can grow freely in oxygen-rich environments.

**Aseptic**—Free from living disease-causing organisms; sterile and without contamination.

**Exudative**—Pertaining to fluid, cells, or other matter that has escaped from blood vessels and become deposited in or on tissue.

**Gram staining**—Use of a purple dye to identify pathogens, usually bacteria.

**Immunosuppressed**—The impaired or nonfunctioning state of the immune system.

**Pathogen**—An organism capable of causing disease.

**Sepsis**—The systemic inflammatory response due to an infectious organism circulating throughout the body. Sepsis can progress to severe sepsis and septic shock, where blood pressure drops (hypotension), the blood supply to tissues decreases, and organs fail.

**Venipuncture**—Puncture of a vein with a needle for the purpose of withdrawing a blood sample for analysis.

introduction of spores into a normally sterile site. Spore-producing anaerobes live in the soil and water, and spores may be introduced via wounds, especially punctures. Anaerobic infections are most likely to be found in persons who are immunosuppressed, those treated recently with broad-spectrum **antibiotics**, and persons who have a decaying tissue injury on or near a mucous membrane, especially if the site is foul-smelling.

Some specimens from which anaerobes are likely to be isolated are:

- blood;
- bile;
- bone marrow;
- cerebrospinal fluid;
- direct lung aspirate;
- tissue biopsy from a normally sterile site;
- fluid from a normally sterile site (like a joint);
- dental abscess;
- abdominal or pelvic abscess;
- knife, gunshot, or surgical wound; and
- severe burn.

Some of the specimens that are not suitable for anaerobic cultures include:

- coughed throat discharge (sputum);
- rectal swab;

- nasal or throat swab;
- urethral swab; and
- voided urine.

### *Specimen collection*

The keys to effective anaerobic bacteria cultures include collecting a contamination-free specimen and protecting it from oxygen exposure. Anaerobic bacteria cultures should be obtained from an appropriate site without the health care professional contaminating the sample with bacteria from the adjacent skin, mucus membrane, or tissue. Swabs should be avoided when collecting specimens for anaerobic culture because cotton fibers may be detrimental to anaerobes. Abscesses or fluids can be aspirated using a sterile syringe that is then tightly capped to prevent entry of air. Tissue samples should be placed into a degassed bag and sealed, or into a gasped out screw top vial that may contain oxygen-free prereduced culture medium and tightly capped. The specimens should be plated as rapidly as possible onto culture media that has been prepared.

### *Culture*

Cultures should be placed in an environment that is free of oxygen, at 95°F (35°C) for at least 48 hours before the plates are examined for growth.

Gram staining is performed on the specimen at the time of culture. While infections can be caused by aerobic or anaerobic bacteria or a mixture of both, some infections have a high probability of being caused by anaerobic bacteria. These infections include brain abscesses, lung abscesses, aspiration pneumonia, and dental infections. Anaerobic organisms can often be suspected because many anaerobes have characteristic microscopic morphology (appearance). For example, *Bacteroides* spp. are gram-negative rods that are pleomorphic (variable in size and shape) and exhibit irregular bipolar staining. *Fusobacterium* spp. are often pale gram-negative spindle-shaped rods having pointed ends. *Clostridium* spp. are large gram-positive rods that form spores. The location of the spore (central, subterminal, terminal, or absent) is a useful differential characteristic. The presence of growth, oxygen tolerance, and Gram stain results are sufficient to establish a diagnosis of an anaerobic infection and begin antibiotic treatment with a drug appropriate for most anaerobes such as clindamycin, metronidazole, or vancomycin.

Gram-negative anaerobes and some of the infections they produce include the following genera:



- *Bacteroides* (the most commonly found anaerobes in cultures; intra-abdominal infections, rectal abscesses, soft tissue infections, liver infection);
- *Fusobacterium* (abscesses, wound infections, pulmonary and intracranial infections);
- *Porphyromonas* (aspiration pneumonia, periodontitis); and
- *Prevotella* (intra-abdominal infections, soft tissue infections).

Gram-positive anaerobes include the following:

- *Actinomyces* (head, neck, pelvic infections; aspiration pneumonia);
- *Bifidobacterium* (ear infections, abdominal infections);
- *Clostridium* (gas, gangrene, food poisoning, tetanus, pseudomembranous colitis);
- *Peptostreptococcus* (oral, respiratory, and intra-abdominal infections); and
- *Propionibacterium* (shunt infections).

The identification of anaerobes is highly complex, and laboratories may use different identification systems. Partial identification is often the goal. For example, there are six species of the *Bacteroides* genus that may be identified as the *Bacteroides fragilis* group rather than identified individually. Organisms are identified by their colonial and microscopic morphology, growth on selective media, oxygen tolerance, and biochemical characteristics. These include sugar fermentation, bile solubility, esculin, starch, and gelatin hydrolysis, casein and gelatin digestion, catalase, lipase, lecithinase, and indole production, nitrate reduction, volatile fatty acids as determined by gas chromatography, and susceptibility to antibiotics. The antibiotic susceptibility profile is determined by the microtube broth dilution method. Many species of anaerobes are resistant to penicillin, and some are resistant to clindamycin and other commonly used antibiotics.

## Diagnosis/Preparation

The health care provider should take special care to collect a contamination-free specimen. All procedures must be performed aseptically. The health care professional who collects the specimen should be prepared to take two samples, one for anaerobic culture and one for aerobic culture, since it is unknown whether the pathogen can grow with or without oxygen. In addition, health care professionals should document any antibiotics that the patient is currently taking and any medical conditions that could influence growth of bacteria.

## Aftercare

In the case of vein puncture for anaerobic blood cultures, direct pressure should be applied to the vein puncture site for several minutes or until the bleeding has stopped. An adhesive bandage may be applied, if appropriate. If swelling or bruising occurs, ice can be applied to the site. For collection of specimens other than blood, the patient and the collection site should be monitored for any complications after the procedure.

## Risks

Special care must be taken by the health care team obtaining, transporting, and preparing the specimen for anaerobic culture. Poor methodology may delay the identification of the bacterium, may allow the patient's condition to deteriorate, and may require the patient to provide more samples than would otherwise be required. Patients may experience bruising, discomfort, or swelling at the collection site when tissue, blood, or other fluids are obtained.

## Results

Negative results will show no pathogenic growth in the sample. Positive results will show growth, the identification of each specific bacterium, and its antibiotic susceptibility profile.

## Patient education

A health care team member should explain the specimen collection procedure to the patient. If the patient is seriously ill, the team member should explain the procedure to the patient's family members. The patient and his or her family should understand that because bacteria need time to grow in the laboratory, several days may be required for bacterium identification.

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Analgesia, patient-controlled see **Patient-controlled analgesia**

# Analgesics

## Definition

Analgesics are medicines that relieve pain.

## Purpose

The primary classes of analgesics are the narcotics, including additional agents that are chemically based on the morphine molecule but have minimal abuse potential; **nonsteroidal anti-inflammatory drugs** (NSAIDs) including the salicylates; and **acetaminophen**. Other drugs, notably the tricyclic antidepressants and anti-epileptic agents such as gabapentin, have been used to relieve pain, particularly neurologic pain, but are not routinely classified as analgesics. Analgesics provide symptomatic relief, but generally have no effect on causation.

## Description

Pain has been classified as “productive” pain and “non-productive” pain. While this distinction has no physiologic meaning, it may serve as a guide to treatment. “Productive” pain has been described as a warning of injury, and so may be both an indication of need for treatment and a guide to diagnosis. “Non-productive” pain by definition serves no purpose either as a warning or diagnostic tool.

Although pain syndromes may be dissimilar, the common factor is a sensory pathway from the affected

organ to the brain. Analgesics work at the level of the nerves, either by blocking the signal from the peripheral nervous system, or by distorting the interpretation by the central nervous system. Selection of an appropriate analgesic is based on consideration of the risk-benefit factors of each class of drugs, based on type of pain, severity of pain, and risk of adverse effects. Traditionally, pain has been divided into two classes, acute and chronic, although severity and projected patient survival are other factors that must be considered in drug selection.

### *Acute pain*

Acute pain is self limiting in duration, and includes post-operative pain, pain of injury, and childbirth. Because pain of these types is expected to be short term, the long-term side effects of analgesic therapy may routinely be ignored. Thus, these patients may safely be treated with narcotic analgesics without concern for their addictive potential, or NSAIDs with only limited concern for their ulcerogenic risks. Drugs and doses should be adjusted based on observation of healing rate, switching patients from high to low doses, and from narcotic analgesics to non-narcotics when circumstances permit.

An important consideration of **pain management** in severe pain is that patients should not be subject to the return of pain. Analgesics should be dosed adequately to assure that the pain is at least tolerable, and frequently enough to avoid the anxiety that accompanies the anticipated return of pain. Analgesics should never be dosed on a “prn” (as needed) basis, but should be administered often enough to assure constant blood levels of analgesic. This applies to both the narcotic and non-narcotic analgesics.

## KEY TERMS

**Acute pain**—Pain that is usually temporary and results from something specific, such as a surgery, an injury, or an infection.

**Chronic pain**—Pain that lasts more than three months and threatens to disrupt daily life.

**Dose limiting**—Case in which the side effects of a drug prevent an increase in dose.

**Inflammation**—Pain, redness, swelling, and heat that usually develops in response to injury or illness.

**Osteoarthritis**—Joint pain resulting from damage to the cartilage.

### Chronic pain

Chronic pain, pain lasting over three months and severe enough to impair function, is more difficult to treat, since the anticipated side effects of the analgesics are more difficult to manage. In the case of narcotic analgesics this means the addiction potential, as well as respiratory depression and constipation. For the NSAIDs, the risk of gastric ulcers may be dose limiting. While some classes of drugs, such as the narcotic agonist/antagonist drugs buprenorphine, nalbuphine and pentazocine, and the selective COX-2 inhibitors celecoxib and rofecoxib represent advances in reduction of adverse effects, they are still not fully suitable for long-term management of severe pain. Generally, chronic pain management requires a combination of drug therapy, life-style modification, and other treatment modalities.

### Narcotic analgesics

The narcotic analgesics, also termed opioids, are all derived from opium. The class includes morphine, codeine, and a number of semi-synthetics including meperidine (Demerol), propoxyphen (Darvon), and others. The narcotic analgesics vary in potency, but all are effective in treatment of pain when used in adequate doses. Adverse effects are dose related. Because these drugs are all addictive, they are controlled under federal and state laws. A variety of dosage forms are available, including oral solids, liquids, intravenous and intrathecal injections, and transcutaneous patches.

NSAIDs, non-steroidal anti-inflammatory drugs, are effective analgesics even at doses too low to have any anti-inflammatory effects. There are a number of chemical classes, but all have similar therapeutic effects and side effects. Most are appropriate only for oral administration; however ketorolac (Toradol) is appropriate for injection and may be used for moderate to severe pain for short periods.

Acetaminophen is a non-narcotic analgesic with no anti-inflammatory properties. It is appropriate for mild to moderate pain. Although the drug is well tolerated in normal doses, it may have significant toxicity at high doses. Because acetaminophen is largely free of side effects at therapeutic doses, it has been considered the first choice for mild pain, including that of osteoarthritis.

### Recommended dosage

Appropriate dosage varies by drug, and should consider the type of pain, as well as other risks associated with patient age and condition. For example,

narcotic analgesics should usually be avoided in patients with a history of substance abuse, but may be fully appropriate in patients with cancer pain. Similarly, because narcotics are more rapidly metabolized in patients who have used these drugs for a long period, higher than normal doses may be needed to provide adequate pain management. NSAIDs, although comparatively safe in adults, represent an increased risk of gastrointestinal bleeding in patients over the age of 60.

### Precautions

Narcotic analgesics may be contraindicated in patients with respiratory depression. NSAIDs may be hazardous to patients with ulcers or an ulcer history. They should be used with care for patients with renal insufficiency or coagulation disorders. NSAIDs are contraindicated in patients allergic to aspirin.

### Side effects

Adverse effects of each drug vary individually. Drugs within a class may vary in their frequency and severity of adverse effects.

The primary adverse effects of the narcotic analgesics are addiction, constipation, and respiratory depression. Because narcotic analgesics stimulate the production of enzymes that cause the metabolism of these drugs, patients on narcotics for a prolonged period may require increasing doses. This is not the same thing as addiction, and is not a reason for withholding medication from patients in severe pain.

NSAIDs are ulcerogenic and may cause kidney problems. Gastrointestinal discomfort is common, although in some cases, these drugs may cause ulcers without the prior warning of gastrointestinal distress. Platelet aggregation problems may occur, although not to the same extent as if seen with aspirin.

### Interactions

Interactions depend on the specific type of analgesic. Patients should see specific drug references or ask their physician.

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## Analgesics, opioid

### Definition

Opioid **analgesics**, also known as narcotic analgesics, are pain relievers that act on the central nervous system. Like all narcotics, they may become habit-forming if used over long periods.

### Purpose

Opioid analgesics are used to relieve pain from a variety of conditions. Some are used before or during surgery, including dental surgery, both to relieve pain and to make anesthetics work more effectively. They may also be used for the same purposes during labor and delivery.

### Description

Opioid analgesics relieve pain by acting directly on the central nervous system. This can also lead to unwanted side effects, such as drowsiness, dizziness, breathing problems, and physical or mental dependence.

Among the drugs in this category are codeine; propoxyphene (Darvon); propoxyphene and **acetaminophen** (Darvocet N); meperidine (Demerol); hydromorphone (Dilaudid); morphine; oxycodone; oxycodone and acetaminophen (Percocet, Roxicet); and hydrocodone and acetaminophen (Lortab, Anexsia). These drugs come in many forms—tablets, syrups, suppositories, and injections—and are sold only by prescription. For some

## KEY TERMS

**Analgesic**—Medicine used to relieve pain.

**Central nervous system**—The brain, spinal cord, and nerves throughout the body.

**Colitis**—Inflammation of the colon, or large bowel.

**Enzyme**—A protein, produced by cells, that causes chemical changes in other substances.

**Hallucination**—A false or distorted perception of objects, sounds, or events that seem real. Hallucinations usually result from drugs or mental disorders.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

**Metabolize**—The chemical changes that occur in the body, including the changes that occur in the liver, converting molecules to forms that are more easily removed from the body.

**Narcotic**—A drug derived from opium or compounds similar to opium. Such drugs are potent pain relievers and can affect mood and behavior. Long-term use of narcotics can lead to dependence and tolerance.

**Tolerance**—A decrease in sensitivity to a drug. When tolerance occurs, a person must take more of the drug to get the same effect.

**Withdrawal symptoms**—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug to which he or she has become dependent.

drugs, a new prescription is required for each new supply; refills are prohibited, according to federal regulations.

### Recommended dosage

Recommended doses vary depending on the type of opioid analgesic and the form in which it is being used. Doses may be different for different patients. The person should check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage, and to understand how to take the drug.

A patient should always take opioid analgesics exactly as directed. Larger or more frequent doses should never be taken, and the drug should not be taken for longer than directed. The person should not stop taking the drug suddenly without checking with the physician or dentist who prescribed it.



Gradually tapering the dose may reduce the risk of withdrawal symptoms.

For pain following major surgery, it is common practice to give narcotic analgesics by intravenous injection for the first 24–48 hours. This may be followed by oral narcotics for the next 24–48 hours, and then non-narcotic analgesics.

Many hospitals use patient-controlled analgesia (PCA), a system in which the analgesics are given intravenously, which is in a vein, and the patient can control the dose by pushing a button on a pump. This system lets the patient have more control over the amount of medication needed to relieve pain, and eliminates the anxiety that comes from expecting the return of pain when the dose wears off.

### Precautions

Anyone who uses opioid analgesics—or any narcotic—over a long time may become physically or mentally dependent on the drug. Physical dependence may lead to withdrawal symptoms when the person stops taking the medicine. Building tolerance to these drugs is also possible when they are used for a long period. The need for larger and more frequent doses is due to enzyme induction, in which narcotics are metabolized by the liver and changed to a form that can be eliminated from the body. The metabolism of narcotics relies on enzymes that are produced by the liver. As narcotics are used, the liver produces more and more of these enzymes, so that a dose of pain medication is removed from the body more rapidly. This is not a problem when narcotics are used for surgical pain, since this type of pain only lasts for a short time.

Opioid analgesics should be taken exactly as directed. It is not advised to take more than the recommended dose, or more often than directed. If the drugs do not seem to be working, the physician should be consulted. These drugs (or any other prescription drugs) should never be shared with others because the drug may have a completely different effect on different people.

Children and older people are especially sensitive to opioid analgesics and may have serious breathing problems after taking them. Children may also become unusually restless or agitated when given these drugs. These problems can be controlled by adjusting the dose of medication to a safer level.

Opioid analgesics increase the effects of alcohol. Anyone taking these drugs should not drink alcoholic beverages. Some of these drugs may also contain **aspirin**, caffeine, or acetaminophen. A person should

refer to the entries on each of these drugs for additional precautions.

### Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take opioid analgesics. Before prescribing these drugs, the physician should be informed of any of these conditions.

**ALLERGIES.** The patient should let the physician know about any allergies to foods, dyes, preservatives, or other substances, and about any previous reactions to opioid analgesics.

**PREGNANCY.** Women who are pregnant or plan to become pregnant while taking opioid analgesics should let their physicians know. No evidence exists that these drugs cause birth defects in people, but some do cause birth defects and other problems when given to pregnant animals in experiments. Babies can become dependent on opioid analgesics if their mothers use too much during pregnancy. This can cause the baby to go through withdrawal symptoms after birth. If taken just before delivery, some opioid analgesics may cause serious breathing problems in the newborn.

**BREAST-FEEDING.** Some opioid analgesics can pass into breast milk. Women who are breast-feeding should check with their physicians about the safety of taking these drugs.

**OTHER MEDICAL CONDITIONS.** These conditions may influence the effects of opioid analgesics:

- head injury—the effects of some opioid analgesics may be stronger and may interfere with recovery in people with head injuries;
- history of convulsions—some of these drugs may trigger convulsions;
- asthma, emphysema, or any chronic lung disease;
- heart disease;
- kidney disease;
- liver disease;
- underactive thyroid—the chance of side effects may be greater;
- Addison's disease, a disease of the adrenal glands;
- colitis;
- gallbladder disease or gallstones—side effects can be dangerous in people with these conditions;
- enlarged prostate or other urinary problems;
- current or past alcohol abuse;
- current or past drug abuse, especially narcotic abuse; or
- current or past emotional problems—the chance of side effects may be greater.



**USE OF CERTAIN MEDICINES.** Taking opioid narcotics with certain other drugs may increase the chances of serious side effects. In some cases, the physician may combine narcotic analgesics with other drugs that increase the activity of the analgesic. These include some sedatives, tranquilizers, and antihistamines. When these drugs are used together with narcotic analgesics, it may be possible to get the same pain relief with a lower dose of narcotic.

### Side effects

Some people experience drowsiness, dizziness, lightheadedness, or a false sense of well-being after taking opioid analgesics. Anyone who takes these drugs should not drive, use machinery, or do anything else that might be dangerous until they know how the drug affects them. Nausea and vomiting are common side effects, especially when first beginning to take the medicine. If these symptoms do not go away after the first few doses, the person should check with the physician or dentist who prescribed the medicine.

Dry mouth is another common side effect, which can be relieved by sucking on sugarless hard candy or ice chips or by chewing sugarless gum. Saliva substitutes, which come in liquid or tablet forms, may also help. Patients who must use opioid analgesics over long periods and who have dry mouth should see their dentists, as the problem can lead to tooth decay and other dental problems.

The following side effects are less common. They usually do not need medical attention and will go away after the first few doses. If they continue or interfere with normal activity, the patient should check with the physician who prescribed the medicine for. The side effects include:

- headache;
- loss of appetite;
- restlessness or nervousness;
- nightmares, unusual dreams, or problems sleeping;
- weakness or tiredness;
- mental sluggishness;
- stomach pain or cramps;
- blurred or double vision or other vision problems;
- problems urinating, such as pain, difficulty urinating, frequent urge to urinate, or decreased amount of urine; and
- constipation.

Other side effects may be more serious and may require quick medical attention. These symptoms could be signs of an overdose. The person should get emergency medical care immediately if he or she experiences:

- cold, clammy skin;
- bluish discoloration of the skin;
- extremely small pupils;
- serious difficulty breathing or extremely slow breathing;
- extreme sleepiness or unresponsiveness;
- severe weakness;
- confusion;
- severe dizziness;
- severe drowsiness;
- slow heartbeat;
- low blood pressure; and/or
- severe nervousness or restlessness.

In addition, the following less-common side effects do not require emergency medical care, but should have medical attention as soon as possible, and include:

- hallucinations, or a sense of unreality;
- depression or other mood changes;
- ringing or buzzing in the ears;
- pounding or unusually fast heartbeat;
- itching, hives, or rash;
- facial swelling;
- trembling or twitching;
- dark urine, pale stools, or yellow eyes or skin (after taking propoxyphene); or
- increased sweating, red or flushed face, which are more common after taking hydrocodone and meperidine.

### Interactions

Anyone taking the following drugs should notify his or her physician before taking opioid analgesics:

- central nervous system (CNS) depressants such as antihistamines and other medicines for allergies, hay fever, or colds; tranquilizers; some other prescription pain relievers; seizure medicines; sleeping pills; some anesthetics, including dental anesthetics;
- monoamine oxidase (MAO) inhibitors such as phenelzine (Nardil) and tranylcypromine (Parnate). The combination of the opioid analgesic meperidine (Demerol) and MAO inhibitors is especially dangerous;
- tricyclic antidepressants such as amitriptyline (Elavil);
- anti-seizure medicines such as carbamazepine (Tegretol), which may lead to serious side effects, including

coma, when combined with propoxyphene and acetaminophen (Darvocet-N) or propoxyphene (Darvon);

- muscle relaxants such as cyclobenzaprine (Flexeril);
- sleeping pills such as triazolam (Halcion);
- blood-thinning drugs such as warfarin (Coumadin);
- Naltrexone (Trexan, Revia), which cancels the effects of opioid analgesics;
- Rifampin (Rifadin); or
- Zidovudine (AZT, Retrovir), which causes serious side effects when combined with morphine.

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## Anesthesia evaluation

### Definition

Anesthesia evaluation refers to the series of interviews, physical examinations, and laboratory tests that are generally used in North America and western Europe to assess the general fitness of patients scheduled for surgery and to determine the need for special precautions or additional testing. There is no universally accepted definition of anesthesia evaluation as of 2003; however, the Task Force on Preanesthesia Evaluation of the American Society of Anesthesiologists (ASA) has tentatively defined it as “...the process of clinical assessment that precedes the delivery of anesthesia care for surgery and for non-surgical procedures.” Anesthesia evaluation is usually discussed in the context of elective or scheduled surgical procedures rather than **emergency surgery**.

Anesthesia evaluation is a relatively recent development in preoperative patient care. Prior to the 1970s, anesthesiologists were often given only brief notes or outlines of the patient’s history and **physical examination** written by the operating surgeon or the patient’s internist. This approach became increasingly

unsatisfactory as the practice of anesthesiology became more complex. In the last four decades, the introduction of new anesthetics and other medications, laser-assisted surgical procedures, increasingly sophisticated monitoring equipment, and new discoveries in molecular biochemistry and genetics have made the **anesthesiologist’s role** more demanding. During the 1980s and 1990s, some departments of anesthesiology in large urban medical centers and major university teaching hospitals began to set up separate clinics for anesthesia evaluation in order to improve the assessment of patients before surgery.

### Purpose

Anesthesia evaluation has several different purposes. The information that is obtained during the evaluation may be used to:

- Guide the selection of anesthetics and other medications to be used during surgery.
- Plan for the patient’s postoperative recovery and pain management.
- Educate the patient about the operation itself, the possible outcomes, and self-care during recovery at home.
- Determine the need for additional staff during or after surgery.
- Minimize confusion caused by rescheduling operations because of last-minute discoveries about patients’ health.
- Improve patient safety and quality of care by collecting data for later review and analysis. The ASA has noted that few controlled trials of different approaches to anesthesia evaluation have been conducted as of 2003, and that further research is needed.

### Description

There are several parts or stages in a typical anesthesia evaluation. The evaluation itself may be done in the hospital where the operation is scheduled, or in a separate facility attached to the hospital. The timing of the evaluation is affected by two major variables: the invasiveness of the operation to be performed and the patient’s overall physical condition. An invasive operation or procedure is one that requires the surgeon to insert a needle, catheter, or instrument into the body or a part of the body. Surgical procedures are classified as high, medium, or low in invasiveness. Procedures that involve opening the chest, abdomen, or skull are usually considered highly invasive. Examples of less invasive procedures would include **tooth extraction**, most forms of **cosmetic surgery**, and operations on the hands and feet.

The patient's physical condition is classified according to the ASA's six-point system, with the letter E added to the classification if an emergency surgical procedure is performed. The classification system is as follows:

- P1. Normal healthy patient.
- P2. Patient with mild systemic disease.
- P3. Patient with severe systemic disease.
- P4. Patient with severe systemic disease that is life-threatening.
- P5. Moribund (dying) patient who is not expected to survive without an operation.
- P6. Brain-dead patient whose organs are being removed for donation.

As of 2003, the ASA recommends that patients with severe disease be interviewed and have their physical examination before the day of surgery. Patients in good health or with mild systemic disease who are scheduled for a highly invasive procedure should also be interviewed and examined before the day of surgery. Patients in categories P1 and P2 who are scheduled for low- or medium-invasive procedures may be evaluated on the day of surgery or before it.

### *Patient history and records*

The first part of an anesthesia evaluation is the anesthesiologist's review of the patient's medical history and records. This review allows the anesthesiologist to evaluate the patient for risk factors that may increase the patient's sensitivity to the sedatives or other medications given before and during the operation; increase the danger of complications related to heart function and breathing; and increase the difficulty of treating such complications.

These risk factors may include:

- Heart or lung disease. These diseases often require the anesthesiologist to lower the dosages of sedatives and pain-control medications.
- Liver or kidney disease. Disorders of these organs often slow down the rate of medication clearance from the patient's body.
- Present prescription medications. These may interact with the sedatives given before the operation or with the anesthetic agent.
- Herbal preparations and other alternative medicines. Some herbal preparations, particularly those taken for insomnia or anxiety (St. John's wort, valerian, kava kava) may intensify the effects of anesthetics. Others, like ginseng or ginkgo biloba, may affect blood pressure or blood clotting. It is important for

## KEY TERMS

**Anesthesiologist**—A doctor of medicine (MD) or osteopathy (DO) who has completed advanced training in administering anesthesia and monitoring patients' well-being during surgery. Many anesthesiologists have completed additional training in critical care medicine or pain management.

**Bronchospasm**—A spasmodic contraction of the muscles that line the two branches of the trachea that lead into the lungs, causing difficulty in breathing. Bronchospasm is a common complication in heavy smokers under anesthesia.

**Clearance**—The rate at which a drug or other substance is removed from the blood by the liver or kidneys.

**Indicated test**—A test that is given for a specific clinical reason.

**Invasiveness**—A term that refers to the extent of surgical intrusion into the body or a part of the body. An invasive procedure is one that requires the insertion of a needle, catheter, or surgical instrument.

**Nurse anesthetist**—A registered nurse who has obtained advanced training in anesthesia delivery and patient care.

**Routine test**—A medical test performed on all patients without regard to specific medical conditions.

**Sedative**—A type of medication given to calm or relax patients before surgery.

patients to include alternative health products in the list of medications that they give the doctor.

- Allergies, particularly allergies to medications.
- Alcohol or substance abuse. Substance use typically affects patients' responses to sedatives and anesthetics in one of two ways. If the patient has developed a tolerance for alcohol or another drug of abuse, he or she may require an increased dose of sedatives or pain medications. On the other hand, if the patient has recently consumed a large amount of alcohol or other mood-altering substance, it may interact with the anesthetic by intensifying its effects.
- Smoking. Smoking increases the risk of coughing, bronchospasm, or other airway problems during the operation.
- Previous adverse reactions to sedatives or anesthetics. A family history of anesthesia problems or sudden or unexplained death during surgery should

be included because some adverse reactions to anesthesia can be inherited.

- **Age.** The elderly and children below the age of puberty do not respond to medications in the same way as adults, and the anesthesiologist must often adjust dosages. In addition, elderly patients often take a number of different prescription medications, each of which may interact with anesthetics in a different way.

### *Patient interview*

During the anesthesia evaluation, the anesthesiologist is responsible for interviewing the patient or the parents or guardians of a minor, or the next of kin, if the patient is unable to communicate. The interview serves in part as additional verification of the patient's identity; cases have been reported in which patients have been scheduled for the wrong procedure because of administrative errors. The anesthesiologist will check the patient's name, date of birth, medical record number, and type or location of scheduled surgery for any inconsistencies. Although the anesthesiologist will ask for some of the same information that is included in the patient's written medical records, he or she may have additional questions. Moreover, it is not unusual for patients to recall significant events or details during the interview that were left out of the written records. The anesthesiologist will explain what will happen during the operation and give instructions about fasting, discontinuing medications, and other precautions that the patient should take before the procedure. The patient will have an opportunity to ask questions about choice of anesthetic and other concerns during the interview.

### *Physical examination*

The physical examination will focus on three primary areas of concern: the heart and circulatory system; the respiratory system; and the patient's airway. Heart and lung function are evaluated because surgery under **general anesthesia** puts these organ systems under considerable stress. The usual tests performed to evaluate heart and lung fitness are an **electrocardiogram (ECG)** and chest x-ray (CXR). These tests may be omitted if the patient was tested within the previous six months and the results were normal. If the patient has an ECG and CXR as part of the anesthesia evaluation and the findings are abnormal, the doctor may order additional tests of heart and lung function. These may include stress or **exercise** tests; **echocardiography**; **angiography**; pulmonary function tests (PFTs); and a computed tomography (CT) scan of the lungs.

Assessment of the airway includes an examination of the patient's teeth, nasal passages, mouth, and throat to check for any signs of disease or structural

abnormalities. Certain physical features, such as an abnormally shaped windpipe, prominent upper incisor teeth, an abnormally small mouth opening, a short or inflexible neck, a throat infection, large or swollen tonsils, and a protruding or receding chin can all increase the risk of airway problems during the operation. A commonly used classification scheme rates patients on a four-point scale, with Class I being the least likely to have airway problems under anesthesia and Class IV the most likely.

### *Laboratory tests*

Laboratory tests are categorized as either routine, meaning that they are given to all patients as part of the anesthesia evaluation, or indicated, which means that the test is ordered for a specific reason for a particular patient. Routine preoperative laboratory tests include blood tests and urine tests. Blood samples are taken for white and red blood cell counts and coagulation studies; tests of kidney function, most commonly measurements of **blood urea nitrogen (BUN)** and creatinine; and measurements of blood glucose and electrolyte levels. Urine samples are taken to evaluate the patient's nutritional status, to test for diabetes or the presence of a urinary tract infection, and to determine whether the patient is dehydrated. Some hospitals will accept blood and urine tests performed within six weeks of the operation if the results were within normal ranges. Some facilities also routinely test urine samples from women of childbearing age for pregnancy.

Indicated laboratory tests include platelet counts, certain blood chemistry measurements, and measurements of blood hemoglobin levels. These tests are usually performed for patients with blood or endocrine disorders; persons taking blood-thinning medications; persons who have been treated with some types of alternative therapy; and persons who are known to have kidney or liver disorders.

### *Consultations*

The anesthesiologist may consult other doctors as part of the anesthesia evaluation in order to obtain additional information about the patient's condition. Consultations are often necessary if the patient is very young or very old; is being treated for cancer; or has a rare disease or disorder.

### *Preparation*

Patients can prepare for an anesthesia evaluation by gathering information beforehand to give the hospital or clinic staff. This information includes such matters as insurance cards and documentation; a list



of medications presently taken and their dosages; a list of previous operations or hospitalizations, if any; the names and telephone numbers of other physicians who have been consulted within the past two years; information about allergies to medications, if any; the name and telephone number of a designated family member or primary contact; and similar matters.

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## Anesthesia, general

### Definition

General anesthesia is the induction of a balanced state of unconsciousness, accompanied by the absence of pain sensation and the paralysis of skeletal muscle over the entire body. It is induced through the administration of anesthetic drugs and is used during major surgery and other invasive surgical procedures.

### Purpose

General anesthesia is intended to bring about five distinct states during surgery:

- analgesia, or pain relief;
- amnesia, or loss of memory of the procedure;
- loss of consciousness;
- motionlessness; and
- weakening of autonomic responses.

### Precautions

A complete medical history, including a history of allergies in family members, or deaths occurring during surgery is an important precaution. Patients may have a potentially fatal response to anesthesia known



Administering general anesthesia. (vario images GmbH & Co.KG / Alamy)



as malignant hyperthermia, even if there is no previous personal history of reaction.

General anesthetics should be administered only by board-certified medical professionals. Anesthesia providers consider many factors, including a patient's age, weight, allergies to medications, medical history, and general health when deciding which anesthetic or combination of anesthetics to use. The American Society of Anesthesiologists has compiled guidelines for classifying patients according to risk levels as follows:

- I: healthy patient
- II: patient with mild systemic disease without functional limitations
- III: patient with severe systemic disease with definite functional limitations
- IV: patient with severe systemic disease that is life-threatening
- V: dying patient not expected to survive for 24 hours without an operation

Equipment for general anesthesia should be thoroughly checked before the operation; all items that might be needed, such as extra tubes or laryngoscope blades, should be available. Staff members should be knowledgeable about the problems that might arise with the specific anesthetic being used, and be able to recognize them and respond appropriately. General anesthetics cause a lowering of the blood pressure (hypotension), a response that requires close monitoring and special drugs to reverse it in emergency situations.

### Description

General anesthetics may be gases or volatile liquids that evaporate as they are inhaled through a mask along with oxygen. Other general anesthetics are given intravenously. The amount of anesthesia produced by inhaling a general anesthetic can be adjusted rapidly, if necessary, by adjusting the anesthetic-to-oxygen ratio that is inhaled by the patient. The degree of anesthesia produced by an intravenously injected anesthetic cannot be changed as rapidly and must be reversed by administration of another drug.

The precise mechanism of general anesthesia is not yet fully understood. There are, however, several hypotheses that may explain why general anesthesia occurs. It is known that anesthetics act in several different ways in the central nervous system. They may interfere with the normal release of neurotransmitters or alter the re-uptake of neurotransmitters and disrupt normal synaptic transmission. The Meyer-Overton theory suggests that anesthesia occurs when a sufficient number of molecules of an inhalation anesthetic dissolve

### KEY TERMS

**Analgesia**—Relief from pain.

**Anticholinergics**—Drugs that interfere with impulses from the parasympathetic nervous system. They may be given before general anesthesia to reduce airway secretions or the risk of bronchospasm.

**Anxiolytics**—Medications given to reduce anxiety; tranquilizers. Benzodiazepines are the anxiolytics most commonly used to premedicate patients before general anesthesia.

**Balanced anesthesia**—The use of a combination of inhalation and intravenous anesthetics, often with opioids for pain relief and neuromuscular blockers for muscle paralysis.

**Clathrates**—Substances in which a molecule from one compound fills a space within the crystal lattice of another compound. One theory of general anesthesia proposes that water molecules interact with anesthetic molecules to form clathrates that decrease receptor function.

**Laryngoscope**—An endoscope equipped for viewing a patient's larynx through the mouth.

**Malignant hyperthermia**—A type of allergic reaction (probably with a genetic basis) that can occur during general anesthesia in which the patient experiences a high fever, the muscles become rigid, and the heart rate and blood pressure fluctuate.

**Volatile anesthetics**—Another name for inhalation anesthetics.

in the lipid cell membrane. Another theory maintains that protein receptors in the central nervous system are involved, in that inhalation anesthetics inhibit the enzyme activity of proteins. A hypothesis, proposed by Linus Pauling in 1961, suggests that anesthetic molecules interact with water molecules to form clathrates (hydrated microcrystals), which in turn inhibit receptor function. Lastly, another theory describes the activation of gamma-aminobutyric acid (GABA) receptors, hypothesizing that the anesthetics may activate GABA channels and hyperpolarise cell membranes. They also may prevent the release of neurotransmitters by inhibiting certain calcium channels.

### Stages of anesthesia

There are four stages of general anesthesia that help providers to better predict the course of events, from anesthesia induction to emergence.

- Stage I begins with the induction of anesthesia, the patient is still conscious and can carry on a conversation, though this stage ends with the patient's loss of consciousness. The patient is able to feel pain in Stage I.
- Stage II, or REM stage, is also known as the excitement stage and may include uninhibited and sometimes dangerous responses to stimuli, including vomiting and uncontrolled movement. The patient may become violent. During this stage, blood pressure rises and may become irregular and breathing rate increases. This stage is typically shortened by administering a barbiturate, such as sodium pentothal, before the anesthetic agent.
- Stage III, or surgical anesthesia, is the stage in which the patient's pupillary gaze is central and the pupils are constricted. This is the target depth of surgical anesthesia. During this stage, the skeletal muscles relax, the patient's breathing becomes regular, and eye movements stop.
- Stage IV, also known as medullary paralysis, occurs if the respiratory centers in the brain stop functioning. This is marked by hypotension or circulatory failure. Death may result if the patient cannot be revived quickly. This stage should never be reached and can be prevented by careful control of the amount of anesthetic that is administered to the patient.
- Nitrous oxide (laughing gas) is used with other such drugs as thiopental to produce surgical anesthesia. It has the fastest induction and recovery time. It is regarded as the safest inhalation anesthetic because it does not slow respiration or blood flow to the brain. Nitrous oxide is a relatively weak anesthetic, therefore it is not suited for use in major surgery. Although it may be used alone for dental anesthesia, it should not be used as a primary agent in more extensive procedures.
- Sevoflurane works quickly and can be administered through a mask since it does not irritate the airway. On the other hand, one of the breakdown products of sevoflurane can cause renal damage.
- Desflurane, a second-generation version of isoflurane, is irritating to the airway and therefore cannot be used for mask (inhalation) inductions, especially not in children. Desflurane causes an increase in heart rate, and so should be avoided for patients with heart problems. Its advantage is that it provides a rapid awakening with few adverse effects.

**INTRAVENOUS ANESTHETICS.** Commonly administered intravenous general anesthetics include ketamine, thiopental (a barbiturate), methohexital (Brevital), etomidate, and propofol (Diprivan). Ketamine produces a different set of reactions from other intravenous anesthetics. It resembles phencyclidine, which is a street drug that may cause hallucinations. Because patients who have been anesthetized with ketamine often have sensory illusions and vivid dreams during post-operative recovery, ketamine is not often given to adult patients. It is, however, useful in anesthetizing children, patients in shock, and trauma casualties in war zones where anesthesia equipment may be difficult to obtain.

### *Types of anesthetic agents*

There are two major types of anesthetics used for general anesthesia, inhalation and intravenous anesthetics. Inhalation anesthetics, which are sometimes called volatile anesthetics, are compounds that enter the body through the lungs and are carried by the blood to body tissues. Inhalation anesthetics are less often used alone in modern clinical practice; they are usually used together with intravenous anesthetics. A combination of inhalation and intravenous anesthetics, often with opioids added for pain relief and neuromuscular blockers for muscle paralysis, is called balanced anesthesia.

**INHALATION ANESTHETICS.** The following are the most commonly used inhalation anesthetics:

- Halothane causes unconsciousness but provides little pain relief; often administered with analgesics. It may be toxic to the liver in adults. Halothane, however, has a pleasant smell and is therefore often the anesthetic of choice when mask induction is used with children.
- Enflurane is less potent, but produces a rapid onset of anesthesia and possibly a faster recovery. Enflurane is not used in patients with kidney failure.
- Isoflurane is not toxic to the liver but can induce irregular heart rhythms.

### *General anesthesia in dental procedures*

The use of general anesthesia in dental and oral surgery patients differs from its use in major surgery because the patient's level of fear is usually a more important factor than the nature of the procedure. In 1985, an NIH Consensus Statement reported that high levels of preoperative anxiety, lengthy and complex procedures, and the need for a pain-free operative period may be indications for general anesthesia in healthy adults and very young children. The NIH statement specified that at least three professionals are required when general anesthesia is used during dental procedures: one is the operating dentist; the second is a professional responsible for observing and monitoring the patient; the third person assists the operating dentist.

Although the United States allows general anesthesia for dental procedures to be administered outside

hospitals (provided that the facility has the appropriate equipment and emergency drugs), Scotland banned the use of general anesthesia outside hospitals in 2000, after a ten-year-old boy died during a procedure to have a tooth removed.

## Preparation

Preparation for general anesthesia includes the taking of a complete medical history and the evaluation of all factors—especially a family history of allergic responses to anesthetics or unexplained deaths during surgery—that might influence the patient's response to specific anesthetic agents.

Patients should not eat or drink before general anesthesia because of the risk of regurgitating food and liquid or aspirating vomitus into the lungs.

## Informed consent

Patients should be informed of the risks associated with general anesthesia as part of their **informed consent**. These risks include possible dental injuries from intubation as well as such serious complications as stroke, liver damage, or massive hemorrhage. If **local anesthesia** is an option for some procedures, the patient should be informed of this alternative. In all cases, patients should be given the opportunity to ask questions about the risks and benefits of the procedure requiring anesthesia as well as questions about the anesthesia itself.

## Premedication

Depending on the patient's level of anxiety and the procedure to be performed, the patient may be premedicated. Most medications given before general anesthesia are either anxiolytics, usually benzodiazepines; or **analgesics**. Patients in severe pain prior to surgery may be given morphine or fentanyl. Anticholinergics (drugs that block impulses from the parasympathetic nervous system) may be given to patients with a known history of bronchospasm or heavy airway secretions.

## Aftercare

The anesthetist and medical personnel provide supplemental oxygen and monitor patients for **vital signs** and monitor their airways. Vital signs include an EKG (unless the patient is hooked up to a monitor), blood pressure, pulse rate, oxygen saturation, respiratory rate, and temperature. The staff also monitors the patient's level of consciousness as well as signs of excess bleeding from the incision.

## Risks

Although the risk of serious complications from general anesthesia are low, they can include heart attack, stroke, brain damage, and **death**. The risk of complications depends in part on the patient's age, sex, weight, allergies, general health, and history of smoking, alcohol or drug use.

The overall risk of mortality from general anesthesia is difficult to evaluate, because so many different factors are involved, ranging from the patient's overall health and the circumstances preceding surgery to the type of procedure and the skill of the physicians involved. The risk appears to be somewhere between 1:1,000 and 1:100,000, with infants younger than age one and patients older than 70 being at greater risk.

## Awareness during surgery

One possible complication is the patient's waking up during the operation. It is estimated that approximately 1–2 per 1,000 patients in the United States come to be aware or feel pain during surgery. This development is in part the result of the widespread use of short-acting general anesthetics combined with blanket use of neuromuscular blockade. The patients are paralyzed with regard to motion, but otherwise “awake and aware.” At present, special devices are available to measure brain wave activity indicating the patient's state of consciousness. The **bispectral index** monitor (BIS) was approved by the FDA in 1996 and the patient state analyzer in 1999. One study has shown that the use of the BIS reduced the frequency of surgical awareness by 82%.

## Nausea and vomiting

Post-operative nausea and vomiting is a common problem during recovery from general anesthesia. In addition, patients may feel drowsy, weak, or tired for several days after the operation, a combination of symptoms sometimes called the hangover effect. Fuzzy thinking, blurred vision, and coordination problems are also possible. For these reasons, anyone who has had general anesthesia should not drive, operate machinery, or perform other activities that could endanger themselves or others for at least 24 hours, or longer if necessary.

## Anesthetic toxicity

Inhalation anesthetics are sometimes toxic to the liver, the kidney, or to blood cells. Halothane may cause hepatic necrosis or hepatitis. Sevoflurane may react with the carbon dioxide absorbents in anesthesia

machines to form compound A, a haloalkene that is toxic to the kidneys. The danger to red blood cells comes from carbon monoxide formed by the breakdown products of inhalation anesthetics in the circuits of anesthesia machines.

### ***Malignant hyperthermia***

Malignant hyperthermia is a genetic condition that causes a life-threatening response to general anesthetics due to a biochemical defect. The signs of malignant hyperthermia include rapid, irregular heartbeat; breathing problems; very high fever; and muscle tightness or spasms. These symptoms can occur following the administration of the following general anesthetics, halothane, sevoflurane, desflurane, isoflurane, enflurane, and methoxyflurane or the muscle relaxant, succinylcholine (anectine). This response can be reversed by the quick administration of an antidote drug called dantrolene.

### **Normal results**

General anesthesia is much safer today than it was in the past, thanks to faster-acting anesthetics; improved safety standards in the equipment used to deliver the drugs; and better devices to monitor breathing, heart rate, blood pressure, and brain activity during surgery. Unpleasant side effects are also less common, in part because of developments in equipment that reduces the problems of anesthetizing patients who are difficult to intubate. These developments include the laryngeal mask airway and the McCoy laryngoscope, which has a hinged tip on its blade that allows a better view of the patient's larynx.

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American Association of Nurse Anesthetists, 222 South Prospect Avenue, Park Ridge, IL, 60068-4001, (847) 692-7050, (847) 692-6968, [info@aana.com](mailto:info@aana.com), <http://www.aana.com>.

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## **Anesthesia, local**

### **Definition**

Anesthesia is used to make it possible for individuals to undergo surgery without pain. Local or regional anesthesia involves the injection or application of an anesthetic, or numbing, drug to a specific area of the body. This is in contrast to **general anesthesia**, which provides anesthesia to the entire body and brain.

### **Purpose**

Local anesthetics are used to prevent patients from feeling pain during medical, surgical, or dental procedures. Over-the-counter local anesthetics are also available to provide temporary relief from pain, irritation, and itching caused by various conditions such as cold sores, canker sores, sore throats, sunburn, insect bites, poison ivy, and minor cuts and scratches.



Regional anesthesia blocks the sensation of pain over a large area of the body. For example, anesthesia is commonly injected into the spinal fluid (an epidural or spinal) to numb sensation in the lower body. Patients who are treated with regional anesthesia remain conscious, but lose feeling in a large part of their body.

### Precautions

People who feel strongly that they do not want to be awake and alert during certain procedures may not be good candidates for local or regional anesthesia; however, other medications that have systemic effects may be given in addition to an anesthetic to relieve anxiety and help the patient relax.

Local anesthetics should be used only for the conditions for which they are intended. For example, a topical anesthetic meant to relieve sunburn pain should not be used on cold sores. Anyone who has had an unusual reaction to a local anesthetic in the past should check with a doctor before using any type of local anesthetic again. The doctor should also be told about any allergies to foods, dyes, preservatives, or other substances.

Older people may be more sensitive to the effects of local anesthetics, especially lidocaine. Children may also be especially sensitive to some local anesthetics; certain types should not be used at all on young children. People caring for these groups need to be aware that they are at increased risk of more severe side effects. Package directions should be followed carefully so that the recommended dosage is not exceeded. A doctor or pharmacist should be consulted about any concerns.

### Regional anesthetics

Serious and possibly life-threatening side effects may occur when injectable or inhaled anesthetics are given to people who use street drugs. Doctors and nurses should inform patients about the dangers of mixing anesthetics with cocaine, marijuana, amphetamines, **barbiturates**, phencyclidine (also known as PCP or angel dust), heroin, or other street drugs. Some anesthetic drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change, or the risk of side effects may be greater. In select cases, a **urinalysis** can help identify drug use.

Patients who have a personal or family history of malignant hyperthermia after receiving a general anesthetic must also be cautious when receiving regional or local anesthetics. Malignant hyperthermia is a serious reaction that involves a fast or irregular heartbeat, high

## KEY TERMS

**Canker sore**—A painful sore inside the mouth.

**Cerebrospinal fluid**—A clear fluid that fills the hollow cavity inside the brain and spinal cord. The cerebrospinal fluid has several functions, including providing a cushion for the brain against shock or impact, and removing waste products from the brain.

**Cold sore**—A small blister on the lips or face, caused by a virus. Also called a fever blister.

**Epidural space**—The space surrounding the spinal fluid sac.

**Malignant hyperthermia**—A type of reaction, probably with a genetic basis, that can occur during general anesthesia, in which the patient experiences a high fever, the muscles become rigid, and the heart rate and blood pressure fluctuate.

**Subarachnoid space**—The space surrounding the spinal cord that is filled with cerebrospinal fluid.

**Topical**—Not ingested; applied to the outside of the body, for example to the skin, eye, or mouth.

fever, breathing problems, and muscle spasms. All patients should be asked if they are aware of such a risk in their family before receiving any kind of anesthetic.

Although problems are rare, some side effects may occur when regional anesthetics are used during labor and delivery. Anesthetics can prolong labor and increase the risk of requiring a Caesarean section. Doctors should discuss the risks and benefits associated with epidural or spinal anesthesia with pregnant patients.

Regional anesthetics should be used only by an experienced anesthesiologist in a properly equipped environment with suitable resuscitative equipment. Although these anesthetics are generally safe when properly selected and administered, severe adverse reactions are still possible. If inadvertent subarachnoid injection occurs, the patient is likely to require resuscitation with oxygen and drug therapy. Careful positioning of the patient is essential to prevent leaking of cerebrospinal fluid.

Patients should not drive or operate machinery immediately following a procedure involving regional anesthesia because numbness or weakness may cause impairment. Doctors and nurses should also warn patients who have had local anesthesia, especially when combined with drugs to make patients sleep or to reduce pain, about operating any type of machinery.



***Injectable local anesthetics***

Until the anesthetic wears off, patients should be careful not to inadvertently injure the numbed area. If the anesthetic was used in the mouth, patients should not eat or chew gum until feeling returns.

***Topical anesthetics***

Unless advised by a doctor, topical anesthetics should not be used on or near any part of the body with large sores, broken or scraped skin, severe injury, or infection. They should also not be used on large areas of skin. Some topical anesthetics contain alcohol and should not be used near an open flame or while smoking.

Patients should be careful not to get topical anesthetics in the eyes, nose, or mouth. If a spray-type anesthetic is to be used on the face, it can be applied with a cotton swab or sterile gauze pad. After using a topical anesthetic on a child, the caregiver should make sure the child does not get the medicine in his or her mouth or eyes.

Topical anesthetics are intended for the temporary relief of pain and itching. They should not be used for more than a few days at a time. A doctor should be consulted if:

- discomfort continues for more than seven days;
- the problem gets worse;
- the treated area becomes infected; or
- new signs of irritation such as skin rash, burning, stinging, or swelling appear.

***Dental anesthetics***

Dental anesthetics should not be used if certain kinds of infections are present. Package directions should be checked or a dentist, pharmacist, or doctor should be consulted if there is any uncertainty. Dental anesthetics should be used only for temporary pain relief. Consult the dentist if problems such as toothache, mouth sores, or pain from dentures or braces continue or if signs of general illness such as fever, rash, or vomiting develop.

Patients should not eat or chew gum while the mouth is numb from a dental anesthetic to avoid accidentally biting the tongue or the inside of the mouth. In addition, the patient should not eat or drink for one hour after applying a dental anesthetic to the back of the mouth or throat because the medicine may interfere with swallowing and could cause choking. If normal feeling does not return to the mouth within a few hours after receiving a dental

anesthetic, or if it is difficult to open the mouth, the dentist should be consulted.

***Ophthalmic anesthetics***

When anesthetics are used in the eye, it is important not to rub or wipe the eye until the effect of the anesthetic has worn off and feeling has returned. Rubbing the eye while it is numb could cause injury.

**Description**

Medical procedures and situations that regularly make use of local or regional anesthesia include the following:

- biopsies, in which skin or tissue samples are taken for diagnostic procedures;
- childbirth;
- scar repair;
- surgery on the face (including plastic surgery), skin, arms, hands, legs, and feet;
- eye surgery; and
- surgery involving the urinary tract or reproductive organs.

Surgery involving the chest or abdomen is usually performed under general anesthesia; however, **laparoscopy** and hernia repair may be performed under local or regional anesthesia.

Local and regional anesthesia have many advantages over general anesthesia. Most importantly, the risk of unusual and sometimes fatal reactions to general anesthesia is lessened. More minor, but significant, risks of general anesthesia include longer recovery time and the psychological discomfort of losing consciousness.

Regional anesthesia typically affects a larger area than local anesthesia. As a result, regional anesthesia is typically used for more involved or complicated procedures. The duration of action of an anesthetic depends on the type and amount of anesthetic administered.

Regional anesthetics are injected. Local anesthesia involves the injection into the skin or application to the skin surface of an anesthetic directly where pain will occur. Local anesthesia can be divided into four groups: injectable, topical, dental (non-injectable), and regional blockade injection.

Local and regional anesthesia work by altering the flow of sodium molecules into nerve cells (neurons) through the cell membrane. The exact mechanism is not understood, since the drug apparently does not bind to any receptor on the cell surface and does not

seem to affect the release of chemicals that transmit nerve impulses (neurotransmitters) from the nerve cells. Experts believe that when the sodium molecules do not get into the neurons, nerve impulses are not generated and pain impulses are not transmitted to the brain.

### ***Regional anesthesia***

Types of regional anesthesia include:

- spinal anesthesia, which involves the injection of a small amount of local anesthetic into the cerebrospinal fluid surrounding the spinal cord, known as the subarachnoid space. A drop in blood pressure is a common but easily treated side effect;
- epidural anesthesia, which involves the injection of a large volume of local anesthetic into the space surrounding the spinal fluid sac, or epidural space, and not directly into the spinal fluid. Pain relief occurs more slowly, but is less likely to produce a drop in blood pressure. The block can be maintained for long periods, even for days if necessary; and
- nerve blockades, which involve the injection of an anesthetic into the area around a sensory or motor nerve that supplies a particular region of the body, preventing the nerve from carrying nerve impulses to and from the brain.

Local and regional anesthetics may be administered with other drugs to enhance their action. Examples include vasoconstrictors such as epinephrine (adrenaline) to decrease bleeding, or sodium bicarbonate to lower acidity, which may make a drug work faster. In addition, medications may be administered to help a patient remain calm and more comfortable or to make them sleepy.

### ***Local anesthesia***

**INJECTABLE LOCAL ANESTHETICS.** Injectable local anesthetics provide pain relief for some part of the body during surgery, dental procedures, or other medical procedures. They are given only by a trained health care professional in a doctor's office or a hospital. Some commonly used injectable local anesthetics are lidocaine (Xylocaine), bupivacaine (Marcaine), and mepivacaine (Carbocaine).

**TOPICAL ANESTHETICS.** Topical anesthetics such as benzocaine, lidocaine (in smaller quantities or doses), dibucaine, and tetracaine relieve pain and itching by blocking the sensory nerve endings in the skin. They are the active ingredients in a variety of nonprescription products that are applied to the skin to relieve the discomfort of sunburn, insect bites or stings, poison ivy, and minor cuts, scratches, and burns. These

products are sold as creams, ointments, sprays, lotions, and gels.

Topical dental anesthetics are intended for pain relief in the mouth or throat. They may be used to relieve throat pain, teething pain, painful canker sores, toothaches, or discomfort from dentures, braces, or bridgework. Some dental anesthetics are available only with a doctor's prescription. Others may be purchased over the counter, including products such as Num-Zit, Orajel, Chloraseptic lozenges, and Xylocaine.

Ophthalmic anesthetics are designed for use in the eye. Lidocaine and tetracaine are used to numb the eye before certain eye examinations. Eye doctors may also use these medicines before measuring eye pressure or removing **stitches** or foreign objects from the eye. These drugs are to be given only by a trained health care professional.

The recommended dosage of a topical anesthetic depends on the type of local anesthetic and the purpose for which it is being used. When using a nonprescription local anesthetic, patients are advised to follow the directions on the package. Questions concerning how to use a product should be referred to a doctor, dentist, or pharmacist.

### **Aftercare**

Most patients can return home immediately after a local anesthetic, but some patients might require limited observation. The degree of aftercare needed depends on where the anesthetic was given, how much was given, and other individual circumstances. Patients who have had their eyes numbed should wear a patch after surgery or treatment until full feeling in the eye area has returned. If the throat was anesthetized, the patient cannot drink until the gag reflex returns. If a major extremity was anesthetized, the patient may have to wait until function returns before being discharged. Some local anesthetics can cause cardiac arrhythmia and therefore require monitoring for a time with an EKG. Patients who have had regional anesthesia or larger amounts of local anesthesia usually recover in a post-anesthesia care unit before being discharged. There, medical personnel watch for immediate postoperative problems. These patients need to be driven home after discharge.

### **Risks**

Side effects of regional or local anesthetics vary depending on the type of anesthetic used and the way it is administered. Any unusual symptoms following the

use of an anesthetic requires the immediate attention of a doctor.

Paralysis after a regional anesthetic such as an epidural, spinal, or ganglionic blockade is extremely rare, but can occur. Paralysis reportedly occurs even less frequently than deaths due to general anesthesia.

There is also a small risk of developing a severe headache called a spinal headache following a spinal or epidural block. This headache is severe when the patient is upright, even when only elevated 30°, and is hardly felt when the patient lies down. It is treated by increasing fluids to help clear the anesthetic and enhance the flow of spinal fluid.

Finally, blood clots or an abscess can form at the site where an anesthetic is injected. Although these can usually be treated, antibiotic resistance is becoming increasingly common. Such infections must be regarded as potentially dangerous, particularly if they develop at the site of a spinal injection.

A physician should be notified immediately if any of the following symptoms occur:

- symptoms of an allergic reaction such as hives (urticaria), which are itchy swellings on the skin, or swelling in the mouth or throat;
- severe headache;
- blurred vision, double vision, or photophobia, which is sensitivity to light;
- dizziness or lightheadedness;
- drowsiness;
- confusion;
- an irregular, too slow, or rapid heartbeat;
- anxiety, excitement, nervousness, or restlessness;
- convulsions or seizures;
- feeling hot, cold, or numb anywhere other than the anesthetized area;
- ringing or buzzing in the ears;
- shivering or trembling;
- sweating;
- pale skin;
- breathing problems; or
- unusual weakness or tiredness.

### Normal results

Local and regional anesthetics help to make many conditions and procedures more comfortable and tolerable with few or no side effects for patients.

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American Academy of Anesthesiologist Assistants, 2209 Dickens Road, Richmond, VA, 23230 2005, (804) 565 6353, (866) 328 5858, (804) 822 0090, <http://www.anesthetist.org>.

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## Anesthesiologist's role

### Definition

The anesthesiologist's role is the practice of medicine dedicated to the relief of pain and total care of the surgical patient before, during, and after surgery.

### Training

Anesthesiologists are fully trained physicians. After completing a four-year college program and four years of medical school, anesthesiologists undergo four additional years of specialized residency training. Some will spend one to two more years



An anesthesiologist monitors a patient. (Mira/Alamy)

training in such anesthesiology subspecialty areas as obstetrics, **neurosurgery**, cardiac surgery, pediatrics, or critically ill patients, or to learn more about the treatment of pain. Others may select to work in research laboratories, investigating, for example, how anesthetics work and how they influence disease or recovery.

In the United States, the education of anesthesiologists takes into account their ever-expanding role in offering the best-quality health care available anywhere in the world.

### Description

In the twenty-first century, the medical expertise of anesthesiologists has significantly expanded the role of the anesthesiologist. Historically, the anesthesiologist's role was limited to that of the physician who administers anesthesia to suppress pain and consciousness in a patient undergoing surgery. In the twenty-first century, anesthesiologists also provide medical care in settings other than the **operating room**. The American Society of Anesthesiologists

defines the anesthesiologist as the perioperative physician—the “all-around” physician responsible for providing medical care to each patient undergoing surgery at all stages. This includes providing the medical evaluation of the patient before surgery (preoperative), holding consultations with the **surgical team**, providing pain control and support of life functions during surgery (intraoperative), supervising care after surgery (postoperative), and discharging the patient from the recovery unit.

Specifically, the anesthesiologist's role has moved beyond just the operating room and into other areas of care.

- Ninety percent of the approximately 40 million anesthetics used annually in the United States is administered by anesthesiologists. During a surgical procedure, the anesthesiologist continually assesses the medical status of the patient, monitoring and controlling vital life functions, as well as managing pain.
- Postoperatively the anesthesiologist determines when a patient can return home following an outpatient procedure and when a patient can be moved to another ward following a procedure that requires hospitalization.
- The anesthesiologist is also involved in postoperative pain management, prescribing the appropriate pain-relieving medication and therapies.
- The anesthesiologist prescribes individualized drug therapies to patients suffering from acute, chronic, and cancer pain.
- During childbirth, the anesthesiologist must provide pain relief with epidural or spinal blocks for the mother while managing the life functions of both the mother and the baby.
- In critical care and trauma medicine, the anesthesiologist makes immediate diagnoses while supporting respiratory and cardiovascular functions, controlling infection, providing airway management, cardiac and pulmonary resuscitation, advanced life support, and pain control.
- The anesthesiologist is also present during cardiac catheterizations, angioplasties, radiological imaging, gastrointestinal endoscopies, in vitro fertilization, electroshock therapy, lithotripsy, nutritional support, and respiratory therapy.
- The anesthesiologist participates in research and clinical studies, as well as medical education programs and legislative activities.

In the past, complications caused by the use of anesthesia were a medical issue; however, since the 1980s, complications have significantly declined. Despite the growing need for anesthesia and the doubling of the



## KEY TERMS

**Anesthetic**—A drug that causes unconsciousness or a loss of general sensation.

**Angioplasty**—The surgical repair of a blood vessel.

**Catheterization**—Placement of a flow-directed catheter for measuring pulmonary arterial pressures.

**Endoscopy**—The visual inspection of any cavity of the body by means of an endoscope.

**Intraoperative**—During surgery.

**Postoperative**—After surgery.

**Preoperative**—Before surgery.

total number of anesthesiologists practicing within the United States since 1970, patient outcomes have improved. Since 1998, the number of deaths resulting from anesthesia have dropped from an estimated 1 in 10,000 to 1 in 250,000. This drop in deaths has occurred during a time when the neonatal intensive care units are performing complicated procedures on the youngest of premature infants and at the other end of the spectrum, while 100-year-old patients are having major surgeries that at one time were believed to be impossible.

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Aneurysm repair, aortic see **Aortic aneurysm repair**

Aneurysm repair, cerebral see **Cerebral aneurysm repair**

## Angiography

### Definition

Angiography is the x-ray (radiographic) study of the blood vessels. An angiogram uses a radiopaque substance, or contrast medium, to make the blood vessels visible under x ray. The key ingredient in most radiographic contrast media is iodine. Arteriography is a type of radiographic examination that involves the study of the arteries.

### Purpose

Angiography is used to detect abnormalities, including narrowing (stenosis) or blockages in the blood vessels (called occlusions) throughout the circulatory system and in some organs. The procedure is commonly used to identify atherosclerosis; to diagnose heart disease; to evaluate kidney function and detect kidney cysts or tumors; to map renal anatomy in transplant donors; to detect an aneurysm (an abnormal bulge of an artery that can rupture leading to hemorrhage), tumor, blood clot, or arteriovenous malformations (abnormal tangles of arteries and veins) in the brain; and to diagnose problems with the retina of the eye. It is also used to provide surgeons with an accurate vascular "map" of the heart prior to open-heart surgery, or of the brain prior to **neurosurgery**. Angiography may be used after penetrating trauma, like a gunshot or knife wound, to detect blood vessel injury; it may be used to check the position of shunts and stents placed by physicians into blood vessels.



## KEY TERMS

**Arteriosclerosis**—A chronic condition characterized by thickening and hardening of the arteries and the build-up of plaque on the arterial walls. Arteriosclerosis can slow or impair blood circulation.

**Carotid artery**—An artery located in the neck.

**Catheter**—A long, thin, flexible tube used in angiography to inject contrast material into the arteries.

**Cirrhosis**—A condition characterized by the destruction of healthy liver tissue. A cirrhotic liver is scarred and cannot break down the proteins in the bloodstream. Cirrhosis is associated with portal hypertension.

**Embolism**—A blood clot, air bubble, or clot of foreign material that travels and blocks the flow of blood in an artery. When blood supply to a tissue or organ is blocked by an embolism, infarction (death of the tissue the artery feeds) occurs. Without immediate and appropriate treatment, an embolism can be fatal.

**Femoral artery**—An artery located in the groin area that is the most frequently accessed site for arterial puncture in angiography.

**Fluorescein dye**—An orange dye used to illuminate the blood vessels of the retina in fluorescein angiography.

**Fluoroscope**—An imaging device that displays “moving x rays” of the body. Fluoroscopy allows the radiologist to visualize the guide wire and catheter he or she is moving through the patient’s artery.

**Guide wire**—A wire that is inserted into an artery to guide a catheter to a certain location in the body.

**Ischemia**—A lack of normal blood supply to a organ or body part because of blockages or constriction of the blood vessels.

**Necrosis**—Cellular or tissue death; skin necrosis may be caused by multiple, consecutive doses of radiation from fluoroscopic or x-ray procedures.

**Plaque**—Fatty material that is deposited on the inside of the arterial wall.

**Portal hypertension**—A condition caused by cirrhosis of the liver. It is characterized by impaired or reversed blood flow from the portal vein to the liver, an enlarged spleen, and dilated veins in the esophagus and stomach.

**Portal vein thrombosis**—The development of a blood clot in the vein that brings blood into the liver. Untreated portal vein thrombosis causes portal hypertension.

## Precautions

Patients with kidney disease or injury may suffer further kidney damage from the contrast media used for angiography. Patients who have blood-clotting problems, have a known allergy to contrast media, or are allergic to iodine may also not be suitable candidates for an angiography procedure. Newer types of contrast media classified as non-ionic are less toxic and cause fewer side effects than traditional ionic agents. Because x rays carry risks of ionizing radiation exposure to the fetus, pregnant women are also advised to avoid this procedure.

## Description

Angiography requires the injection of a contrast medium that makes the blood vessels visible to x ray. The contrast medium is injected through a procedure known as arterial puncture. The puncture is usually made in the groin area, armpit, inside elbow, or neck.

Patients undergoing an angiogram are advised to stop eating and drinking eight hours prior to the procedure. They must remove all jewelry before the

procedure and change into a hospital gown. If the arterial puncture is to be made in the armpit or groin area, shaving may be required. A sedative may be administered to relax the patient for the procedure. An intravenous (IV) line is also inserted into a vein in the patient’s arm before the procedure begins, in case medication or blood products are required during the angiogram or complications arise.

Prior to the angiographic procedure, patients are briefed on the details of the test, the benefits and risks, and the possible complications involved, and asked to sign an **informed consent** form.

The site is cleaned with an antiseptic agent and injected with a local anesthetic. Then, a small incision is made in the skin to help the needle pass. A needle containing a solid inner core called a stylet is inserted through the incision and into the artery. When the radiologist has punctured the artery with the needle, the stylet is removed and replaced with another long wire called a guide wire. It is normal for blood to spurt out of the needle before the guide wire is inserted.

The guide wire is fed through the outer needle into the artery to the area that requires angiographic study.

A fluoroscope displays a view of the patient's vascular system and is used to direct the guide wire to the correct location. Once it is in position, the needle is then removed, and a catheter is threaded over the length of the guide wire until it reaches the area of study. The guide wire is then removed, and the catheter is left in place in preparation for the injection of the contrast medium.

Depending on the type of angiographic procedure being performed, the contrast medium is either injected by hand with a syringe or is mechanically injected with an automatic injector, sometimes called a power injector, connected to the catheter. An automatic injector is used frequently because it is able to deliver a large volume of contrast medium very quickly to the angiographic site. Usually a small test injection is made by hand to confirm that the catheter is in the correct position. The patient is told that the injection will start, and is instructed to remain very still. The injection causes some mild to moderate discomfort. Possible side effects or reactions include headache, dizziness, irregular heartbeat, nausea, warmth, burning sensation, and chest pain, but they usually last only momentarily. To view the area of study from different angles or perspectives, the patient may be asked to change positions several times, and subsequent contrast medium injections may be administered. During any injection, the patient or the imaging equipment may move.

Throughout the injection procedure, radiographs (x-ray pictures) or fluoroscopic images are obtained. Because of the high pressure of arterial blood flow, the contrast medium dissipates through the patient's system quickly and becomes diluted, so images must be obtained in rapid succession. One or more automatic film changers may be used to capture the required radiographic images. In many imaging departments, angiographic images are captured digitally, obviating the need for film changers. The ability to capture digital images also makes it possible to manipulate the information electronically allowing for a procedure known as digital subtraction angiography (DSA). Because every image captured is comprised of tiny picture elements called pixels, computers can be used to manipulate the information in ways that enhance diagnostic information. One common approach is to electronically remove or (subtract) bony structures that otherwise would be superimposed over the vessels being studied, hence the name digital subtraction angiography.

Once the x rays are complete, the catheter is slowly and carefully removed from the patient. Manual pressure is applied to the site with a sandbag or other weight for 10 to 20 minutes to allow for clotting to

take place and the arterial puncture to reseal itself. A pressure bandage is then applied.

Most angiograms follow the general procedures outlined above, but vary slightly depending on the area of the vascular system being studied. A variety of common angiographic procedures are outlined below:

### *Cerebral angiography*

Cerebral angiography is used to detect aneurysms, stenosis, blood clots, and other vascular irregularities in the brain. The catheter is inserted into the femoral or carotid artery, and the injected contrast medium travels through the blood vessels in the brain. Patients frequently experience headache, warmth, or a burning sensation in the head or neck during the injection portion of the procedure. A cerebral angiogram takes two to four hours to complete.

### *Coronary angiography*

Coronary angiography is administered by a cardiologist with training in radiology or, occasionally, by a radiologist. The arterial puncture is typically made in the femoral artery, and the cardiologist uses a guide wire and catheter to perform a contrast injection and x-ray series on the coronary arteries. The catheter may also be placed in the left ventricle to examine the mitral and aortic valves of the heart. If the cardiologist requires a view of the right ventricle of the heart or of the tricuspid or pulmonic valves, the catheter is inserted through a large vein and guided into the right ventricle. The catheter also serves the purpose of monitoring blood pressures in these different locations inside the heart. The angiographic procedure takes several hours, depending on the complexity of the procedure.

### *Pulmonary angiography*

Pulmonary, or lung, angiography is performed to evaluate blood circulation to the lungs. It is also considered the most accurate diagnostic test for detecting a pulmonary embolism. The procedure differs from cerebral and coronary angiography in that the guide wire and catheter are inserted into a vein instead of an artery, and are guided up through the chambers of the heart and into the pulmonary artery. Throughout the procedure, the patient's **vital signs** are monitored to ensure that the catheter doesn't cause arrhythmias, or irregular heartbeats. The contrast medium is then injected into the pulmonary artery where it circulates through the lungs' capillaries. The test typically takes up to 90 minutes and carries more risk than other angiography procedures.

### ***Kidney (renal) angiography***

Patients with chronic renal disease or injury can suffer further damage to their kidneys from the contrast medium used in a renal angiogram, yet they often require the test to evaluate kidney function. These patients should be well hydrated with an intravenous saline drip before the procedure, and may benefit from available medications (e.g., dopamine) that help to protect the kidney from further injury associated with contrast agents. During a renal angiogram, the guide wire and catheter are inserted into the femoral artery in the groin area and advanced through the abdominal aorta, the main artery in the abdomen, and into the renal arteries. The procedure takes approximately one hour.

### ***Fluorescein angiography***

Fluorescein angiography is used to diagnose retinal problems and circulatory disorders. It is typically conducted as an outpatient procedure. The patient's pupils are dilated with eye drops, and he or she rests the chin and forehead against a bracing apparatus to keep it still. Sodium fluorescein dye is then injected with a syringe into a vein in the patient's arm. The dye travels through the patient's body and into the blood vessels of the eye. The procedure does not require x rays. Instead, a rapid series of close-up photographs of the patient's eyes are taken, one set immediately after the dye is injected, and a second set approximately 20 minutes later once the dye has moved through the patient's vascular system. The entire procedure takes up to one hour.

### ***Celiac and mesenteric angiography***

Celiac and mesenteric angiography involves radiographic exploration of the celiac and mesenteric arteries, arterial branches of the abdominal aorta that supply blood to the abdomen and digestive system. The test is commonly used to detect aneurysm, thrombosis, and signs of ischemia in the celiac and mesenteric arteries, and to locate the source of gastrointestinal bleeding. It is also used in the diagnosis of a number of conditions, including portal hypertension and cirrhosis. The procedure can take up to three hours, depending on the number of blood vessels studied.

### ***Splenoportography***

A splenoportograph is a variation of an angiogram that involves the injection of contrast medium directly into the spleen to view the splenic and portal veins. It is used to diagnose blockages in the splenic vein and portal-vein thrombosis and to assess the

patency and location of the vascular system prior to **liver transplantation**.

Most angiographic procedures are typically paid for by major medical insurance. Patients should check with their individual insurance plans to determine their coverage.

Computerized tomographic angiography (CTA), a new technique, is used in the evaluation of patients with intracranial aneurysms. CTA is particularly useful in delineating the relationship of vascular lesions with bony anatomy close to the skull base. While such lesions can be demonstrated with standard angiography, it often requires studying several projections of the two-dimensional films rendered with standard angiography. CTA is ideal for more anatomically complex skull-base lesions because it clearly demonstrates the exact relationship of the bony anatomy with the vascular pathology. This is not possible using standard angiographic techniques. Once the information has been captured a workstation is used to process and reconstruct images. The approach yields shaded surface displays of the actual vascular anatomy that are three dimensional and clearly show the relationship of the bony anatomy with the vascular pathology.

Angiography can also be performed using MRI (**magnetic resonance imaging**) scanners. The technique is called MRA (magnetic resonance angiography). A contrast medium is not usually used, but may be used in some body applications. The active ingredient in the contrast medium used for MRA is one of the rare earth elements, gadolinium. The contrast agent is injected into an arm vein, and images are acquired with careful attention being paid to the timing of the injection and selection of MRI specific imaging parameters. Once the information has been captured, a workstation is used to process and reconstruct the images. The post-processing capabilities associated with CTA and MRA yield three-dimensional representations of the vascular pathology being studied and can also be used to either enhance or subtract adjacent anatomical structures.

### **Aftercare**

Because life-threatening internal bleeding is a possible complication of an arterial puncture, an overnight stay in the hospital is sometimes recommended following an angiographic procedure, particularly with cerebral and coronary angiography. If the procedure is performed on an outpatient basis, the patient is typically kept under close observation for a period of at six to 12 hours before being released. If the arterial

puncture was performed in the femoral artery, the patient is instructed to keep his or her leg straight and relatively immobile during the observation period. The patient's blood pressure and vital signs are monitored, and the puncture site observed closely. Pain medication may be prescribed if the patient is experiencing discomfort from the puncture, and a cold pack is often applied to the site to reduce swelling. It is normal for the puncture site to be sore and bruised for several weeks. The patient may also develop a hematoma at the puncture site, a hard mass created by the blood vessels broken during the procedure. Hematomas should be watched carefully, as they may indicate continued bleeding of the arterial puncture site.

Angiography patients are also advised to have two to three days of rest after the procedure in order to avoid placing any undue stress on the arterial puncture site. Patients who experience continued bleeding or abnormal swelling of the puncture site, sudden dizziness, or chest pain in the days following an angiographic procedure should seek medical attention immediately.

Patients undergoing a fluorescein angiography should not drive or expose their eyes to direct sunlight for 12 hours following the procedure.

### Risks

Because angiography involves puncturing an artery, internal bleeding or hemorrhage are possible complications of the test. As with any invasive procedure, infection of the puncture site or bloodstream is also a risk, but this is rare.

A stroke or heart attack may be triggered by an angiogram if blood clots or plaque on the inside of the arterial wall are dislodged by the catheter and form a blockage in the blood vessels, or if the vessel undergoes temporary narrowing or spasm from irritation by the catheter. The heart may also become irritated by the movement of the catheter through its chambers during pulmonary and coronary angiographic procedures, and arrhythmias may develop.

Patients who develop an allergic reaction to the contrast medium used in angiography may experience a variety of symptoms, including swelling, difficulty breathing, heart failure, or a sudden drop in blood pressure. If the patient is aware of the allergy before the test is administered, certain medications can be administered at that time to counteract the reaction.

Angiography involves minor exposure to radiation through the x rays and fluoroscopic guidance used in the procedure. Unless the patient is pregnant,

or multiple radiological or fluoroscopic studies are required, the dose of radiation incurred during a single procedure poses little risk. However, multiple studies requiring fluoroscopic exposure that are conducted in a short time period have been known to cause skin necrosis in some individuals. This risk can be minimized by careful monitoring and documentation of cumulative radiation doses administered to these patients, particularly in those who have therapeutic procedures performed along with the diagnostic angiography.

### Normal results

The results of an angiogram or arteriogram depend on the artery or organ system being examined. Generally, test results should display a normal and unimpeded flow of blood through the vascular system. Fluorescein angiography should result in no leakage of fluorescein dye through the retinal blood vessels.

Abnormal results of an angiogram may display a narrowed blood vessel with decreased arterial blood flow (ischemia) or an irregular arrangement or location of blood vessels. The results of an angiogram vary widely by the type of procedure performed, and should be interpreted by and explained to the patient by a trained radiologist.

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## Angioplasty

### Definition

Angioplasty is a procedure used to widen narrowed or partially blocked, or occluded, blood vessels. There are various types of angioplasty. The specific names of these procedures are derived from the type of equipment used and the path of entry to the blood vessel. For example, percutaneous transluminal angioplasty (PTA) means that the vessel is entered through the skin (percutaneous) and that the catheter is moved into the blood vessel of interest through the same vessel or one that communicates with it (transluminal). In the case of an angioplasty involving the coronary arteries, the point of entry might be the femoral artery in the groin, with the catheter/guidewire system passed through the aorta to the heart and the origin of the coronary arteries at the base of the aorta just outside the aortic valve.

### Purpose

An angioplasty is done to reopen a partially blocked blood vessel so that blood can flow through it again at a normal rate. In patients with an occlusive vascular disease such as atherosclerosis, the flow of blood to other organs or remote parts of the body is limited by the narrowing (stenosis) of the vessel's lumen due to fatty deposits or patches known as plaque. Once the vessel has been widened, an adequate blood flow is restored, but the vessel may narrow again over time (restenosis) at the same location and the procedure may need to be repeated.

### Description

Angioplasties were originally performed by dilating the blood vessel with the introduction of larger and larger stiff catheters through the narrowed space. The complications that resulted from this approach led researchers to develop other ways to open the vessel with smaller devices. An alternative approach was developed in which the catheters used to perform angioplasties contain balloons that are gradually inflated to widen the vessel. Stents, which are thin collapsed tubes made of wire mesh sometimes coated with drugs that help prevent the blood vessel from reclosing can be inserted to provide structural support for the vessel. Lasers may be used to help break up the plaque or fat deposits lining the vessel. Some catheters are equipped with spinning wires or drill tips to clean out the plaque.

Angioplasty may be performed while the patient is either sedated or anesthetized, depending on which vessels are involved. If a percutaneous transluminal coronary angioplasty (PTCA) is to be performed, the patient is sedated so that he or she can report discomfort and cough if asked to do so. PTCA procedures are performed in **cardiac catheterization** laboratories with sophisticated monitoring devices. If angioplasty is performed in the radiology department's angiographic suite, the patient may be sedated for the procedure while a nurse monitors the patient's **vital signs**. Angioplasties performed by vascular surgeons are done in an **operating room** or specially designed vascular procedure suite.

Typically, patients are given anticoagulant, or blood thinning, medications before the procedure to assist in the prevention of thromboses (blood clots), even though these drugs may slow down the sealing of the entry point of the catheter into the vein. Patients may also be given calcium channel blockers and nitrates to reduce the risk of vascular spasm. The angioplasty is performed using fluoroscopic guidance and contrast media. Since the decision to perform angioplasty may have been made following a diagnostic angiogram, the patient's sensitivity to contrast media containing iodine is likely to be known. The procedure may then require the use of an alternative contrast agent.

The patient's skin is cleansed with an antiseptic solution at the site where the surgeon will insert the catheter and other equipment, and the area is protected with a sterile drape. Although many angioplasties are performed by puncturing the vessel through the skin, others are done by surgically exposing the site of entry. Direct view of the vessel's puncture site aids in monitoring damage to the vessel or excessive bleeding at the site. After the vessel has been punctured and the guidewire introduced, a fluoroscope is used to monitor the small amounts of contrast media that have been injected. This technique allows the surgeon to see the guidewire's movement through the vessel. If the fluoroscope has a feature called "roadmap," the amount of contrast media injected is greater in order to define the full route the guidewire will take. The fluoroscopy system then superimposes subsequent images over the roadmap while the physician moves the guidewire along the mapped route to the destination.

When the surgeon reaches the location of the stenosis, he or she inflates the balloon on the catheter that has been passed along the guidewire. The size of the balloon and the duration of its inflation depend on the size and location of the vessel. In some cases, the surgeon may also use a stent, which is opened or expanded inside the blood vessel after it has been



## KEY TERMS

**Anticoagulant**—A type of medication given to prevent the formation of blood clots. Anticoagulants are also known as blood thinners.

**Arteriosclerosis**—A chronic condition characterized by thickening and hardening of the arteries and the build-up of plaque on the arterial walls. Arteriosclerosis can slow or impair blood circulation.

**Calcium channel blocker**—A drug that lowers blood pressure by regulating calcium-related electrical activity in the heart.

**Cardiac catheterization**—A procedure to pass a catheter to the heart and its vessels for the purpose of diagnosing coronary artery disease, assessing injury or disease of the aorta, or evaluating cardiac function.

**Contrast medium**—A substance that is swallowed or injected into the body to create clearer images in radiographic studies of internal structures.

**Electrocardiogram (EKG)**—A graphic tracing of the electrical activity of the heart. By looking at the graph, some heart abnormalities can be diagnosed/

**Embolus (plural emboli)**—A gas or air bubble, bit of tissue, blood clot, or foreign object that circulates in the bloodstream until it lodges in a vessel. A large embolus can narrow or block the vessel, which leads to decreased blood flow in the organ supplied by that vessel.

**Fluoroscopy**—A radiologic technique that creates X-ray images of internal body structures for immediate projection on a fluorescent screen.

**Hematoma**—A localized collection of blood in an organ or tissue due to broken blood vessels.

**Lumen**—The cavity or channel inside a blood vessel or tube-shaped organ.

**Occlusion**—An obstruction or blockage in a blood vessel.

**Patency**—Being widely open. A blood vessel that has been widened or reopened is said to be patent.

**Plaque**—In atherosclerosis, a swollen area in the lining of an artery formed by fatty deposits.

**Stenosis (plural, stenoses)**—The narrowing or constriction of an opening or passageway in the body.

**Stent**—A thin rod-like or tube-like device made of wire mesh, inserted into a vein or artery to keep the vessel open.

guided to the proper location. The blood vessel may be widened before, during, or after the stent has been opened up. In cases where the vessel is tortuous (twisted) or at intersections of vessels, a graft may be necessary to strengthen the walls of the blood vessel. Stents, grafts, and balloon dilation may all be used together or separately. Sometimes radiation is used when a stent is placed.

After the surgeon has widened the blood vessel, he or she verifies its patency by using fluoroscopy and contrast media to produce an angiogram, by using intravascular **ultrasound**, or by using both techniques. After the imaging studies have been completed, the surgeon removes the equipment from the blood vessel and closes the puncture site.

## Risks

There is a danger of puncturing the vessel with the guidewire during an angioplasty, although the risk is very small. Patients must be monitored for hematoma or hemorrhage at the puncture site. There is also a small risk of heart attack, stroke, and, although unlikely, death—all related to vessel spasm (transient vessel narrowing from irritation by the catheter), or from emboli (as plaque can be dislodged by the catheter or and travel to the heart or brain). Abrupt closure of the coronary artery occurs in about 4% of patients.

Recurrence of stenosis, known as restenosis, is an additional potential complication. The risk of recurrence is highest in the first six months after angioplasty, with rates as high as 35% reported in some studies.

The length of the patient's hospital stay following an angioplasty depends on his or her overall health, the occurrence of complications, and the availability of **home care**.

## Alternatives

For some patients, **thrombolytic therapy** (treatment with drugs that dissolve blood clots) coupled with lifestyle changes is an alternative to angioplasty. Many medical centers, in fact, restrict the use of angioplasty to patients who cannot be treated with thrombolytic therapy.

## Health care team roles

Physicians often have specially trained assistants for vascular procedures. These assistants may be nurses, surgical technicians, or X-ray specialists. Cardiac catheterization laboratories will include someone specially trained in monitoring EKG equipment and

vital signs. Either a nurse, nurse anesthetist, or anesthesiologist will administer sedation or anesthesia for the procedure.

## Resources

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### ORGANIZATIONS

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242 8721, <http://www.americanheart.org>.

National Heart, Lung, and Blood Institute Information Center, P.O. Box 30105, Bethesda, MD, 20824 0105, (301) 592 8573, (240) 629 3246, <http://www.nhlbi.nih.gov>.

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## Anterior temporal lobectomy

### Definition

An anterior temporal lobectomy (ATL) is the complete removal of the anterior portion of the temporal lobe of the brain.

### Purpose

ATL surgery has been recognized as an efficient treatment option for certain types of seizures in patients diagnosed with temporal lobe epilepsy (TLE). Characterized by transient disturbances of brain function and seizures, TLE is the most common form of epilepsy. ATL is optimal for patients with

seizures that do not respond to medications, patients who are unable to tolerate medication side effects, or patients with seizures caused by structural abnormalities in the brain.

### Demographics

Epilepsy is the most common serious neurological condition in the United States. Its incidence is greatest in young children and in the elderly, with five to 10 cases diagnosed per 1,000. The lifetime prevalence amounts to 2–5% of the population. Epilepsy is slightly more common in males than females. The frequency of seizure activity in the epileptic population is as follows.

- 33% have less than one seizure per year
- 33% have one to 12 seizures per year
- 33% have more than one seizure per month
- 60% also have other neuropsychiatric problems

### Description

ATL surgical procedures involve these steps:

- Anesthesia. The patient is anesthetized with a combination of drugs that achieves a state of unconsciousness.
- Preparation of the surgical field. An antiseptic solution is applied to the patient's scalp, face, and neck. Surgical drapes are placed around the surgical region to maintain a sterile surgical field.
- Temporal incision. Using a scalpel blade, the neurosurgeon makes an incision in the skin and muscle of the temporal region of the head located on the side of the head above the ear, and pulls away the flap of scalp.
- Control of bleeding. Blood obstructing the surgeon's view of the surgical field is irrigated and suctioned away as surgery proceeds.
- Craniotomy. Using a high-speed drill, the neurosurgeon removes a section of bone (bone flap) from the skull and makes an incision through the protective membranes of the brain (dura) in order to expose the temporal lobe.
- Removal of the anterior lobe. Using an operating microscope to enlarge the features of the surgical area, the neurosurgeon removes the temporal anterior lobe.
- Closure. Once bleeding is under control, every layer of tissue cut or divided to reach the surgical site is closed. The cavity is irrigated completely and the dura is closed in a watertight manner using tack-up sutures. The bone flap is returned into place. Muscle and tissues are closed with sutures, while the skin is closed with staples. No drain is needed.

## KEY TERMS

**Anesthesia**—A combination of drugs administered by a variety of techniques by trained professionals that provide sedation, amnesia, analgesia, and immobility adequate for the accomplishment of the surgical procedure with minimal discomfort, and without injury, to the patient.

**Cerebral cortex**—The outer portion of the brain, consisting of layers of nerve cells and their connections. The cerebral cortex is the part of the brain in which thought processes take place.

**Craniotomy**—A surgical incision into the skull.

**Electroencephalogram (EEG)**—A diagnostic test that measures the electrical activity of the brain (brain waves) using highly sensitive recording equipment attached to the scalp by electrodes.

**Epilepsy**—Chronic medical condition produced by temporary changes in the electrical function of the brain, causing seizures that affect awareness, movement, and/or sensation.

**Seizures**—Attacks consisting of sudden and abnormal muscle, sensory, or psychic events resulting from transient dysfunction of the brain.

**Temporal lobe epilepsy (TLE)**—The most common type of epilepsy, with elaborate and multiple sensory, motor, and psychic symptoms. A common feature is the loss of consciousness and amnesia during seizures. Other manifestations may include more complex behaviors like bursts of anger, emotional outbursts, fear, or automatisms.

## Diagnosis/Preparation

An ATL pre-surgical diagnosis requires reliable diagnostic levels classified as (1) seizure, (2) epilepsy, and (3) syndrome. The epilepsy and syndromic diagnoses are usually combined. The seizure diagnosis is determined from the physical and neurological manifestations of the condition recorded in the patient's history and from electroencephalogram (EEG) evaluations. Because seizures commonly result from cortical damage, neuroimaging techniques are used to identify and localize the damaged area. They include:

- Magnetic resonance imaging (MRI). Brain MRI is the best structural imaging technique available. Every ATL surgical evaluation usually includes a complete MRI study.
- Positron emission tomography (PET). Unlike MRI, PET provides information on brain metabolism rather

than on structure. Typically, the epileptic region's metabolism is lowered unless the scan is obtained during a seizure.

- Single photon emission tomography (SPECT). SPECT scans visualize blood flow through the brain and are used as another method for localizing the epileptic site.

Routinely, all ATL candidates also undergo neuropsychological testing.

To prepare for ATL, the patient discontinues any medication being taken and that has been associated with bleeding disorders at least three weeks prior to ATL surgery. **Antibiotics** may be administered intravenously one hour before surgery. Minimal hair is shaved over the temporal area of the head.

## Aftercare

After ATL surgery, the neurosurgeon provides instructions for the nurses, pharmacists, therapists, and other physicians caring for the patient postoperatively. Once the anesthesiologist determines that the patient is stable, the surgeon authorizes transport to the **postoperative care** area. Most patients go to the recovery area, but some critical patients may be taken to an **intensive care unit (ICU)** for close monitoring. As is the case for almost all types of brain surgery, the patient is initially nursed with the head of the bed elevated to 30 degrees.

## Risks

All surgical procedures are associated with risks and complications that vary depending on the location of the procedure (the approach and dissection required), the pathology (what has to be done to accomplish the surgical objective), and patient factors (such as age, general medical condition, etc.).

A specific risk associated with ATL is possible injury to the cerebral cortex, the outer portion of the brain that consists of layers of nerve cells and their connections, during the lobectomy procedure.

## Normal results

ATL offers a high chance of seizure-free outcome in patients suffering from drug-resistant seizures originating in the temporal lobe of the brain. The procedure is considered to be the most common and rewarding of all the surgeries for epilepsy.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

ATL is performed in a hospital that has neurosurgery facilities. A typical treatment team may consist of neurologists, epileptologists, neurosurgeons, electroencephalography (EEG) technicians, neuropsychologists, and a specially trained epilepsy nursing staff. Such advanced resources as EEG monitoring, single photon emission computerized tomography (SPECT), magnetic resonance imaging (MRI), and positron emission tomography (PET) will usually be available.

### Morbidity and mortality rates

ATL is the most common surgery performed to treat medically refractory epilepsy and, in most cases, will diminish or abolish seizures.

In 1997, Sperling et al. reported in the *Epilepsy Quarterly* the five-year outcomes of 89 patients with uncontrolled seizures who underwent ATL at the Graduate Hospital in Philadelphia, Pennsylvania. The patients in this study underwent ATL as a result of no response (or allergy) to at least three medications. Five years postoperatively, 80 of 89 patients (90%) no longer had seizures or experienced more than 80% seizure reduction. Only five patients (6%) exhibited no worthwhile improvement, although a modest reduction in seizure frequency may have been noted. Among the seizure-free patients, 49 were cured of their epilepsy (i.e., they had no seizures after temporal lobectomy).

### Alternatives

#### *Anti-convulsant drug development programs*

Once the diagnosis of epilepsy is established, a course of medication is usually prescribed for the control of seizures. ATL only becomes the preferred approach when a patient does not respond to medication. As an alternative to surgery, a patient may elect to become an active participant in an anti-convulsant drug development program that may offer an opportunity to participate in studies of experimental medications.

#### *Other surgical techniques*

Other surgical techniques such as **corpus callosotomy** can be performed in selected patients who are

## QUESTIONS TO ASK THE DOCTOR

- What are the possible complications involved in ATL surgery?
- If the cortex is injured during the surgery, what will the consequences be?
- How long will it take to recover from the surgery?
- What procedures do you follow?
- How many ATL surgeries do you perform each year?

ineligible for ATL. In this procedure, the white matter tract connecting the two halves of the brain is cut to halt the spread of seizures and to limit their severity.

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#### ORGANIZATIONS

The American Academy of Neurology. 1080 Montreal Avenue, Saint Paul, MN 55116. (800) 879 1960. <http://www.aan.com/>.

The American Epilepsy Society. 342 North Main Street, West Hartford, CT 06117 2507. (860) 586 7505. <http://www.aesnet.org/>.

The Epilepsy Foundation. 4351 Garden City Drive Landover, MD 20785 7223. (800) 332 1000. <http://www.epilepsyfoundation.org/>.

Monique Laberge, Ph.D.

## Antianxiety drugs

### Definition

Antianxiety drugs are medicines that calm and relax people with excessive anxiety, nervousness, or tension, or for short-term control of social phobia disorder or specific phobia disorder.

### Purpose

Antianxiety agents, or anxiolytics, may be used to treat mild transient bouts of anxiety as well as more pronounced episodes of social phobia and specific phobia. Clinically significant anxiety is marked by several symptoms. The patient experiences marked or persistent fear of one or more social or performance situations in which he or she is exposed to unfamiliar people or possible scrutiny by others, and may react in a humiliating or embarrassing way. The exposure to the feared situation produces an anxiety attack. Fear of these episodes of anxiety leads to avoidance behavior, which impairs normal social functioning, including working or attending classes. The patient is aware that these fears are unjustified.

Antianxiety drugs, particularly the injectable benzodiazepines lorazepam (Ativan) and midazolam (Versed) are also used for preoperative sedation in

surgery. Used for this purpose, they may induce relaxation, provide sedation, and also reduce memory of an unpleasant experience. They offer the combined benefits of relaxing the patient and reducing the need for other agents including **analgesics**, anesthetics, and **muscle relaxants**. Lorazepam is also used to treat the nausea and vomiting from cancer treatments, epilepsy, irritable bowel syndrome, and insomnia.

### Description

In psychiatric practice, treatment of anxiety has largely turned from traditional antianxiety agents, anxiolytics, to antidepressant therapies. The benzodiazepines, the best-known class of anxiolytics, have been largely supplanted by serotonin-specific reuptake inhibitors (SSRIs, including citalopram, fluoxetine, fluvoxamine, and others), which have a milder side effect profile and less risk of dependency. Traditional anxiolytics remain useful for patients who need a rapid onset of action, or whose frequency of exposure to anxiety-provoking stimuli is low enough to eliminate the need for continued treatment. While SSRIs may require three to five weeks to show any effects, and must be taken continuously, benzodiazepines may produce a response within 30 minutes, and may be dosed on an as-needed basis.

The intermediate-action benzodiazepines, alprazolam (Xanax), and lorazepam (Ativan), are the appropriate choice for treatment of mild anxiety and social phobia. Diazepam (Valium) is still widely used for anxiety, but its active metabolite, desmethyldiazepam, has a long half-life, making this a poorer choice than other drugs in its class. There is considerable variation between individuals in the metabolism of benzodiazepines, so patient response may not be predictable. As a class, benzodiazepines are used not only as anxiolytics, but also as sedatives, muscle relaxants (making them useful in the treatment of fibromyalgia and restless leg syndrome), and in treatment of epilepsy and alcoholism. The distinctions between these uses are largely determined by onset and duration of action, and route of administration.

Buspirone (BuSpar), which is not chemically related to other classes of central nervous system drugs, is also a traditional anxiolytic, although it is considered either a third-line or adjunctive agent for use after trials of SSRIs and benzodiazepines. It is appropriate for use in patients who have either failed trials of other treatments, or who should not receive benzodiazepines because of a history of substance abuse problems. Buspirone, in common with antidepressants, requires a two- to three-week



## KEY TERMS

**Anxiety**—Worry or tension in response to real or imagined stress, danger, or dreaded situations. Physical reactions such as fast pulse, sweating, trembling, fatigue, and weakness may accompany anxiety.

**Epilepsy**—A brain disorder with symptoms that include seizures.

**Panic disorder**—An disorder in which people have sudden and intense attacks of anxiety in certain situations.

**Phobia**—An intense, abnormal, or illogical fear of something specific such as heights or open spaces.

**Pregnancy category B**—Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies.

**Pregnancy category C**—No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data.

**Seizure**—A sudden attack, spasm, or convulsion.

period before there is clinical evidence of improvement, and must be continuously dosed to maintain its effects. Buspirone causes drowsiness, so patients should be careful not to drive or operate machinery until they know how the drug affects them.

In surgery, antianxiety drugs may be used to provide relaxation and reduce fear of surgery. They may reduce the need for anesthetics and muscle relaxants. In addition, some antianxiety drugs may impair memory, which is a benefit since it reduces concern about an unpleasant experience. Short-acting benzodiazepines such as midazolam (Versed) and lorazepam (Ativan) are most often used for this purpose.

Benzodiazepines are controlled drugs under federal law. Buspirone is not a controlled substance and has no established abuse potential.

## Recommended dosage

Presurgical dosing of midazolam varies with the route of administration, the age and physical condition of the patient, and the other drugs to be used. For patients under the age of 60 who have not received narcotic analgesics, a dose of 2–3 milligrams (mg) is normally adequate, but some elderly patients may respond to a dose as low as 1 mg. The usual dose of lorazepam is up to 4 mg, administered by intramuscular injection at least two hours prior to surgery. If the drug

is given intravenously, a dose of up to 2 mg may be given 15–20 minutes before surgery.

Benzodiazepines should be administered 30–60 minutes before exposure to the anticipated stress. Dosage should be individualized to minimize sedation. The normal dose of alprazolam is 0.25–0.5 mg. The usual dose of lorazepam is 2–3 mg. Doses may be repeated if necessary.

Buspirone is initially dosed at 5 mg three times a day, as a tablet taken by mouth. The dosage should be increased 5 mg/day, at intervals of two to three days, as needed. A dosage of 60 mg/day should not be exceeded. Two to three weeks may be required before a satisfactory response is observed.

## Precautions

Precautions and warnings apply to the use of antianxiety agents for use over long periods of time. They are unlikely to occur in patients who have only received a single dose prior to surgery.

Benzodiazepines should not be used in patients with psychosis, acute narrow-angle glaucoma, or liver disease. The drugs can act as respiratory depressants and should be avoided in patients with respiratory conditions. Benzodiazepines are potentially addictive and should not be administered to patients with substance abuse disorders. Benzodiazepines are sedatives and should be avoided in patients who must remain alert. Their use for periods over four months has not been documented. These drugs should not be used during the second and third trimester of pregnancy, although use during the first trimester appears to be safe. They should not be taken while breastfeeding. Specialized references for use in children should be consulted.

Buspirone is metabolized by the liver and excreted by the kidney, and should be used with care in patients with hepatic or renal disease. The drug is classified as schedule B during pregnancy, but should not be taken during breast-feeding. Its use in children under the age of 18 years has not been studied.

## Interactions

The metabolism of alprazolam may be increased by cimetidine, oral contraceptives, disulfiram, fluoxetine, isoniazid, ketoconazole, metoprolol, propoxyphene, propranolol, and valproic acid. The absorption of all benzodiazepines is inhibited by concomitant use of antacids. Benzodiazepines may increase blood levels of digoxin, and reduce the efficacy of levodopa. Other drug interactions have been reported.

Buspirone levels will be increased by concomitant use of erythromycin, itraconazole, and nefazadone. Doses should be adjusted based on clinical response. Use of buspirone at the same time as monoamine oxidase inhibitors (MAOIs, including phenelzine and tranylcypromine) may cause severe blood pressure elevations. Use of buspirone with MAOIs should be avoided.

### Side effects

The most common side effects of benzodiazepines are secondary to their central nervous system (CNS) effects and include sedation and sleepiness, depression, lethargy, apathy, fatigue, hypoactivity, lightheadedness, memory impairment, disorientation, anterograde amnesia, restlessness, confusion, crying or sobbing, delirium, headache, slurred speech, aphonia, dysarthria, stupor, seizures, coma, syncope, rigidity, tremor, dystonia, vertigo, dizziness, euphoria, nervousness, irritability, difficulty in concentration, agitation, inability to perform complex mental functions, akathisia, hemiparesis, hypotonia, unsteadiness, ataxia, incoordination, weakness, vivid dreams, psychomotor retardation, “glassy-eyed” appearance, extrapyramidal symptoms, and paradoxical reactions. Other reactions include changes in heart rate and blood pressure, changes in bowel function, severe skin rash, and changes in genitourinary function. Other adverse effects have been reported.

Buspirone has a low incidence of side effects. Dizziness and drowsiness are the most commonly reported adverse effects. The drug may also cause difficulty sleeping, nervousness, lightheadedness, weakness, excitement, fatigue, depression, headache, fast or irregular heartbeat, blurred vision, and unusual movements of the head or neck muscles. Other CNS effects include dream disturbances, depersonalization, dysphoria, noise intolerance, euphoria, akathisia, fearfulness, loss of interest, disassociative reaction, hallucinations, suicidal ideation, seizures, feelings of claustrophobia, cold intolerance, stupor and slurred speech, and psychosis. Rarely, heart problems, including congestive heart failure and myocardial infarction, have been reported. Other adverse effects have been reported.

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Antibiotic prophylaxis see **Prophylaxis, antibiotic**

## Antibiotics

### Definition

Antibiotics may be informally defined as the subgroup of anti-infectives derived from bacterial sources and used to treat bacterial infections.

### Purpose

Antibiotics are used for treatment or prevention of bacterial infection. Other classes of drugs, most notably the **sulfonamides**, may be effective antibacterials. Similarly, some antibiotics may have secondary uses, such as the use of demeclocycline (Declomycin, a tetracycline derivative) to treat the syndrome of inappropriate antidiuretic hormone (SIADH) secretion. Other antibiotics may be useful in treating protozoal infections.

### Description

Although there are several classification schemes for antibiotics, based on bacterial spectrum (broad versus narrow), route of administration (injectable versus oral versus topical), or type of activity (bactericidal versus bacteriostatic), the most useful is based on chemical structure. Antibiotics within a structural

class will generally show similar patterns of effectiveness, toxicity, and allergic potential.

### *Penicillins*

The penicillins are the oldest class of antibiotics and have a common chemical structure that they share with the **cephalosporins**. The two groups are classed as the beta-lactam antibiotics, and are generally bacteriocidal—that is, they kill bacteria rather than inhibit growth. The penicillins can be further subdivided. The natural penicillins are based on the original penicillin G structure; penicillinase-resistant penicillins, notably methicillin and oxacillin, are active even in the presence of the bacterial enzyme that inactivates most natural penicillins. Aminopenicillins such as ampicillin and amoxicillin have an extended spectrum of action compared with the natural penicillins; extended spectrum penicillins are effective against a wider range of bacteria. These generally include coverage for *Pseudomonas aeruginosa* and may provide the penicillin in combination with a penicillinase inhibitor.

### *Cephalosporins*

Cephalosporins and the closely related cephamycins and carbapenems, like the penicillins, contain a beta-lactam chemical structure. Consequently, there are patterns of cross-resistance and cross-allergenicity among the drugs in these classes. The “cepha” drugs are among the most diverse classes of antibiotics, and are themselves subgrouped into first, second, and third generations. Each generation has a broader spectrum of activity than the one before. In addition, cefoxitin (Mefoxin), a cephamycin, is highly active against anaerobic bacteria, which makes it useful in prevention and treatment of infections of the intestines. The third generation drugs, cefotaxime, ceftizoxime, ceftriaxone, and others, cross the blood-brain barrier and may be used to treat meningitis and encephalitis. Cephalosporins are the usually preferred agents for prevention of infection during surgery.

### *Fluoroquinolones*

The **fluoroquinolones** are synthetic antibacterial agents, and are not derived from bacteria. They are included here because they can be readily interchanged with traditional antibiotics. An earlier, related class of antibacterial agents, the quinolones, were not well absorbed, and could be used only to treat urinary tract infections. The fluoroquinolones, which are based on the older group, are broad-spectrum bacteriocidal drugs that are chemically unrelated to the penicillins or the cephalosporins. They are well distributed

## KEY TERMS

**Anaerobic**—An organism that lives without oxygen. Anaerobic bacteria are commonly found in the mouth and the intestines.

**Bacteria**—Tiny, one-celled forms of life that cause many diseases and infections.

**Bacteriocidal**—An agent that kills bacteria.

**Bacteriostatic**—An agent that stops the multiplication of bacteria.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

**Meningitis**—Inflammation of tissues that surround the brain and spinal cord.

**Microorganism**—An independent unit of life that is too small to be seen with the naked eye.

**Pregnancy category**—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

into bone tissue, and so well absorbed that in general they are as effective by the oral route as by intravenous infusion.

### *Tetracyclines*

**Tetracyclines** got their name because they share a chemical structure having four rings. They are derived from a species of *Streptomyces* bacteria. Broad-spectrum bacteriostatic agents, the tetracyclines may be effective against a wide variety of microorganisms, including rickettsia and amebic parasites.

### *Macrolides*

The macrolide antibiotics are derived from *Streptomyces* bacteria, and got their name because they all have a macrocyclic lactone chemical structure. Erythromycin, the prototype of this class, has a spectrum and use similar to penicillin. Newer members of the group, azithromycin and clarithromycin, are particularly useful for their high level of lung penetration.

Clarithromycin has been widely used to treat *Helicobacter pylori* infections, the cause of stomach ulcers. For people who are allergic to penicillin, erythromycin is a valuable alternative. But, unlike penicillin, erythromycin can be very irritating both to the stomach when given by mouth, or to veins when given by injection.

### Other classes

Other classes of antibiotics include the aminoglycosides, which are particularly useful for their effectiveness in treating *Pseudomonas aeruginosa* infections, and the lincosamides, clindamycin and lincomycin, which are highly active against anaerobic pathogens. In addition, other individual drugs are available that may have utility in specific infections.

### Recommended dosage

Dosage varies with drug, route of administration, pathogen, site of infection, and severity of infection. Additional considerations include renal, or kidney, function, age of patient, and other factors. Patients should consult drug references or ask their physicians.

### Side effects

All antibiotics cause risk of overgrowth by non-susceptible bacteria. Manufacturers list other major hazards by class; however, the health care provider should review each drug individually to assess the degree of risk. Generally, breast-feeding is not recommended while taking antibiotics because of risk of alteration to infant's intestinal flora, and risk of masking infection in the infant. Excessive or inappropriate use may promote growth of resistant pathogens.

- **Penicillins.** Hypersensitivity may be common, and cross allergenicity with cephalosporins has been reported. Penicillins are classed as category B during pregnancy.
- **Cephalosporins.** Several cephalosporins and related compounds have been associated with seizures. Cefmetazole, cefoperazone, cefotetan and ceftriaxone may be associated with a fall in prothrombin activity and coagulation abnormalities. Pseudomembranous colitis (inflammation of the colon) has been reported with cephalosporins and other broad spectrum antibiotics. Some drugs in this class may cause renal toxicity. Pregnancy category B.
- **Fluoroquinolones.** Lomefloxacin has been associated with increased photosensitivity. All drugs in this class have been associated with convulsions. Pregnancy category C.
- **Tetracyclines.** Demeclocycline may cause increased photosensitivity. Minocycline may cause dizziness.

Children under the age of eight should not use tetracyclines, and specifically during periods of tooth development. Oral tetracyclines bind to anions such as calcium and iron. Although doxycycline and minocycline may be taken with meals, patients are advised to take other tetracycline antibiotics on an empty stomach, and not to take the drugs with milk or other calcium-rich foods. Expired tetracycline should never be administered. Pregnancy category D; use during pregnancy may cause alterations in bone development.

- **Macrolides.** Erythromycin may aggravate the weakness of patients with myasthenia gravis. Azithromycin has, rarely, been associated with allergic reactions, including angioedema, anaphylaxis, and dermatologic reactions, including Stevens-Johnson syndrome and toxic epidermal necrolysis. Oral erythromycin may be highly irritating to the stomach and may cause severe phlebitis (inflammation of the vein) when given by injection. These drugs should be used with caution in patients with liver dysfunction. Pregnancy category B: Azithromycin, erythromycin. Pregnancy category C: Clarithromycin, dirithromycin, troleandomycin.
- **Aminoglycosides.** This class of drugs causes kidney and hearing problems. These problems can occur even with normal doses. Dosing should be based on renal function, with periodic testing of both kidney function and hearing. Pregnancy category D.

### Interactions

Use of all antibiotics may temporarily reduce the effectiveness of birth control pills; alternative birth control methods should be used while taking these medications. Antacids should be avoided while on tetracyclines as the calcium can impair absorption of this antibiotic class. For this reason, tetracyclines should not be taken just before or after consuming foods rich in calcium or iron. Consult specialized references for additional interactions to specific antibiotics.

### Recommended usage

To minimize risk of adverse reactions and development of resistant strains of bacteria, antibiotics should be restricted to use in cases where there is either known or a reasonable presumption of bacterial infection. The use of antibiotics in viral infections is to be avoided. Avoid use of fluoroquinolones for trivial infections.

In severe infections, presumptive therapy with a broad-spectrum antibiotic such as a third generation



cephalosporin may be appropriate. Treatment should be changed to a narrow spectrum agent as soon as the pathogen has been identified. After 48 hours of treatment, if there is clinical improvement, an oral antibiotic should be considered.

When the pathogen is known or suspected to be *Pseudomonas*, a suitable beta-lactam drug is often prescribed in combination with an aminoglycoside. A single agent cannot be relied upon for treatment of *Pseudomonas*. When the patient has renal insufficiency, azactam should be considered in place of the aminoglycoside.

In treatment of children with antibiotic suspensions, caregivers should be instructed in use of oral syringes or measuring teaspoons. Household teaspoons are not standardized and will give unreliable doses.

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## Antibiotics, topical

### Definition

Topical **antibiotics** are medicines applied to the skin to kill or stop the growth of bacteria.

### Purpose

Topical antibiotics help prevent infections caused by bacteria that get into minor cuts, scrapes, and burns. Treating minor wounds with antibiotics allows quicker healing. If the wounds are left untreated, the bacteria will multiply, causing pain, redness, swelling,

## KEY TERMS

**Bacteria**—Tiny, one-celled forms of life that cause many diseases and infections.

**Conception**—The union of egg and sperm to form a fetus.

**Fungal**—Caused by a fungus.

**Fungus**—A member of a group of simple organisms that are related to yeast and molds.

**Incision**—A cut, usually made by a surgeon during a surgical procedure.

**Incontinence**—The inability to control the bladder or bowel.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

itching, and oozing. Untreated infections can eventually spread and become much more serious.

Topical antibiotics may also be applied to surgical incision sites to prevent infection; however, when antibiotics are given intravenously, which is in a vein, or during surgery and intravenously, or by mouth following surgery, this may be enough to prevent infection, and antibiotic ointments may not be needed.

Different kinds of topical antibiotics kill different kinds of bacteria. Many antibiotic first-aid products contain combinations of antibiotics to make them effective against a broad range of bacteria.

When treating a wound, it is not enough to simply apply a topical antibiotic. The wound must first be cleaned with soap and water and patted dry. After the antibiotic is applied, the wound should be covered with a dressing such as a bandage or a protective gel or spray. For many years, it was thought that wounds heal best when exposed to the air. Now most experts say it is best to keep wounds clean and moist while they heal, but the covering should still allow some air to reach the wound.

### Description

Some topical antibiotics are available without a prescription and are sold in many forms, including creams, ointments, powders, and sprays. Some widely used topical antibiotics are bacitracin, neomycin, mupirocin, and polymyxin B. Among the products that contain one or more of these ingredients are Bactroban (a prescription item), Neosporin, Polysporin, and Triple Antibiotic Ointment or Cream.



## Recommended dosage

The recommended dosage depends on the type of topical antibiotic. The patient is advised to follow the directions on the package label or ask a pharmacist for directions.

Only the ointment or cream that actually touches the skin has any benefit, therefore a thin layer of topical antibiotic ointment or cream will usually work just as well as a thick layer.

In general, topical antibiotics should be applied within four hours after injury. It is advised not to use more than the recommended amount and do not apply it more often than three times a day; the medicine should not be applied over large areas of skin or on open wounds.

When topical antibiotics are used for surgical incision sites, a surgeon or nurse should be consulted for instructions.

## Precautions

Many public health experts are concerned about antibiotic resistance, a problem that can develop when antibiotics are overused. Over time, bacteria develop new defenses against the antibiotics that once were effective against them. Because bacteria reproduce so quickly, these defenses can be rapidly passed on through generations of bacteria until almost all are immune to the effects of a particular antibiotic. The process happens faster than new antibiotics can be developed. To help control the problem, many experts advise people to use topical antibiotics only for short periods, that is, until the wound heals, and only as directed. For the topical antibiotic to work best, it should be used only to prevent infection in a fresh wound, not to treat an infection that has already started. Wounds that are not fresh may need the attention of a physician to prevent complications such as blood poisoning.

Topical antibiotics are meant to be used only on the skin and for only a few days at a time. If the wound has not healed in five days, the patient is advised to stop using the antibiotic and call a doctor.

It is advised not to use topical antibiotics on large areas of skin or on open wounds. These products should not be used to treat diaper rash in infants or incontinence rash in adults.

Only minor cuts, scrapes, and burns should be treated with topical antibiotics. Certain kinds of injuries may need medical care and should not be self-treated with topical antibiotics. These include:

- large wounds;
- deep cuts;
- cuts that continue bleeding;
- cuts that may need stitches;
- burns any larger than a few inches in diameter;
- scrapes imbedded with particles that will not wash away;
- animal bites;
- deep puncture wounds; or
- eye injuries.

Regular topical antibiotics should never be used in the eyes. Special antibiotic products are available for treating eye infections.

Although topical antibiotics control infections caused by bacteria, they may allow fungal infections to develop. The use of other medicines to treat the fungal infections may be necessary. It is recommended to check with a physician.

Some people may be allergic to one or more ingredients in a topical antibiotic product. If an allergic reaction develops, the person should stop using the product immediately and call a physician.

No harmful or abnormal effects have been reported in babies whose mothers used topical antibiotics while pregnant or nursing; however, pregnant women generally are advised not to use any drugs during the first three months after conception. A woman who is pregnant or breast-feeding or who plans to become pregnant should check with her physician before using a topical antibiotic.

Unless directed by a physician to do so, topical antibiotics should not be used on children under two years of age.

## Side effects

The most common minor side effects are itching or burning. These problems usually do not require medical treatment unless they do not go away or they interfere with normal activities.

If any of the following side effects occur, a doctor should be consulted as soon as possible:

- rash;
- swelling of the lips and face;
- sweating;
- tightness or discomfort in the chest;
- breathing problems;
- fainting or dizziness;
- low blood pressure;

- nausea;
- diarrhea; or
- hearing loss or ringing in the ears.

Other rare side effects may occur. Anyone who has unusual symptoms after using a topical antibiotic should get in touch with the physician who prescribed it or the pharmacist who recommended the medication.

### Interactions

Using certain topical antibiotics at the same time as hydrocortisone, which is a topical corticosteroid used to treat inflammation, may hide signs of infection or allergic reaction. These two medicines should not be used at the same time unless recommended by a health care provider.

Anyone who is using any other type of prescription or nonprescription (over-the-counter) medicine on the skin should check with a doctor before using a topical antibiotic.

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Antibody screening see **Type and screen**

## Antibody tests, immunoglobulins

### Definition

Antibodies, also called immunoglobulins, are proteins produced by the body's immune system that are responsible for fighting off various invaders, such as viruses, bacteria, toxins, and mold spores. They work to clear the body of potentially threatening infections or substances.

The body's immune system is made up of lymphoid organs, including lymph nodes, the bone marrow (located within the center of long bones) and the thymus (located in the chest). These lymphoid organs

produce lymphocytes, including T cells and B cells. These lymphocytes circulate within the bloodstream, within the lymph system, and are also positioned in clumps within organs and on mucosal surfaces of the body. When a B cell encounters a foreign invader, it recognizes it as foreign by virtue of a chemical identifier on its surface (called an antigen). Once the B cell recognizes an antigen, the B cell gives rise to a large number of plasma cells. These plasma cells are capable of producing antibodies.

Antibodies are made up of units called "chains." All antibodies are composed of two larger chains (called heavy chains) and two smaller chains (called light chains). The tip of the antibody is referred to as the hypervariable region. This hypervariable region is responsible for unique chemical properties possessed by each antibody that allow a specific antibody to "recognize" and match up to a particular antigen. The combination of an antibody with a specific antigen, creates an antibody-antigen complex, marking the invader as foreign and in need of inactivation or destruction by other immune cells in the body.

The first time an antigen is encountered by the immune system, the body's response is slow. Time is required in order to activate the machinery necessary to produce the very specific type of antibody necessary to combat that antigen; however, if that particular antigen is encountered in the future, the needed machinery is already available, and antibody production in response to a "familiar" antigen is quite rapid.

Antibodies are divided into five different specific classes of immunoglobulins, termed IgA, IgG, IgM, IgE, and IgD. Each of these classes of immunoglobulins has different characteristics, including overall percentage of immunoglobulins, location, timing of action, and type of antigen to which it attaches:

- About 80% of all circulating antibodies are IgG. IgG is found in blood and tissue fluids. It coats invading particles, marking them so that they can more easily and rapidly be taken up by other types of immune cells. IgG is the predominant antibody cell in the later or secondary phase of immune response.
- IgM makes up about 13% of all antibodies. IgM is primarily found in the blood. It functions to kill bacteria, and is found in the earlier phases of immune response to bacterial invasion of the bloodstream (bacteremia).
- IgA makes up about 6% of the body's total antibodies. IgA is found in large quantities in a variety of bodily fluids, such as breast milk, tears, saliva, and on the surface mucosal lining of the respiratory and digestive tracts. In these locations, IgA is poised to

protect these areas that serve as entrances to the body.

- IgE is the least prevalent antibody, composing about 0.002% of the body's total antibodies. IgE is found bound to immune cells called basophils and mast cells. It is involved in fighting parasites, and is also the predominant antibody seen in allergic reactions.
- Only about 1% of the body's antibodies are IgD. IgD primarily stays attached to B cells, and helps mediate the B cells' early response to antigen exposure. IgD antibodies are particularly active in newborn babies.

One of the important attributes of a healthy, well-functioning immune system rests on its ability to distinguish between "self" and "other." This means that it's important that the antibodies don't mistakenly identify parts of the body itself as foreign invaders. When this does happen, the body's immune system attacks the body, damaging and destroying it. Conditions in which this occurs are referred to as autoimmune disorders. One example of an autoimmune disorder is the condition called rheumatoid arthritis or RA. In RA, the lining of the joints is mis-recognized by the immune system as foreign, resulting in the immune system creating specific antibodies that repeatedly attack, damage, and destroy the joints' lining, resulting in the severe symptoms that accompany this disease.

Another way that the immune system can accidentally work against the body involves the reaction known as allergy or hypersensitivity reactions. In this situation, the immune system reacts overly strongly to a commonly-encountered substance, such as pollen, animal dander, a food ingredient, or an antibiotic medication. While most people's immune systems do not respond to these substances as antigens, an allergic individual's immune system identifies some aspect of the substance as an antigen, triggering an immune reaction. As a result of the ensuing immune response, the individual experiences symptoms of allergy, which are secondary to the immune system's overly-exuberant response to a substance that is usually ignored by most people's immune systems. Allergic responses can vary from mild reactions to overwhelming, life-threatening (anaphylactic) responses.

Strong activation of the immune system to specific chemical markers on transplanted organs is the phenomenon responsible for organ rejection. In this instance, the individual's immune cells identify the transplanted organ's cells as foreign invaders, and specific antibodies that match the organ's antigens are produced. The organ is attacked by the immune system, and damaged, interfering with the organ's

functioning or even destroying it. This same phenomenon is responsible for a **transfusion** reaction; the individual's immune system reacts to the presence of a foreign antigen within the transfused blood, kicking off an immune reaction. The blood cells are attacked by the body's immune cells, and a transfusion reaction ensues.

An understanding of the antibody response is harnessed and used to advantage in the preparation of vaccines or immunizations. In this instance, the vaccine is given in order to "introduce" the body to a particular viral invader that it may encounter in the future. This is done by inactivating the virus (that is, making it unable to actually cause illness). The inactivated virus still has its identifying surface antigen present, allowing the immune system to become acquainted with it. After this introduction, if the individual is actually exposed to that virus, the immune response will be rapid, which will either prevent any illness that occurs due to that virus, or result in a less-severe, shorter course of illness.

### Purpose

Immunoglobulin or antibody tests may provide quantitative or qualitative information. Quantitative testing reveals the levels of a particular antibody. Qualitative testing is done to demonstrate the presence or absence of a specific type of antibody.

Immunoglobulin or antibody tests are performed in order to:

- verify that an individual has been exposed to a particular microbial agent or substance (IgG or IgM testing for infectious agents, IgA testing for allergic exposures);
- check to see whether an individual is immune to a particular microbial agent (IgG or IgM testing);
- diagnose and/or monitor an autoimmune disorder;
- ascertain the reason for organ rejection or a transfusion reaction;
- diagnose an allergy (IgE and/or IgA testing);
- verify that you are immune to a particular disease (sometime used to make sure that an immunization was effective);
- monitor treatment for the bacteria that causes stomach ulcers (*Helicobacter pylori*);
- monitor treatment for cancers that affect the functioning of the bone marrow;
- diagnose multiple myeloma or macroglobulinemia (types of cancer that affect immune cells); and
- diagnose and/or monitor the course of an infection (usually IgG and IgM testing). This may require two

samples, one during the height of the illness (called the acute sample) and one some weeks later (called the convalescent sample). IgM is usually present in the case of a recent infection; IgG is usually present in the event of an infection that occurred at some point in the past.

### Precautions

A number of situations may skew the test results, and should be taken into account when planning an antibody test. These situations include:

- the use of certain medicines, such as birth control pills, antiseizure medications (including phenytoin), corticosteroids, methotrexate, asparaginase, aminophenazone, phenylbutazone, and hydralazine;
- recent cancer treatment (radiation and/or chemotherapy);
- having received a blood transfusion within the previous six months;
- recent (within the previous six months) immunizations, especially those requiring repeat booster doses;
- recent use of alcohol or illegal drugs; and
- recent radioactive scan (within the three days previous to immunoglobulin testing).

### Description

This test requires blood to be drawn from a vein (usually one in the forearm), usually by a nurse or phlebotomist (an individual who has been trained to draw blood). A tourniquet is applied to the arm above the area where the needle stick will be performed. The site of the needle stick is cleaned with antiseptic, and the needle is inserted. The blood is collected in vacuum tubes. After collection, the needle is withdrawn, and pressure is kept on the blood draw site to stop any bleeding and decrease bruising. A bandage is then applied.

### Preparation

There are no restrictions on diet or physical activity, either before or after the blood test.

### Aftercare

As with any blood tests, discomfort, bruising, and/or a very small amount of bleeding is common at the puncture site. Immediately after the needle is withdrawn, it is helpful to put pressure on the puncture site until the bleeding has stopped. This decreases the chance of significant bruising. Warm packs may relieve minor discomfort. Some individuals may feel briefly woozy after a blood test, and they should be encouraged to lie down and rest until they feel better.

## KEY TERMS

**Antibody**—A protein that the body produces in response to exposure to a foreign invader such as a virus, bacteria, fungus, or allergen.

**Antigen**—The protein marker that prompts the body's immune system to produce antibodies.

**Autoimmune disorder**—A condition in which the body produces antibodies that serve to attack organs or tissues of the body itself.

**Immune system**—The collection of organs, tissues, and cells that serve to protect the body against foreign invaders, such as bacteria, viruses, and fungi.

**Lymphocyte**—A white blood cell; part of the immune system responsible for the production of antibodies.

**Plasma cell**—The specific type of white blood cell that produces antibodies.

### Risks

Basic blood tests, such as immunoglobulin or antibody testing, do not carry any significant risks, other than slight bruising and the chance of brief dizziness.

### Results

Antibody tests are performed by mixing a sample of the patient's blood with a sample containing a known, identified antigen. If the patient's blood contains antibody to that antigen, then the antibody will bind to the antigen, creating an antibody-antigen complex. This complex can be measured. Depending on the reason for testing, results may be reported very simply as "detected" or "not detected." Alternatively, results may report on whether the amount of complex detected exceed a predetermined level, one which might reflect the individual's immune status to the antigen-containing substance. In this case, the resulting laboratory report might read "immune" or "not-immune." Lastly, the results might be reported as a concentration, in milligrams per deciliter (mg/dL) or grams per liter (g/L).

Normal results for antibody concentrations are as follows:

- Ig: 85–385 mg/dL or 0.85–3.085 g/L
- IgG: 565–1765 mg/dL or 5.65–17.65 g/L
- IgM: 55–375 mg/dL or 0.55–3.75 g/L
- IgD: Less than 8 mg/dL or 5–30 micrograms per liter
- IgE: 10–1421 micrograms per liter



**High levels**

High levels of IgA may indicate a monoclonal gammopathy, the presence of multiple myeloma, autoimmune disease (rheumatoid arthritis or systemic lupus erythematosus, for example), or liver disease (including cirrhosis of the liver or chronic hepatitis).

High levels of IgG may indicate the presence of a chronic infection (including AIDS), or multiple myeloma, chronic hepatitis, or multiple sclerosis.

High levels of IgD may indicate multiple myeloma.

High levels of IgE may indicate the presence of a parasitic infection, as well as an allergic response, asthma, atopic dermatitis, autoimmune disease, cancer or multiple myeloma.

**Low levels**

Abnormally low levels of IgA may occur in the presence of leukemia, nephritic syndrome, intestinal diseases, rare congenital immune deficiencies of IgA, or a rare genetic disease called ataxia-telangiectasia.

Abnormally low levels of IgG may occur in macroglobulinemia, leukemia, nephritic syndrome, and rare congenital immune deficiencies of IgG.

Abnormally low levels of IgM may occur in the presence of multiple myeloma, leukemia, and some genetic immune disorders.

Abnormally low levels of IgE may occur in the presence of ataxia telangiectasia.

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**ORGANIZATIONS**

American Association for Clinical Chemistry, 1850 K Street, NW, Suite 625, Washington, DC, 20006, (800) 892 1400, <http://www.aacc.org>.

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Anticlotting drugs see **Anticoagulant and antiplatelet drugs**

## Anticoagulant and antiplatelet drugs

**Definition**

Anticoagulants are drugs used to prevent clot formation or to prevent a clot that has formed from enlarging. They inhibit clot formation by blocking the action of clotting factors or platelets. Anticoagulant drugs fall into one of three categories: inhibitors of clotting factor synthesis, inhibitors of thrombin, and antiplatelet drugs.

**Purpose**

Anticoagulant drugs reduce the ability of the blood to form clots. Although blood clotting is essential to prevent serious bleeding in the case of skin cuts, clots inside the blood vessels block the flow of blood to major organs and cause heart attacks and strokes. Although these drugs are sometimes called blood thinners, they do not actually thin the blood. Furthermore, this type of medication will not dissolve clots that already have formed, although the drug stops an existing clot from worsening. However, another type of drug, used in **thrombolytic therapy**, will dissolve existing clots.

Anticoagulant drugs are used for a number of conditions. For example, they may be given to prevent blood clots from forming after the replacement of a heart valve or to reduce the risk of a stroke or another heart attack after a first heart attack. They are also used to reduce the chance of blood clots forming during open-heart surgery or bypass surgery. Low doses of these drugs may be given to prevent blood clots in patients who must stay in bed for a long time after certain types of surgery. They may also be used to prevent the formation of clots in needles or tubes that are inserted into veins, such as indwelling catheters.

Anticoagulants may be given after major surgery to prevent the formation of clots due to lack of physical activity. Patients who are unable to move around may be at risk of developing clots, particularly in the legs. Anticoagulants are given to prevent this. At the same time, compression stockings may be used to reduce the risk of clots in the legs. Compression stocks are worn on the lower legs, and act by increasing the pressure on the veins of the leg, then relaxing. The compression-relaxation keeps the blood in the veins moving, and reduces the risk of clots following surgery.

Because anticoagulants affect the blood's ability to clot, they can increase the risk of severe bleeding and heavy blood loss. It is thus essential to take these drugs exactly as directed and to see a physician



## KEY TERMS

**Anticoagulant**—Drug used to prevent clot formation or to prevent a clot that has formed from enlarging.

**Antiplatelet drug**—Drug that inhibits platelets from aggregating to form a plug.

**Atherosclerosis**—Condition characterized by deposits of fatty plaque in the arteries.

**Catheter**—A tube for passage of fluid into the body or into a body cavity.

**Clot**—A soft, semi-solid mass that forms when blood gels.

**Platelet**—A small, disk-shaped body in the blood that has an important role in blood clotting: they form the initial plug at the rupture site of a blood vessel.

**Thrombin**—A protein produced by the body that is a specific clotting factor that plays an important role in the blood-clotting process.

**Thrombin inhibitor**—One type of anticoagulant medication used to help prevent formation of harmful blood clots in the body by blocking the activity of thrombin.

regularly as long as they are prescribed. With some of these drugs, regular blood tests, as often as once a day, may be required.

## Description

Most anticoagulant drugs are available only with a physician's prescription. They come in tablet and injectable forms. They fall into three groups:

- Inhibitors of clotting factor synthesis. These anticoagulants inhibit the production of certain clotting factors in the liver. One example is warfarin (brand name: Coumadin).
- Inhibitors of thrombin. These drugs interfere with blood clotting by blocking the activity of thrombin. They include heparin and lepirudin (Refludan).
- Antiplatelet drugs. These drugs interact with platelets, which is a type of blood cell, to block platelets from aggregating into harmful clots. They include aspirin, ticlopidine (Ticlid), clopidogrel (Plavix), tirofiban (Aggrastat), and eptifibatide (Integrilin).

## Recommended dosage

The recommended dosage depends on the type of anticoagulant drug and the medical condition for which it is prescribed. The prescribing physician or

the pharmacist who fills the prescription can provide information concerning the correct dosage. Usually, the physician will adjust the dose after checking the patient's clotting time.

Anticoagulant drugs must be taken exactly as directed by the physician. Larger or more frequent doses should not be taken, and the drug should also not be taken for longer than prescribed. Taking too much of this medication can cause easy bruising or severe bleeding. Anticoagulants should also be taken on schedule. A record of each dose should be kept as it is taken. If a dose is missed, it should be taken as soon as possible followed by the regular dose schedule. However, a patient who forgets to take a missed dose until the next day should not take the missed dose at all and should not double the next dose, as this could lead to bleeding. A record of all missed doses should be kept for the prescribing physician who should be informed at the scheduled visits.

## Precautions

Persons who take anticoagulants should see a physician regularly while taking these drugs, particularly at the beginning of therapy. The physician will order periodic blood tests to check the blood's clotting ability. The results of these tests will help the physician determine the proper amount of medication to be taken each day.

Time is required for normal clotting ability to return after anticoagulant treatment. During this period, patients must observe the same precautions they observed while taking the drug. The length of time needed for the blood to return to normal depends on the type of anticoagulant drug that was taken. The prescribing physician will advise as to how long the precautions should be observed.

People who are taking anticoagulant drugs should tell all physicians, dentists, pharmacists, and other medical professionals who provide them with medical treatments or services that they are taking such a medication. They should also carry identification stating that they are using an anticoagulant drug.

Other prescription drugs or over-the-counter medicine—especially aspirin—should be not be taken without the prescribing physician being informed.

Because of the risk of heavy bleeding, anyone who takes an anticoagulant drug must take care to avoid injuries. Sports and other potentially hazardous activities should be avoided. Any falls, blows to the body or head, or other injuries should be reported to a physician, as internal bleeding may occur without any obvious symptoms. Special care should be taken in

shaving and in brushing and flossing the teeth. Soft toothbrushes should be used and the flossing should be very gentle. Electric razors should be used instead of a blade.

Alcohol can change the way anticoagulant drugs affect the body. Anyone who takes this medicine should not have more than one to two alcoholic drinks at any one time, and should not drink alcohol every day.

### *Special conditions*

People with specific medical conditions or who are taking certain other medicines can have problems if they take anticoagulant drugs. Before taking these drugs, the prescribing physician should be informed about any of these conditions.

**ALLERGIES.** Anyone who has had unusual reactions to anticoagulants in the past should let the physician know before taking the drugs again. The physician should also be told about any allergies to beef, pork, or other foods; dyes; preservatives; or other substances.

**PREGNANCY.** Anticoagulants may cause many serious problems if taken during pregnancy. Birth defects, severe bleeding in the fetus, and other problems that affect the physical or mental development of the fetus or newborn are possible. The mother may also experience severe bleeding if she takes anticoagulants during pregnancy, during delivery, or even shortly after delivery. Women should not start taking anticoagulants during pregnancy and should not become pregnant while taking the drug. Any woman who becomes pregnant or suspects that she has become pregnant while taking an anticoagulant should check with her physician immediately.

**BREASTFEEDING.** Some anticoagulant drugs may pass into breast milk. Blood tests can be done on nursing babies to see whether the drug is causing any problems. If it is, other medication may be prescribed to counteract the effects of the anticoagulant drug.

**OTHER MEDICAL CONDITIONS.** Before using anticoagulant drugs, people should inform their physician about any medical problems they have. They should also let the physician who prescribed the medicine know if they are being treated by any other medical physician or dentist. In addition, people who will be taking anticoagulant drugs should let their physician know if they have recently had any of the following:

- fever lasting more than one to two days
- severe or continuing diarrhea
- childbirth
- heavy or unusual menstrual bleeding

- insertion of an intrauterine contraceptive device (i.e., IUD)
- falls, injuries, or blows to the body or head
- any type of surgery, including dental surgery
- spinal anesthesia
- radiation treatment
- any intestinal condition

### **Side effects**

The most common minor side effects are bloating or gas. These problems usually go away as the body adjusts to the drug and do not require medical treatment.

More serious side effects may occur, especially if excessive anticoagulant is taken. If any of the following side effects occur, a physician should be notified immediately:

- bleeding gums
- sores or white spots in the mouth or throat
- unusual bruises or purplish areas on the skin
- unexplained nosebleeds
- unusually heavy bleeding or oozing from wounds
- unexpected or unusually heavy menstrual bleeding
- blood in the urine
- cloudy or dark urine
- painful or difficult urination or sudden decrease in amount of urine
- black, tarry, or bloody stools
- coughing up blood
- vomiting blood or something that looks like coffee grounds
- constipation
- pain or swelling in the stomach or abdomen
- back pain
- stiff, swollen, or painful joints
- painful, bluish or purplish fingers or toes
- puffy or swollen eyelids, face, feet, or lower legs
- changes in the color of the face
- skin rash, itching, or hives
- yellow eyes or skin
- severe or continuing headache
- sore throat and fever, with or without chills
- breathing problems or wheezing
- tightness in the chest
- dizziness
- unusual tiredness or weakness
- weight gain

In addition, patients taking anticoagulant drugs should check with their physicians as soon as possible if any of these side effects occur:

- nausea or vomiting
- diarrhea
- stomach pain or cramps

Other side effects may occur. Anyone who has unusual symptoms while taking anticoagulant drugs should get in touch with the prescribing physician.

### Interactions

Anticoagulants may interact with many other medications. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be increased. Anyone who takes anticoagulants should inform the prescribing physician about other prescription or nonprescription (over-the-counter) medicines he or she is taking—even **aspirin**, **laxatives**, vitamins, and antacids.

Diet also affects the way anticoagulant drugs work in the body. A normal, balanced diet should be followed every day while taking such medication. No dietary changes should be made without informing first the prescribing physician, who should also be told of any illness or other condition interfering with the ability to eat normally. Diet is a very important consideration because the amount of vitamin K in the body affects how anticoagulant drugs work. Dicoumarol and warfarin act by reducing the effects of vitamin K, which is found in meats, dairy products, leafy, green vegetables, and some multiple vitamins and nutritional supplements. For the drugs to work properly, it is best to have the same amount of vitamin K in the body all the time. Foods containing vitamin K should not be increased or decreased without consulting with the prescribing physician. If the patient takes vitamin supplements, he or she should check the label to see if it contains vitamin K. Because vitamin K is also produced by intestinal bacteria, a severe case of diarrhea or the use of laxatives may also alter a person's vitamin K levels.

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Antiemetic drugs see **Antinausea drugs**

## Antihypertensive drugs

### Definition

Antihypertensive drugs are medicines that help lower blood pressure.

### Purpose

All antihypertensive agents lower blood pressure, although the mechanisms of action vary greatly. Within this therapeutic class, there are several subgroups. There are a very large number of drugs used to control hypertension, and the drugs listed below are representatives, but not the only members of their classes.

### Description

The calcium channel blocking agents, also called slow channel blockers or calcium antagonists, inhibit the movement of ionic calcium across the cell membrane. This reduces the force of contraction of heart muscles and arteries. Although the calcium channel blockers are treated as a group, there are four different chemical classes, leading to significant variations in the activity of individual drugs. Nifedipine (Adalat, Procardia) has the greatest effect on the blood vessels, while verapamil (Calan, Isoptin) and diltiazem (Cardizem) have a greater effect on the heart muscle itself.

Peripheral vasodilators such as hydralazine (Apre-soline), isoxuprine (Vasodilan), and minoxidil (Loniten) act by relaxing blood vessels.

There are several groups of drugs that act by reducing adrenergic nerve stimulation, the excitatory nerve stimulation that causes contraction of the

## KEY TERMS

**Adrenergic**—Activated by adrenaline (norepinephrine), loosely applied to the sympathetic nervous system responses.

**Angioedema**—An allergic skin disease characterized by patches of circumscribed swelling involving the skin and its subcutaneous layers, the mucous membranes, and sometimes the viscera also called angioneurotic edema, giant urticaria, Quincke's disease, or Quincke's edema.

**Arteries**—Blood vessels that carry blood away from the heart to the cells, tissues, and organs of the body.

**Laryngospasm**—Spasmodic closure of the larynx.

**Pregnancy category**—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

**Sympathetic nervous system**—The part of the autonomic nervous system that is concerned with preparing the body to react to situations of stress or emergency; it contains chiefly adrenergic fibers and tends to depress secretion, decrease the tone and contractility of smooth muscle, and increase heart rate.

muscles in the arteries, veins, and heart. These drugs include the beta-adrenergic blockers and alpha/beta adrenergic blockers. There are also non-specific adrenergic blocking agents.

Beta-adrenergic blocking agents include propranolol (Inderal), atenolol (Tenormin), and pindolol (Visken). Propranolol acts on the beta-adrenergic receptors anywhere in the body, and has been used as a treatment for emotional anxiety and rapid heart beat. Atenolol and acebutolol (Sectral) act specifically on the nerves of the heart and circulation.

There are two alpha/beta adrenergic blockers, labetalol (Normodyne, Trandate) and carvedilol (Coreg). These work similarly to the beta blockers.

Angiotensin-converting enzyme inhibitors (ACE inhibitors) act by inhibiting the production of angiotensin

II, a substance that induces both constriction of blood vessels and retention of sodium, which leads to water retention and increased blood volume. As of the early 2000s, there are 10 ACE inhibitors marketed in the United States, including captopril (Capoten), benazepril (Lotensin), enalapril (Vasotec), lisinopril (Prinivil, Zestril), and quinapril (Acupril). The primary difference between these drugs is their onset and duration of action.

The ACE II inhibitors, losartan (Cozaar), candesartan (Atacand), irbesartan (Avapro), telmisartan (Micardis), valsartan (Diovan), and eprosartan (Teveten) directly inhibit the effects of ACE II rather than blocking its production. Their actions are similar to the ACE inhibitors, but they appear to have a more favorable side effect and safety profile.

In addition to these drugs, other classes of drugs have been used to lower blood pressure, most notably the thiazide **diuretics**. There are a number of thiazide diuretics marketed in the United States, including hydrochlorothiazide (Hydrodiuril, Esidrex), indapamide (Lozol), polythiazide (Renese), and hydroflumethiazide (Diucardin). The drugs in this class appear to lower blood pressure through several mechanisms. By promoting sodium loss they lower blood volume. At the same time, the pressure of the walls of blood vessels, the peripheral vascular resistance, is lowered. Thiazide diuretics are commonly used as the first choice for reduction of mild hypertension, and may be used in combination with other antihypertensive drugs. These drugs cause a constant loss of potassium from the body; patients should check with their physicians about augmenting their potassium intake.

Sodium nitroprusside (Nitropress) and diazoxide (Hyperstat) are used for rapid treatment of hypertensive emergencies. They are given by vein, often during surgery, to reduce blood pressure that suddenly becomes elevated.

Many classes of antihypertensive drugs have been used before surgery to maintain a low blood pressure during the procedure. There does not appear to be a significant difference between drugs when they are used for blood pressure reduction during surgery.

## Recommended dosage

Recommended dosage varies with patient, drug, severity of hypertension, and whether the drug is being used alone or in combination with other drugs. Patients should consult specialized references or ask a physician for further information.



## Precautions

The warnings and precautions given below apply to the use of antihypertensive drugs over a long period of time. These adverse effects are generally not a problem when the drugs are given as a single dose prior to surgery.

Because of the large number of classes and individual drugs in this group, patients should ask their physicians about specific drugs.

Peripheral vasodilators may cause dizziness and orthostatic hypotension—a rapid lowering of blood pressure when the patient stands up in the morning. Patients taking these drugs must be instructed to rise from bed slowly. Pregnancy risk factors for this group are generally category C, meaning they may result in adverse effects on the fetus. Hydralazine has been shown to cause cleft palate in animal studies, but there is no human data available. Breast-feeding is not recommended.

ACE inhibitors are generally well tolerated, but may rarely cause dangerous reactions including laryngospasm and angioedema. Persistent cough is a common side effect. ACE inhibitors should not be used in pregnancy. When used in pregnancy during the second and third trimesters, ACE inhibitors can cause injury to and even **death** in the developing fetus. When pregnancy is detected, discontinue the ACE inhibitor as soon as possible. Breast-feeding is not recommended.

ACE II inhibitors are generally well tolerated and do not cause cough. Pregnancy risk factor is category C during the first trimester and category D (known to cause adverse effects in the fetus) during the second and third trimesters. Drugs that act directly on the renin-angiotensin system can cause fetal and neonatal morbidity and death when administered to pregnant women. Several dozen cases have been reported in patients who were taking ACE inhibitors. When pregnancy is detected, discontinue ACE inhibitors as soon as possible. Breast-feeding is not recommended.

Thiazide diuretics commonly cause potassium depletion. Patients should have potassium supplementation either through diet, or potassium supplements. Pregnancy risk factor is category B (chlorothiazide, chlorthalidone, hydrochlorothiazide, indapamide, metolazone) or category C (bendroflumethiazide, benzthiazide, hydroflumethiazide, methyclothiazide, trichlormethiazide). Routine use during normal pregnancy is inappropriate. Thiazides are found in breast milk. Breast-feeding is not recommended.

Beta blockers may cause a large number of adverse reactions including dangerous heart rate abnormalities. Pregnancy risk factor is category B (acebutolol, pindolol, sotalol) or category C (atenolol, labetalol, esmolol, metoprolol, nadolol, timolol, propranolol, penbutolol, carteolol, bisoprolol). Breast-feeding is not recommended.

## Interactions

Patients should ask their doctors and consult specific references for food and drug interactions.

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## Antinausea drugs

### Definition

Antinausea drugs are medicines that control nausea—a feeling of sickness or queasiness in the stomach with an urge to vomit. These drugs also prevent or stop vomiting. Drugs that control vomiting are called antiemetic drugs.

### Purpose

Prochlorperazine (Compazine or Compro), the medication described in detail in this entry, controls both nausea and vomiting. Prochlorperazine is also sometimes prescribed for symptoms of mental disorders, such as schizophrenia, and psychotic symptoms such as hostility and hallucinations. Prochlorperazine may be used to control the nausea and vomiting that occur during recovery from the general anesthetics used in surgery and is used to treat the nausea and vomiting that follow chemotherapy or radiation therapy for cancer.

Some antihistamines such as dimenhydrinate (Dramamine) and meclizine (Antivert, Bonine) are useful for treatment of the nausea and vomiting associated with motion sickness.

A group of drugs called the 5-HT<sub>3</sub> receptor antagonists, ondansetron (Zofran) and granisetron (Kytril), are used to control the nausea and vomiting associated with anticancer drugs. Ondansetron and granisetron are also valuable for controlling nausea and vomiting following surgery.

Corticosteroid hormones such as dexamethasone (Decadron, Hexdrol) may also be used as antiemetics.



## KEY TERMS

**Anesthetic**—Medicine that causes a loss of feeling, especially pain. Some anesthetics also cause a loss of consciousness.

**Antihistamine**—Medicine that prevents or relieves allergy symptoms.

**Central nervous system**—The brain, spinal cord and the nerves throughout the body.

**Corticosteroid**—A steroid molecule, produced by the adrenal gland, used in medicine to reduce inflammation. May also apply to synthetic compounds which have structures and uses similar to the natural compounds.

**Spasm**—Sudden, involuntary tensing of a muscle or a group of muscles.

**Tardive dyskinesia**—A disorder brought on by certain medications that is characterized by uncontrollable muscle spasms.

**Tranquilizer**—Medicine that has a calming effect and is used to treat anxiety and mental tension.

## Description

Prochlorperazine is available only with a physician's prescription. It is sold in syrup, capsule, tablet, injection, and suppository forms.

## Recommended dosage

To control nausea and vomiting in adults, the usual dose is:

- Tablets: one 5-milligram (mg) or 10-mg tablet three to four times a day
- Extended-release capsules: one 15-mg capsule first thing in the morning or one 10-mg capsule every 12 hours
- Suppository: 25 mg, twice a day
- Syrup: 5–10 mg three to four times a day
- Injection: 5–10 mg injected into a muscle three to four times a day

Doses for children must be determined by a physician.

## Precautions

Prochlorperazine may cause a movement disorder called tardive dyskinesia (TD), particularly if used for long periods of time. TD may develop in patients who are being treated with antipsychotic drugs. Signs of

this disorder are involuntary twitches and muscle spasms in the face and body and jutting or rolling movements of the tongue. The condition may be permanent; however, it may remit if treatment with the drug is stopped. Older people, especially women, are particularly at risk of developing this problem when they take prochlorperazine.

Antinausea drugs may also cause or worsen the symptoms of the movement disorder known as restless leg syndrome.

Some people feel drowsy, dizzy, lightheaded, or less alert when using this medicine. The drug may also cause blurred vision, and movement problems. For these reasons, people who take this drug should not drive, use machines, or do anything else that might be dangerous until they have found out how the drug affects them.

Prochlorperazine makes some people sweat less, which can allow the body to overheat. The drug may also make the skin and eyes more sensitive to the sun. People who are taking prochlorperazine should try to avoid extreme heat and exposure to the sun. When going outdoors, they should wear protective clothing, a hat, a sunscreen with a skin protection factor (SPF) of at least 15, and sunglasses that block ultraviolet (UV) light. Saunas, sunlamps, tanning booths, tanning beds, hot baths, and hot tubs should be avoided while taking this medicine. Anyone who must be exposed to extreme heat while taking the drug should check with his or her physician.

This medicine adds to the effects of alcohol and other drugs that slow down the central nervous system, such as antihistamines, cold and flu medicines, tranquilizers, sleep aids, anesthetics, some pain medicines, and **muscle relaxants**. People taking prochlorperazine should not drink alcohol, and should check with the physician who prescribed the drug before combining it with any other medicines.

Patients should not stop taking this medicine without checking with the physician who prescribed it. Stopping the drug suddenly can cause dizziness, nausea, vomiting, tremors, and other side effects. When stopping the medicine, it may be necessary to taper the dose gradually.

Prochlorperazine may cause false pregnancy tests.

Women who are pregnant, planning to become pregnant, or breast-feeding should check with their physicians before using this medicine.

Before using prochlorperazine, people with any of these medical problems should make sure their physicians are aware of their conditions:

- previous sensitivity or allergic reaction to prochlorperazine or any other medicines, including a bad reaction to insulin;
- heart disease;
- glaucoma;
- brain tumor;
- intestinal blockage;
- abnormal blood conditions, such as leukemia;
- exposure to pesticides;
- liver or kidney disease;
- lung disease, including emphysema, chronic bronchitis, or asthma; or
- an enlarged prostate or difficulty urinating.

### Side effects

Many side effects are possible with this drug. Drowsiness is most common, so be careful not to drive or operate machinery until you know how it affects you. Patients who experience any of the following side effects should immediately contact their physician: difficulty swallowing, restlessness or pacing, tremors, slow speech, difficulty speaking, spasms of the muscles in the jaw, back, and/or neck, skin rashes, shuffling walk, or a yellowing of the skin or eyes. Anyone who has unusual or troublesome symptoms after taking prochlorperazine should contact his or her physician.

### Interactions

Prochlorperazine may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Among the drugs that may interact with prochlorperazine are antiseizure drugs such as phenytoin (Dilantin) and carbamazepine (Tegretol), anticoagulants such as warfarin (Coumadin), and drugs that slow the central nervous system such as alprazolam (Xanax), diazepam (Valium), and secobarbital (Seconal). Not every drug that interacts with prochlorperazine is listed here, and all patients should consult with a physician or pharmacist before taking any other prescription or nonprescription (over-the-counter) drug with prochlorperazine.

### Resources

#### BOOKS

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- “Ondansetron.” Medline Plus. January 1, 2007. <http://www.nlm.nih.gov/medlineplus/druginfo/medmaster/a601209.html> (February 27, 2008).
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Antiplatelet drugs see **Anticoagulant and antiplatelet drugs**

## Antiseptics

### Definition

An antiseptic is a substance that inhibits the growth and development of microorganisms. For practical purposes, antiseptics are routinely thought of as topical agents, for application to skin, mucous membranes, and inanimate objects, although a formal definition includes agents that are used internally, such as the urinary tract antiseptics.

### Purpose

Antiseptics are a diverse class of drugs that are applied to skin surfaces or mucous membranes for their anti-infective effects. This may be either bacteriocidal (kills bacteria) or bacteriostatic (stops the growth of bacteria). Their uses include cleansing of skin and wound surfaces after injury, preparation of skin surfaces prior to injections or surgical procedures, and routine disinfection of the oral cavity as part of a program of oral hygiene. Antiseptics are also used for disinfection of inanimate objects, including instruments and furniture surfaces.

Commonly used antiseptics for skin cleaning include benzalkonium chloride, chlorhexidine, hexachlorophene, iodine compounds, mercury compounds, alcohol, and hydrogen peroxide. Other agents that have been used for this purpose, but have largely been supplanted by more effective or safer agents,

## KEY TERMS

**Antibiotic**—A medicine used to treat infections.

**Bacteria**—Tiny, one-celled forms of life that cause many diseases and infections.

**Mucous membrane**—The moist lining of a body cavity or structure, such as the mouth or nose.

**Pregnancy category**—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

include boric acid and volatile oils such as methyl salicylate (oil of wintergreen).

Chlorhexidine shows a high margin of safety when applied to mucous membranes, and has been used in oral rinses and preoperative total body washes.

Benzalkonium chloride and hexachlorophene are used primarily as hand scrubs or face washes. Benzalkonium may also find application as a disinfecting agent for instruments, and in low concentration as a preservative for drugs including ophthalmic solutions. Benzalkonium chloride is inactivated by organic compounds, including soap, and must not be applied to areas that have not been fully rinsed.

Iodine compounds include tincture of iodine and povidone iodine compounds. Iodine compounds have the broadest spectrum of all topical anti-infectives, with action against bacteria, fungi, viruses, spores, protozoa, and yeasts. Iodine tincture is highly effective, but its alcoholic component is drying and extremely irritating when applied to abraded (scraped or rubbed) skin. Povidone iodine, an organic compound, is less irritating and less toxic, but not as effective. Povidone iodine has been used for hand scrubs and disinfection of surgical sites. Aqueous solutions of iodine have also been used as antiseptic agents, but are less effective than alcoholic solutions and less convenient to use than the povidone iodine compounds.

Hydrogen peroxide acts through the liberation of oxygen gas. Although the antibacterial activity of

hydrogen peroxide is relatively weak, the liberation of oxygen bubbles produces an effervescent action, which may be useful for wound cleansing through removal of tissue debris. The activity of hydrogen peroxide may be reduced by the presence of blood and pus. The appropriate concentration of hydrogen peroxide for antiseptic use is 3%, although higher concentrations are available.

Thimerosal (Mersol) is a mercury compound with activity against bacteria and yeasts. Prolonged use may result in mercury toxicity.

## Recommended dosage

Dosage varies with product and intended use. Patients should ask their physician or a pharmacist.

## Precautions

Precautions vary with individual product and use.

Hypersensitivity reactions should be considered with organic compounds such as chlorhexidine, benzalkonium, and hexachlorophene.

Skin dryness and irritation should be considered with all products, but particularly with those containing alcohol.

Systemic toxicity may result from ingestion of iodine-containing compounds or mercury compounds.

Most antiseptics have not been rated according to pregnancy category under the pregnancy risk factor system. Hexachlorophene is category C during pregnancy, and should not be used on newborns due to risk of systemic absorption with potential central nervous system (CNS) effects, including convulsions. Application of hexachlorophene to open wounds, mucous membranes, or areas of thin skin, such as the genitalia, should be avoided, since this may promote systemic absorption.

Chlorhexidine should not be instilled into the ear. There is one anecdotal report of deafness following use of chlorhexidine in a patient with a perforated eardrum. Safety in pregnancy and breast-feeding have not been reported; however, there is one anecdotal report of an infant developing slowed heartbeat apparently related to maternal use of chlorhexidine.

Iodine compounds should be used sparingly during pregnancy and lactation due to risk of infant absorption of iodine with alterations in thyroid function.

## Interactions

Antiseptics are not known to interact with any other medicines; however, they should not be used together with any other topical cream, solution, or ointment.

## Resources

### PERIODICALS

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## Antrectomy

### Definition

An antrectomy is the resection, or surgical removal, of a part of the stomach known as the antrum. The antrum is the lower third of the stomach that lies between the body of the stomach and the pyloric canal, which empties into the first part of the small intestine. It is also known as the antrum pyloricum or the gastric antrum. Because an antrectomy is the removal of a portion of the stomach, it is sometimes called a partial or subtotal **gastrectomy**.

### Purpose

An antrectomy may be performed to treat several different disorders that affect the digestive system:

- **Peptic ulcer disease (PUD).** An antrectomy may be done to treat complications from ulcers that have not responded to medical treatment. These complications include uncontrolled or recurrent bleeding and obstructions that prevent food from passing into the small intestine. Because the antrum produces gastrin, which is a hormone that stimulates the

production of stomach acid, its removal lowers the level of acid secretions in the stomach.

- **Cancers of the digestive tract and nearby organs.** An antrectomy may be performed not only to remove a malignant gastric ulcer, but also to relieve pressure on the lower end of the stomach caused by cancers of the pancreas, gallbladder, or liver.
- **Arteriovenous malformations (AVMs) of the stomach.** AVMs are collections of small blood vessels that may develop in various parts of the digestive system. AVMs can cause bleeding into the gastrointestinal tract, resulting in hematemesis (vomiting blood) or melena (black or tarry stools containing blood). The type of AVM most likely to occur in the antrum is known as gastric antral vascular ectasia (GAVE) syndrome. The dilated blood vessels in GAVE produce reddish streaks on the wall of the antrum that look like the stripes on a watermelon.
- **Gastric outlet obstruction (GOO).** GOO is not a single disease or disorder but a condition in which the stomach cannot empty because the pylorus is blocked. In about 37% of cases, the cause of the obstruction is benign—most often PUD, gallstones, bezoars, or scarring caused by ingestion of hydrochloric acid or other caustic substance. The other 63% of cases are caused by pancreatic cancer, gastric cancer, or other malignancy that has spread to the digestive tract.
- **Penetrating gunshot or stab wounds** that have caused severe damage to the duodenum and pancreas. An antrectomy may be done as an emergency measure when the blood vessels supplying the duodenum have been destroyed.

### Demographics

Peptic ulcer disease (PUD) is fairly common in the general United States population. According to the Centers for Disease Control (CDC), about 10% of all Americans will develop an ulcer in the stomach or duodenum at some point in their life. About four million adults are diagnosed or treated each year for PUD; one million will be hospitalized for treatment; and 40,000 will have surgery for an ulcer-related condition. About 6,500 Americans die each year from complications related to PUD. The annual costs to the United States economy from peptic ulcer disease are estimated to be over \$6 billion.

Peptic ulcers can develop at any age, but in the United States they are very unusual in children and uncommon in adolescents. Adults between the ages of 30 and 50 are most likely to develop duodenal ulcers, while gastric ulcers are most common in those over 60.



## KEY TERMS

**Antrum**—The lower part of the stomach that lies between the pylorus and the body of the stomach. It is also called the gastric antrum or antrum pyloricum.

**Bezoar**—A collection of foreign material, usually hair or vegetable fibers or a mixture of both, that may occasionally occur in the stomach or intestines and block the passage of food.

**Dumping syndrome**—A complex physical reaction to food passing too quickly from the stomach into the small intestine, characterized by sweating, nausea, abdominal cramps, dizziness, and other symptoms.

**Duodenum**—The first portion of the small intestine, lying between the pylorus and the jejunum.

**Dysphagia**—Difficulty or discomfort in swallowing.

**Endoscopy**—A technique for looking inside the stomach or esophagus with the help of a flexible instrument containing a light and miniature video camera on one end.

**Gastrin**—A hormone produced by cells in the antrum that stimulates the production of gastric acid.

**Gastroenterology**—The branch of medicine that specializes in the diagnosis and treatment of disorders affecting the stomach and intestines.

***Helicobacter pylori***—A spiral-shaped bacterium that was discovered in 1982 to be the underlying cause of most ulcers in the stomach and duodenum.

**Hematemesis**—Vomiting blood.

**Melena**—The passing of blackish-colored stools containing blood pigments or partially digested blood.

**Nonsteroidal anti-inflammatory drugs (NSAIDs)**—A term used for a group of analgesics that are often given to arthritis patients. About 20% of peptic ulcers are thought to be caused by frequent use of NSAIDs.

**Perforation**—An opening or hole in the tissues of the stomach caused by a disease process.

**Pylorus**—The opening at the lower end of the stomach, encircled by a band of muscle. The contents of the stomach are pumped into the duodenum through the pylorus.

**Resection**—Removal of an organ or structure. An antrectomy is a resection of the antrum.

**Vagotomy**—Cutting or dividing various parts of the vagus nerve that supply the stomach. A vagotomy is done to reduce acid secretion.

**Watermelon stomach**—A type of arteriovenous malformation (AVM) that develops in the antrum. The dilated blood vessels in the AVM resemble the stripes of a watermelon. Watermelon stomach is also known as gastric antral vascular ectasia, or GAVE syndrome.

Duodenal ulcers are more common in men, and gastric ulcers are more common in women. Other risk factors for PUD include heavy smoking and a family history of either duodenal or gastric ulcers.

GAVE, or watermelon stomach, is a very rare cause of gastrointestinal bleeding that was first identified in 1952. It has been associated with such disorders as scleroderma, cirrhosis of the liver, familial Mediterranean fever, and heart disease. GAVE affects women slightly more than twice as often as men. It is almost always found in the elderly; the average age at diagnosis is 73 in women and 68 in men.

Gastric cancer is the 14th most common type of malignant tumor in the United States; however, it occurs much more frequently in Japan and other parts of Asia than in western Europe and North America. About 24,000 people in the United States are diagnosed each year with gastric cancer. Risk factors for developing it include infection of the stomach lining by *Helicobacter pylori*; Asian American, Hispanic,

or African American heritage; age 60 or older; heavy smoking; a history of pernicious anemia; and a diet heavy in dry salted foods. Men are more likely to develop gastric cancer than women. Some doctors think that exposure to certain toxic chemicals in the workplace is also a risk factor for gastric cancer.

### Description

At present almost all antrectomies are performed as open procedures, which means that they are done through a large incision in the patient's abdomen with the patient under **general anesthesia**. After the patient is anesthetized, a urinary catheter is placed to monitor urinary output, and a nasogastric tube is inserted. After the patient's abdomen has been cleansed with an antiseptic, the surgeon makes a large incision from the patient's rib cage to the navel. After separating the overlying layers of tissue, the surgeon exposes the stomach. One clamp is placed at the lower end and another clamp somewhat higher, dividing off the lower third of



the stomach. A cutting stapler may be used to remove the lower third (the antrum) and attach the upper portion of the stomach to the small intestine. After the stomach and intestine have been reattached, the area is rinsed with saline solution and the incision closed.

Most antrectomies are performed together with a **vagotomy**. This is a procedure in which the surgeon cuts various branches of the vagus nerve, which carries messages from the brain to the stomach to secrete more stomach acid. The surgeon may choose to perform a selective vagotomy in order to disable the branches of the nerve that govern gastric secretion without cutting the branches that control stomach emptying.

Some surgeons have performed antrectomies with a laparoscope, which is a less invasive type of surgery. However, as of 2003, this technique is still considered experimental.

## Diagnosis/Preparation

### Diagnosis

Diagnosis of PUD and other stomach disorders begins with taking the patient's history, including a family history. In many cases the patient's primary care physician will order tests in order to narrow the diagnosis. If the patient is older or has lost a large amount of weight recently, the doctor will consider the possibility of gastric cancer. If there is a history of duodenal or gastric ulcers in the patient's family, the doctor may ask questions about the type of discomfort the patient is experiencing. Pain associated with duodenal ulcers often occurs at night, is relieved at mealtimes, but reappears two to three hours after eating. Pain from gastric ulcers, on the other hand, may be made worse by eating and accompanied by nausea and vomiting. Vomiting that occurs repeatedly shortly after eating suggests a gastric obstruction.

The most common diagnostic tests for stomach disorders are:

- **Endoscopy.** An endoscope is a thin flexible tube with a light source and video camera on one end that can be passed through the mouth and throat in order to look at the inside of the upper digestive tract. The video camera attached to the endoscope projects images on a computer screen that allow the doctor to see ulcers, tissue growths, and other possible problems. The endoscope can be used to collect tissue cells for a cytology analysis, or a small tissue sample for a biopsy. A tissue biopsy can be used to test for the presence of *Helicobacter pylori*, a spiral bacterium that was discovered in 1982 to be the underlying cause of most gastric ulcers, as well as to test for

cancer. Endoscopy is one of the most effective tests for diagnosing AVMs.

- **Double-contrast barium x-ray study of the upper gastrointestinal tract.** This test is sometimes called an upper GI series. The patient is given a liquid form of barium to take by mouth. The barium coats the tissues lining the esophagus, stomach, and small intestine, allowing them to be seen more clearly on an x ray. The radiologist can also watch the barium as it moves through the digestive system in order to pinpoint the location of blockages.
- **Urease breath test.** This test can be used to monitor the effects of ulcer treatment as well as to diagnose the presence of *H. pylori*. The patient is given urea labeled with either carbon 13-C or 14-C. *H. pylori* produces urease, which will break down the urea in the test dose to ammonia and carbon dioxide containing the labeled carbon. The carbon dioxide containing the labeled carbon can then be detected in the patient's breath.

### Preparation

Preparation for an antrectomy requires tests to evaluate the patient's overall health and fitness for surgery. These tests include an EKG, x rays, blood tests, and a urine test. The patient is asked to discontinue **aspirin** and other blood-thinning medications about a week before surgery. No solid food or liquid should be taken after midnight of the evening before surgery.

In most hospitals the patient will be given a sedative before the operation either intravenously or by injection. The general anesthesia is given in the **operating room**.

### Aftercare

Aftercare in the hospital for an antrectomy is similar to the aftercare given for other operations involving the abdomen, in terms of **incision care**, pain medication, and **antibiotics** to minimize the risk of infection. Recuperation at home usually takes several weeks. The patient is given an endoscopic check-up about six to eight weeks after surgery.

The most important aspect of aftercare following an antrectomy is careful attention to diet and eating habits. About 30% of patients who have had an antrectomy or a full gastrectomy develop what is known as dumping syndrome. Dumping syndrome results from food leaving the stomach too quickly after a meal and being "dumped" into the small intestine. There are two types of dumping syndrome, early and late. Early dumping occurs 10–20 minutes after

meals and is characterized by feelings of nausea, lightheadedness, sweating, heart palpitations, rapid heart-beat, and abdominal cramps. Late dumping occurs one to three hours after meals high in carbohydrates and is accompanied by feelings of weakness, hunger, and mental confusion. Most patients are able to manage dumping syndrome by eating six small meals per day rather than three larger ones; by choosing foods that are high in protein and low in carbohydrate; by chewing the food thoroughly; and by drinking fluids between rather than with meals.

### Risks

In addition to early or late dumping syndrome, other risks associated with antrectomies include:

- **Diarrhea.** This complication is more likely to occur in patients who had a vagotomy as well as an antrectomy.
- **Weight loss.** About 30–60% of patients who have had a combined antrectomy/vagotomy lose weight after surgery. The most common cause of weight loss is reduced food intake due to the smaller size of the stomach. In some cases, however, the patient loses weight because the nutrients in the food are not being absorbed by the body.
- **Malabsorption/malnutrition.** Iron-deficiency anemia, folate deficiency, and loss of calcium sometimes occur after an antrectomy because gastric acid is necessary for iron to be absorbed from food.
- **Dysphagia.** Dysphagia, or discomfort in swallowing, may occur after an antrectomy when digestive juices from the duodenum flow upward into the esophagus and irritate its lining.
- **Recurrence of gastric ulcers.**
- **Bezoar formation.** Bezoars are collections of foreign material (usually vegetable fibers or hair) in the stomach that can block the passage of food into the small intestine. They may develop after an antrectomy if the patient is eating foods high in plant fiber or is not chewing them thoroughly.

### Normal results

Normal results of an antrectomy depend on the reasons for the surgery. Antrectomies performed to reduce acid secretion in PUD or to remove premalignant tissue to prevent gastric cancer are over 95% successful. The success rate is even higher in treating watermelon stomach. Antrectomies performed to treat gastric cancer or penetrating abdominal trauma are less successful, but this result is related to the severity of the patient's illness or injury rather than the surgical procedure itself.

### Morbidity and mortality rates

The mortality rate for antrectomies related to ulcer treatment is about 1–2%; for antrectomies related to gastric cancer, 1–3%.

The rates of complications associated with antrectomies for ulcer treatment are:

- Recurrence of ulcer: 0.5–1%.
- Dumping syndromes: 25–30%.
- Diarrhea: 10%.

### Alternatives

As of 2003, antrectomy is no longer the first line of treatment for either peptic ulcer disease or GAVE. It is usually reserved for patients with recurrent bleeding or other conditions such as malignancy, perforation, or obstruction.

Although surgery, including antrectomy, is the most common treatment for stomach cancer, it is almost always necessary to combine it with chemotherapy, radiation treatment, or biological therapy (immunotherapy). The reason for a combination of treatments is that stomach cancer is rarely discovered early. Its first symptoms are often mild and easily mistaken for the symptoms of heartburn or a stomach virus. As a result, the cancer has often spread beyond the stomach by the time it is diagnosed.

### Medication

Treatment of peptic ulcers caused by *H. pylori* has changed its focus in recent years from lowering the level of acidity in the stomach to eradicating the bacterium. Since no single antibiotic is effective in curing *H. pylori* infections, so-called triple therapy typically consists of a combination of one or two antibiotics to kill the bacterium plus a medication to lower acid production and a third medication (usually bismuth subsalicylate) to protect the stomach lining.

Specific types of medications that are used as part of triple therapy or for relief of discomfort include:

- **H<sub>2</sub> blockers.** These are used together with antibiotics in triple therapy to reduce stomach acid secretion. H<sub>2</sub> blockers include cimetidine, ranitidine, famotidine, and nizatidine. Some are available as over-the-counter (OTC) medications.
- **Proton pump inhibitors.** These medications include drugs such as omeprazole and lansoprazole. They are given to suppress production of stomach acid.
- **Prostaglandins.** These are given to treat ulcers produced by a group of pain medications known as NSAIDs. Prostaglandins protect the stomach lining

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

An antrectomy is performed as an inpatient procedure in a hospital. It is usually performed by a specialist in gastrointestinal surgery or surgical oncology.

as well as lower acid secretion. The best-known medication in this category is misoprostol.

- **Sucralfate.** Sucralfate is a compound of sucrose and aluminum that covers ulcers with a protective coating that allows eroded tissues to heal.
- **Antacids.** These compounds are available as OTC tablets or liquids.
- **Bismuth subsalicylate.** Sold as an OTC under the trade name Pepto-Bismol, this medication has some antibacterial effectiveness against *H. pylori* as well as protecting the stomach lining.

### Endoscopy

Endoscopy can be used for treatment as well as diagnosis. About 10 different methods are in use as of 2003 for treating bleeding ulcers and AVMs with the help of an endoscope; the most common involve the injection of epinephrine or a sclerosing solution; the application of a thermal probe to the bleeding area; or the use of an Nd:YAG laser to coagulate the open blood vessels. Watermelon stomach is now treated more often with argon plasma coagulation than with an antrectomy. Recurrent bleeding, however, occurs in 15–20% of ulcers treated with endoscopic methods.

### Complementary and alternative (CAM) approaches

Complementary and alternative approaches that have been used to treat gastric ulcers related to PUD include acupuncture, Ayurvedic medicine, and herbal preparations. Ayurvedic medicine, which is the traditional medical system of India, classifies people according to metabolic body type. People who belong to the type known as pitta are considered particularly prone to ulcers and treated with a diet that emphasizes “cooling” foods, including large quantities of vegetables. In Japanese medicine, ulcer remedies made from licorice or bupleurum are frequently prescribed. Western herbalists recommend preparations containing fennel, fenugreek, slippery elm, or marshmallow root

## QUESTIONS TO ASK THE DOCTOR

- What are the alternatives to an antrectomy for my condition? Which would you recommend and why?
- How many antrectomies have you performed?
- How likely am I to develop dumping syndrome if I have the procedure?
- What is your opinion of laparoscopic antrectomies? Would I be eligible to participate in a clinical study of this procedure?

in addition to licorice to relieve the pain of stomach ulcers.

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- American Gastroenterological Association (AGA). 4930 Del Ray Avenue, Bethesda, MD 20814. (301) 654-2055. [www.gastro.org](http://www.gastro.org).
- American Society for Gastrointestinal Endoscopy (ASGE). 1520 Kensington Road, Suite 202, Oak Brook, IL 60523 (630) 573-0600. [www.asge.org](http://www.asge.org).
- Canadian Association of Gastroenterology (CAG). 2902 South Sheridan Way, Oakville, ON L6J 7L6 (888) 780-0007 or (905) 829-2504. [www.cag-acg.org](http://www.cag-acg.org).
- Centers for Disease Control and Prevention (CDC). 1600 Clifton Road, Atlanta, GA 30333. (888) MY-ULCER or (404) 639-3534. [www.cdc.gov](http://www.cdc.gov).
- National Cancer Institute (NCI). NCI Public Inquiries Office, Suite 3036A, 6116 Executive Boulevard, MSC8332, Bethesda, MD 20892-8322. (800) 4-CANCER or (800) 332-8615 (TTY). [www.nci.nih.gov](http://www.nci.nih.gov).
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Anxiolytics see **Antianxiety drugs**

## Aortic aneurysm repair

### Definition

Aortic aneurysm repair involves the removal of a dilated (enlarged) portion of the aorta replaced by a woven or knitted Dacron graft to continue uninterrupted blood flow through the aorta and all branch vessels.

### Purpose

Aortic aneurysm repair is performed when a portion of the aorta has become dilated as a result of medionecrosis in the ascending aorta or atherosclerosis in the arch and descending segments. Congenital defects in connective tissue are also a risk factor. A history of blunt trauma may be associated with this disease propagation. Prior to 1950, patients exposed to syphilis were at risk of developing aortic aneurysm. Risk of clot formation and rupture of the aneurysm, seen in 50% of cases, as well as dilation to a size greater than 4 inches (10 centimeters) promote repair of the aneurysm by surgical techniques.

### Demographics

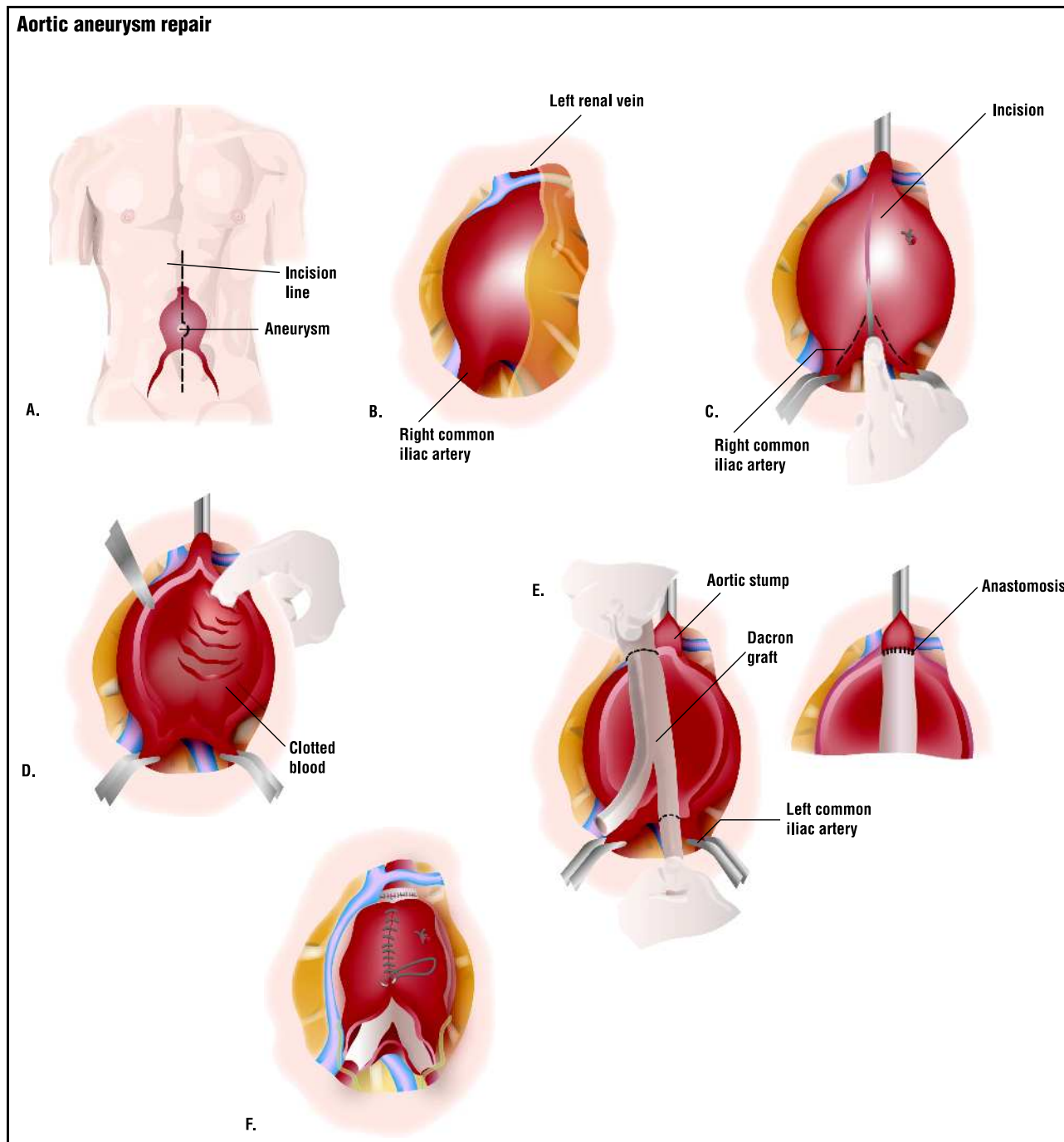
The patient population for this procedure is typically male with an average age of 65 and a history of medionecrosis or atherosclerosis of the aorta. Patients with a medical history significant for syphilis or blunt trauma are at risk. Congenital defects associated with Marfan syndrome or Ehlers-Danlos syndrome (disorders resulting in abnormal tissue formation) need to be monitored.

All patients will be monitored until the aneurysm demonstrates consistent enlargement over time, or grows to greater than 2.2 in (5.5 cm) in diameter at which time surgery is suggested. At a diameter of 4 in (10 cm) surgery is the best option, as risk of rupture increases. Many patients live without symptoms, having the aneurysm identified during other medical procedures.

### Description

After **general anesthesia** is administered, the surgeon will make an incision through the length of the sternum to repair an ascending, arch, or thoracic aortic aneurysm. Abdominal aneurysms are approached through a vertical incision in the abdominal wall. Depending on the location of the aneurysm, cardiopulmonary bypass with deep hypothermic circulatory arrest (arch), cardiopulmonary bypass (ascending), or left heart bypass (thoracic) may be required. All





An incision is made in the abdomen (A), and the aneurysm is visualized (B). The aorta is clamped above the aneurysm, and the aorta is cut open (C). The clotted blood is removed (D). A synthetic graft may be used to replace the part of the aorta that had the aneurysm, and it is stitched in place (E). The aorta is then stitched over the graft (F). (Illustration by GGS Information Services. Cengage Learning, Gale.)

procedures require some amount of anticoagulation, usually heparin, to be administered to prevent blood clot formation. Clamps will be applied across the aorta to prevent blood flow into the aneurysm. The

aneurysm will be opened to an area where the tissue is healthy. The healthy tissue will be sutured to a synthetic fiber fabric graft. The fabric is knit or woven Dacron fibers and may be impregnated with collagen,



## KEY TERMS

**Abdominal aneurysm**—Aneurysm that involves the descending aorta from the diaphragm to the point at which it separates into two iliac arteries.

**Hemostatic**—Relating to blood clotting and coagulation.

**Medionecrosis**—Death of the middle layer of tissues in a vessel.

**Rupture**—Severing of the aorta allowing blood to spill out into the body instead of being carried by the blood vessels.

**Systemic circulation**—Blood vessels not involved in carrying blood to and from the lungs between the right and left sides of the heart.

**Thoracic aneurysm**—Aneurysm that involves the ascending, arch, or descending thoracic aorta using the diaphragm as a landmark for transition to abdominal aorta.

gelatin, or other substances. Blood flow is reinstituted to check for a secure seal. Additional sutures will be added to prevent leaking. The incision is then closed at the completion of the procedure with blood drains penetrating the incision during healing.

Ascending aortic aneurysms may involve the aortic valve or coronary arteries. If the aortic valve is damaged, a graft with an integral aortic valve is used. The coronary arteries are reconnected to the graft.

Aortic arch aneurysms require the reattachment of the arch vessels, the innominate artery, the left common carotid artery, and the left subclavian artery. To decrease surgery time, these three vessels can be treated as a single vessel by using part of the patient's native aorta to create an island. This island is then connected to the graft.

Thoracic aneurysms require special care to protect the spinal vessels that supply blood to the spinal cord. Protecting the spinal cord during repair is still an area of intensive research. Some surgeons feel that rapid implant of the graft to restore blood flow is the best method to protect the spinal cord. A bypass graft called a Gott shunt can be used to redirect the blood flow around the area during surgical repair. Left-heart bypass provides the same benefit as a Gott shunt, with the addition of a mechanical pump for more controlled blood flow to the abdomen and lower extremities.

The abdominal aortic aneurysm is repaired by rapid anastomosis of the graft to return blood flow to the circulation. If the renal arteries are involved in

the aneurysm, they will be reattached to the graft. Additionally, if the superior celiac, mesenteric, or inferior celiac arteries are involved, they will also be reattached to the graft. Finally, it is common for the bifurcation (separation into two) of the iliac arteries to be involved; this may require a Y-shaped graft to be used to reattach both lower limb vessels.

## Diagnosis/Preparation

A simple x ray may provide the initial diagnosis of aortic aneurysm. Initial diagnosis can be made with non-invasive transesophageal **echocardiography** or **ultrasound**. Additional tests such as **magnetic resonance imaging** (MRI) or computed tomography (CT) will allow for additional visualization of the aneurysm. An **angiography** is the preferred method for determining the severity. Blood vessel and aortic valve health can be evaluated.

## Aftercare

Following surgery the patient will be cared for in an **intensive care unit**. Cardiac monitoring will be continued for blood pressure and heart function. Intravenous fluids will continue to be given, and may include blood products. Additional medications will be continued to support cardiac function as needed. The ventilator will be removed after the patient is able to breathe on his/her own. The stay in the intensive care unit is approximately two to five days with hospital discharge following a week.

## Risks

There are risks associated with general anesthesia not associated with the aortic aneurysm repair. Additional risks of cardiopulmonary bypass are not associated with surgical repair. Depending on the type of aneurysm involved, the risks can differ significantly. Since blood flow to the spinal cord is jeopardized by the surgical repair, thoracic aorta aneurysm repair carries a relatively high rate of paralysis. Ascending arch aneurysms may jeopardize coronary blood flow and aortic valve function. Infection of the sternum can influence recovery time. Renal function can be impacted by abdominal aortic aneurysm repair. Renal function may improve or remain compromised. Long-term complications associated with the abdominal surgery include intra-abdominal adhesions, small bowel obstructions, and incisional hernia. Aortic arch aneurysms carry a risk of brain damage associated with deep hypothermic circulatory arrest.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Cardiothoracic or cardiovascular surgeons or vascular surgeons can perform these procedures. Abdominal and thoracic aortic aneurysm repairs require less sophisticated equipment during the surgical procedure, but do need extensive intensive care post-operatively. Anesthetic management plays a crucial role in the decrease in complications associated with these procedures. Facilities that can also provide cardiovascular surgery are best equipped to manage these patients, but this is not a limitation for all procedures.

### Normal results

Repair of the aneurysm will provide normal blood flow to the systemic circulation. Pain associated with the aneurysm will be relieved by the repair. The risk of aneurysm rupture will be eliminated.

### Morbidity and mortality rates

During 1999 over 15,000 deaths in the United States were attributed to aortic aneurysm as reported by the American Heart Association. Without treatment, the five-year survival rate is 13%. The Multicentre Aneurysm Screening Group studied non-emergent abdominal aortic aneurysm repair, showing a 2–6% mortality rate at 30 days post surgery. Emergency surgeries demonstrate 37% mortality. In another study, treatment of cardiac disease by open heart surgery, not **cardiac catheterization** intervention, demonstrated a better outcome prior to elective treatment for abdominal aortic aneurysm.

During treatment of thoracic aneurysm repair the incidence of paraplegia is 6–10%. Left vocal cord paralysis is recognized if the laryngeal nerve has been compromised by the procedure. Multiple organ failure is incident in **death**, with respiratory failure being among the most common. If the aneurysm is above or involves the renal arteries, renal failure can occur in 4–9% of patients.

Treatment of the ascending aorta and aortic arch repair carry many of the risks associated with cardiopulmonary bypass, including hemostatic difficulties, left ventricle dysfunction, or myocardial (heart muscle) dysfunction. Irreversible brain damage is also an additional risk.

## QUESTIONS TO ASK THE DOCTOR

- How many of these procedures have been performed by the surgeon?
- What is the mortality rate for this procedure at the institution?
- What side effects are associated with this surgical procedure, and at what rate are they experienced by patients?
- What is the expected length of stay in the hospital?
- Are there any other suitable procedures, such as endovascular grafting?
- How long before normal activities, exercise, work, and driving can be resumed?

Cardiac function can be compromised in all patients with thoracic or abdominal aortic aneurysms. Hemorrhage is of frequent concern and is more of a risk as the number of suture lines increases. Forty to seventy percent of all deaths can be contributed to cardiac malfunction and blood loss.

### Alternatives

Endovascular graft placement is being used as a suitable option to the open surgical procedure. The endovascular graft can be placed using minimally invasive techniques that reduce or eliminate the stay in the intensive care unit. Light sedation and epidural anesthetic are often adequate.

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Aortic stenting see **Endovascular stent surgery**

## Aortic valve replacement

### Definition

Aortic valve replacement is the insertion of a mechanical or tissue valve in place of the diseased biological aortic valve.

### Purpose

Aortic valve replacement is necessary when the aortic valve has become diseased. The aortic valve can suffer from insufficiency (inability to perform adequately) or stenosis (narrowing). An insufficient valve is leaky and allows blood to flow backward from the aorta to the left ventricle during diastole, which occurs when the ventricles fill with blood. A stenotic valve prevents the forward-moving flow of blood from the left ventricle to the aorta, during systole, which is the time period when the heart is contracting.

Either situation can result in heart failure and an enlarged left ventricle. With aortic stenosis, the symptoms of angina pectoris, fainting, and congestive heart failure will develop with the severity of the narrowing. There is an increased rate of sudden **death** of patients with aortic stenosis. Dyspnea (labored breathing), fatigue, and palpitations are late symptoms of aortic insufficiency. Angina pectoris is associated with the latest stages of aortic insufficiency.

### Demographics

Congenital birth defects involving a bicuspid aortic valve can develop stenosis. These patients may become symptomatic in mid-teen years through age 65. Patients with a history of rheumatic fever have a disposition for aortic stenosis, but may live symptom

## KEY TERMS

**Antithrombic**—Preventing clot formation.

**Biological tissue valve**—A replacement heart valve that is harvested from the patient (autograft), a human cadaver (homograft or allograft), or other animal, such as a pig (heterograft).

**Diastole**—Period between contractions of the heart.

**Hemolysis**—Separation of hemoglobin from the red blood cells.

**Mechanical valve**—An artificial device used to replace the patient's heart valve. They include three types: ball valve, disk valve, and bileaflet valve.

**Systole**—Period while the heart is contracting.

free for more than four decades. Calcification of the aortic valve tends to effect an older population with 30% of patients over age 85 having stenosis at autopsy.

Patients with aortic stenosis who have angina, dyspnea, or fainting are candidates for aortic valve replacement. Asymptomatic patients undergoing coronary artery bypass grafting should be treated with aortic valve replacement, but otherwise are not candidates for preventive aortic valve replacement.

Patients with a history of rheumatic fever or syphilitic aortitis (inflammation of the aorta) face the possibility of developing aortic insufficiency. Successful treatment has decreased this causative relationship. Primary causes of aortic valve disease include bacterial endocarditis, trauma, aortic dissection, and congenital diseases.

Patients showing acute symptoms, including pulmonary edema, heart rhythm problems, or circulatory collapse, are candidates for aortic valve replacement. Chronic pathologies are recommended for surgery when patients appear symptomatic, demonstrating angina and dyspnea. Asymptomatic patients also must be monitored for heart dysfunction. Left ventricular dimensions greater than 2 in (50 mm) at diastole or 3 in (70 mm) at systole are indications for replacement when aortic insufficiency is diagnosed.

### Description

While receiving **general anesthesia** in preparation for the surgery, the patient's cardiac function will be

monitored. A sternotomy (incision into the sternum) or **thoracotomy** may be used to expose the heart, with the thoracotomy providing a smaller incision through the ribs. Minimally invasive techniques may also be used, utilizing a partial sternotomy or a lateral mini-thoracotomy. These approaches seem to decrease patient recovery time, as well as decreasing potential complications. Anticoagulant is administered in preparation for cardiopulmonary bypass. Cardiopulmonary bypass is instituted by exposing and cannulating (putting tubes into) the great blood vessels of the heart, or by cannulating the femoral artery and vein. A combination of cannulation sites may also be used. The heart is stopped after the aorta is clamped. The base of the aorta root is opened, and the diseased valve is removed. Sutures are placed in the aortic rim and into the replacement valve. The replacement valve can be either mechanical or biological tissue. The replacement valve will be sized prior to implant to ensure that it fits the patient based on the size of the aortic valve annulus. Once seated, the valve is secured by tying the individual sutures. The heart is then deaired. The cross clamp is removed and the heart is allowed to beat as deairing continues by manipulation of the left ventricle. Cardiopulmonary bypass is terminated, the tubes are removed, and drugs to reverse anticoagulation are administered.

A heart valve prevents the flow of blood backward during heartbeats. Replacement heart valves can be mechanical or biological tissue valves. For patients younger than 65 years of age, the mechanical valve offers superior longevity. Anticoagulant medication is required for the life of the patient implanted with a mechanical valve. The biological tissue valve does not require anticoagulation but suffers from deterioration, leading to **reoperation**, particularly in those under age 50. Women considering bearing children should be treated with biological tissue valves because the anticoagulant of choice with mechanical valves, warfarin, is associated with developmental effects in the fetus. **Aspirin** can be substituted in certain circumstances.

### Diagnosis/Preparation

Initial diagnosis by auscultation (listening) is done with a **stethoscope**. Additional procedures associated with diagnosis to judge severity of the lesion include **chest x ray**, **echocardiography**, and **angiography** with **cardiac catheterization**. In the absence of angiography, **magnetic resonance imaging (MRI)** or computed tomographic (CT) imaging may be used.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Hospitals with cardiac surgery services provide aortic valve replacement. Specialization is required for young adults and pediatric patients. Cardiovascular and cardiac surgeons are trained to provide this treatment and the initial follow-up care. These surgeons are trained in their cardiac surgical residency to evaluate and perform these procedures and to care for the patient during the postoperative period.

### Aftercare

The patient will have continuous cardiac monitoring performed in the **intensive care unit (ICU)** postoperatively. Medications or mechanical circulatory assist may be instituted during the surgery or postoperatively to help the heart provide the necessary cardiac output to sustain the pulmonary and systemic circulations. These will be discontinued as cardiac function improves. As the patient is able to breathe without assistance, ventilatory support will be discontinued. Drainage tubes allow blood to be collected from the chest cavity during healing and are removed as blood flow decreases. Prophylactic **antibiotics** are given. Anticoagulation (warfarin, aspirin, or a combination) therapy is instituted and continued for patients who have received a mechanical valve. The ICU stay is approximately three days with a final hospital discharge occurring within a week after the procedure.

The patient receive **wound care** instructions prior to leaving the hospital. The instructions include how to recognize such adverse conditions as infection or valve malfunction, contact information for the surgeon, and guidelines on when to return to the emergency room.

### Risks

There are unassociated risks with general anesthetic and cardiopulmonary bypass. Risks associated with aortic valve replacement include embolism, bleeding, and operative valvular endocarditis. Hemolysis is associated with certain types of mechanical valves, but is not a contraindication for implantation.

### Normal results

Myocardial function typically improves rapidly, with decrease in left ventricle enlargement and size of the inner chamber over several months, allowing the



## QUESTIONS TO ASK THE DOCTOR

- What type of valve is best suited for me?
- What are the pros and cons associated with each type of valve for a person with my disease and/or associated diseases?
- Why am I a candidate for valve replacement?
- Are there any other more suitable alternative procedures?
- If I am a female interested in having children or am currently pregnant, are there additional options?
- How often has the surgeon performed this procedure and what are the morbidity/mortality statistics for this surgeon and institution?
- If I have an associated disease or complicated scenario, does the surgeon have experience with follow-up care?

heart to return to normal dimensions. Anticoagulation therapy will be continued, depending on the type of mechanical valve implanted. Implantation of biological tissue valves are associated with the formation of blood clots. If non-cardiac surgery or dental care is needed, the anticoagulant medication will be adjusted to prevent bleeding complications.

### Morbidity and mortality rates

There is a 3–5% hospital mortality associated with aortic valve replacement. The average survival rate after five years is 85% for patients suffering from aortic stenosis who undergo aortic valve replacement. Structural valve deterioration can occur and is higher in mechanical valves during the first five years; however, biological tissue and mechanical valves have the same failure incidence at 10 years, with a 60% probability of death at 11 years as a result of valve-related complications. Patients with a mechanical valve are more likely to experience bleeding complications. Reoperation is more likely for patients treated with a biological tissue valve, but not significantly different when compared to their mechanical valve counterparts. This combines to an average rate of significant complications of 2–3% per year, with death rate of approximately 1% per year associated directly with the prosthesis.

### Alternatives

Balloon valvotomy may provide short-term relief of aortic stenosis, but is considered a temporary treatment

until valve replacement can be accomplished. Aortic valve repair by direct commissurotomy may also be successful for some cases of aortic stenosis. Medical treatment for inoperable patients with severe aortic stenosis is used to relieve pulmonary congestion and prevent atrial fibrillation.

Severe aortic insufficiency can be treated with medical therapy. Pharmaceuticals to decrease blood pressure, along with **diuretics** and vasodilators, are helpful in patients with aortic insufficiency.

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Aortofemoral bypass see **Peripheral vascular bypass surgery**

Apheresis see **Transfusion**

Apicoectomy see **Root canal treatment**

## Appendectomy

### Definition

Appendectomy is the surgical removal of the appendix. The appendix is a worm-shaped hollow pouch attached to the cecum, the beginning of the large intestine.

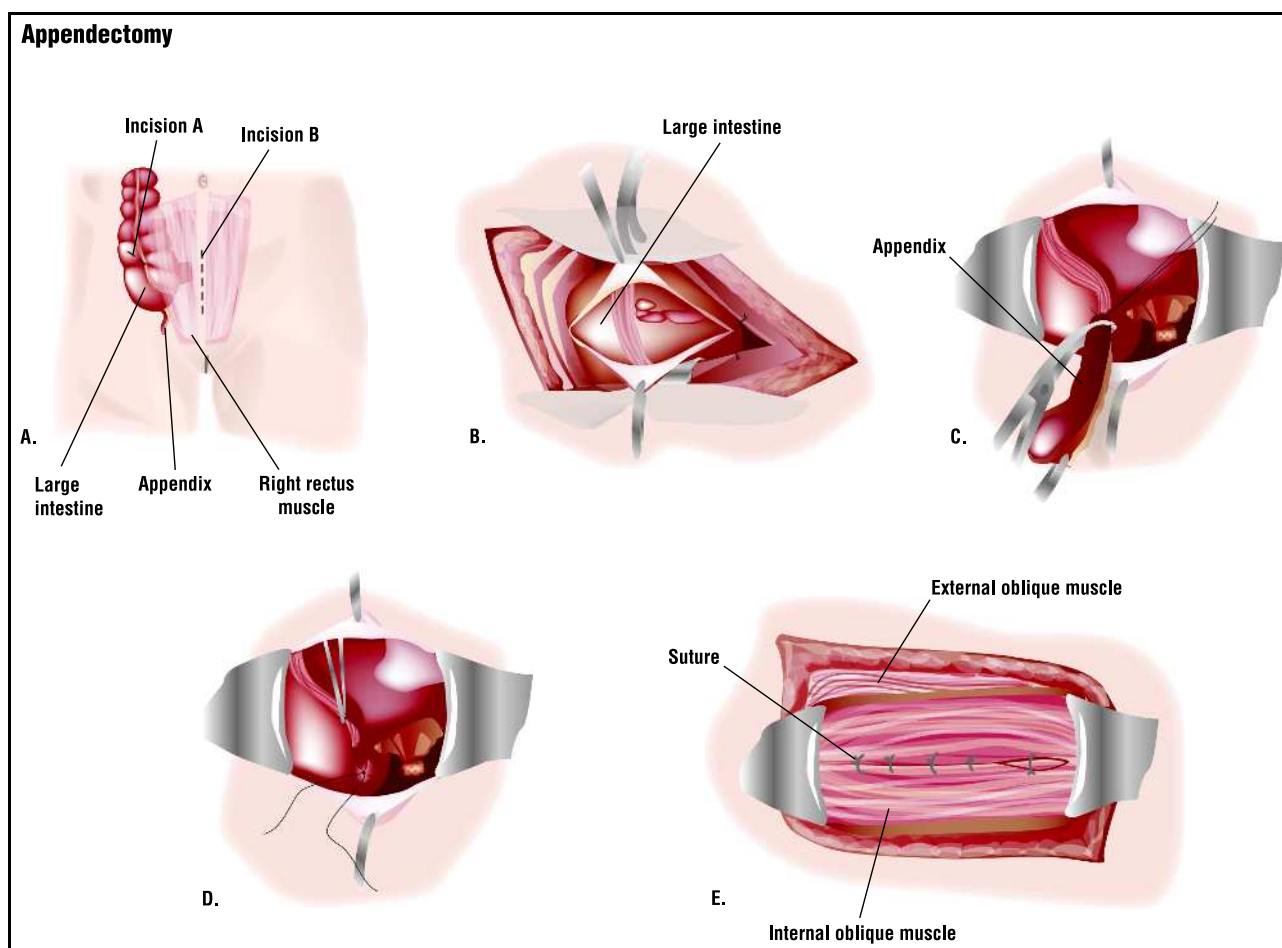
### Purpose

Appendectomies are performed to treat appendicitis, an inflamed and infected appendix.

### Description

After the patient is anesthetized, the surgeon can remove the appendix either by using the traditional open procedure (in which a 2–3 in [5–7.6 cm] incision is made in the abdomen) or via **laparoscopy** (in which four 1-in [2.5-cm] incisions are made in the abdomen).





To remove a diseased appendix, an incision is made in the patient's lower abdomen (A). Layers of muscle and tissue are cut, and large intestine, or colon, is visualized (B). The appendix is visualized (C), tied, and removed (D). The muscle and tissue layers are stitched (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

### *Traditional open appendectomy*

When the surgeon uses the open approach, he makes an incision in the lower right section of the abdomen. Most incisions are less than 3 in (7.6 cm) in length. The surgeon then identifies all of the organs in the abdomen and examines them for other disease or abnormalities. The appendix is located and brought up into the wounds. The surgeon separates the appendix from all the surrounding tissue and its attachment to the cecum, and then removes it. The site where the appendix was previously attached, the cecum, is closed and returned to the abdomen. The muscle layers and then the skin are sewn together.

### *Laparoscopic appendectomy*

When the surgeon performs a laparoscopic appendectomy, four incisions, each about 1 in (2.5 cm) in

length, are made. One incision is near the umbilicus, or navel, and one is between the umbilicus and the pubis. Two smaller incisions are made on the right side of the lower abdomen. The surgeon then passes a camera and special instruments through these incisions. With the aid of this equipment, the surgeon visually examines the abdominal organs and identifies the appendix. The appendix is then freed from all of its attachments and removed. The place where the appendix was formerly attached, the cecum, is stitched. The appendix is removed through one of the incisions. The instruments are removed and then all of the incisions are closed.

Studies and opinions about the relative advantages and disadvantages of each method are divided. A skilled surgeon can perform either one of these procedures in less than one hour; however, laparoscopic appendectomy (LA) always takes longer than traditional appendectomy (TA). The increased time required to do an LA

## KEY TERMS

**Abscess**—A collection of pus buried deep in the tissues or in a body cavity.

**Anesthesia**—A combination of drugs administered by a variety of techniques by trained professionals that provide sedation, amnesia, analgesia, and immobility adequate for the accomplishment of the surgical procedure with minimal discomfort to the patient.

**Anesthesiologist**—A physician who has special training and expertise in anesthesia techniques.

**Anesthetics**—Drugs used to make a body area free of sensation or pain.

**Cecum**—The beginning of the large intestine and the place where the appendix attaches to the intestinal tract.

**General surgeon**—A physician who has special training and expertise in performing a variety of operations.

**Pelvic organs**—The organs inside of the body that are located within the confines of the pelvis. This includes the bladder and rectum in both sexes, and the uterus, ovaries, and fallopian tubes in females.

**Pubis**—The front portion of the pelvis located in the anterior abdomen.

**Thrombophlebitis**—Inflammation of the veins, usually in the legs, which causes swelling and tenderness in the affected area.

**Umbilicus**—The navel.

increases the patient's exposure to anesthetics, and, therefore, the risk of complications. The longer time requirement also increases the fees charged by the hospital for the **operating room**, and by the anesthesiologist. Since LA also requires specialized equipment, the fees for its use also increase the hospital charges. Patients with either operation have similar pain medication needs, begin eating diets at comparable times, and stay in the hospital equivalent amounts of time. LA is of special benefit to women for whom diagnosis is difficult and gynecological disease (such as endometriosis, pelvic inflammatory disease, ruptured ovarian follicles, ruptured ovarian cysts, and tubal pregnancies) may be the source of pain and not appendicitis. If LA is done in these patients, the pelvic organs can be more thoroughly examined and a definitive diagnosis made prior to removal of the appendix. Most surgeons select either TA or LA based on the individual needs and circumstances of the patient.

Insurance plans do cover the costs of appendectomy. Fees are charged independently by the hospital and the physicians. Hospital charges include fees for operating and **recovery room** use, diagnostic and laboratory testing, as well as the normal hospital room charges. Surgical fees vary from region to region and range between \$250–750. The anesthesiologist's fee depends on the health of the patient and the length of the operation.

## Preparation

Once the diagnosis of appendicitis is made and the decision has been made to perform an appendectomy, the patient undergoes the standard preparation for an operation. This usually takes only one to two hours and includes signing the operative consents, patient identification procedures, evaluation by the anesthesiologist, and moving the patient to the operating area of the hospital. Occasionally, if the patient has been ill for a prolonged period of time or has had protracted vomiting, a delay of several hours may be necessary to give the patient fluids and **antibiotics**.

## Aftercare

Recovery from an appendectomy is similar to other operations. Patients are allowed to eat when the stomach and intestines begin to function again. Usually the first meal is a clear liquid diet—broth, juice, soda, and gelatin. If patients tolerate this meal, the next meal usually is a regular diet. Patients are asked to walk and resume their normal physical activities as soon as possible. If TA was done, work and physical education classes may be restricted for a full three weeks after the operation. If a LA was done, most patients are able to return to work and strenuous activity within one to three weeks after the operation.

## Risks

Certain risks are present when any operation is performed under **general anesthesia** and the abdominal cavity is opened. Pneumonia and collapse of the small airways (atelectasis) often occurs. Patients who smoke are at a greater risk for developing these complications. Thrombophlebitis, or inflammation of the veins, is rare but can occur if the patient requires prolonged bed rest. Bleeding can occur but rarely is a blood **transfusion** required. Adhesions (abnormal connections to abdominal organs by thin fibrous tissue) are a known complication of any abdominal surgery such as appendectomy. These adhesions can lead to intestinal obstruction that prevents the normal flow of intestinal contents. Hernia is a complication of any

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

An appendectomy is performed by a fully trained surgeon who, after medical school, has gone through years of training in an accredited residency program to learn the specialized skills of a surgeon. A sign of a surgeon's competence is certification by a national surgical board approved by the American Board of Medical Specialties (ABMS). All board-certified surgeons have completed an approved training program and have passed a rigorous specialty examination. The letters F.A.C.S. (Fellow of the American College of Surgeons) after a surgeon's name are a further indication of a surgeon's qualifications.

Appendectomy is considered a major surgical operation. Therefore, the surgeon must perform this operation in the operating room of a hospital. An anesthesiologist is also present during the operation to administer an anesthetic.

incision; however, they are rarely seen after appendectomy because the abdominal wall is very strong in the area of the standard appendectomy incision.

The overall complication rate of appendectomy depends upon the status of the appendix at the time it is removed. If the appendix has not ruptured, the complication rate is only about 3%. If the appendix has ruptured, the complication rate rises to almost 59%. Wound infections do occur and are more common if the appendicitis was severe, far advanced, or ruptured. An abscess may also form in the abdomen as a complication of appendicitis.

Occasionally, an appendix will rupture prior to its removal, spilling its contents into the abdominal cavity. Peritonitis is a generalized infection in the abdomen will occur. Treatment of peritonitis as a result of a ruptured appendix includes removal of what remains of the appendix, insertion of drains (rubber tubes that promote the flow of infection inside the abdomen to outside of the body), and antibiotics. Fistula formation (an abnormal connection between the cecum and the skin) rarely occurs. It is only seen if the appendix has a broad attachment to the cecum and the appendicitis is far advanced, causing destruction of the cecum itself.

The complications associated with undiagnosed, misdiagnosed, or delayed diagnosis of appendicitis are very significant. This has led surgeons to perform an appendectomy any time that they feel appendicitis is the

## QUESTIONS TO ASK THE DOCTOR

- What are the possible risks involved with this surgery?
- What are the expected results after having a laparoscopic appendectomy versus having an open abdominal appendectomy?
- Will I have a scar?
- Which procedure will you use to perform the appendectomy?
- Must I do anything special after the operation?
- How long does it take to recover?
- How many appendectomies do you perform each year?

diagnosis. Most surgeons feel that in approximately 20% of their patients, a normal appendix will be removed. Rates much lower than this would seem to indicate that the diagnosis of appendicitis was being frequently missed.

### Normal results

Most patients feel better immediately after an operation for appendicitis. Many patients are discharged from the hospital within 24 hours after the appendectomy. Others may require a longer stay, from three to five days. Almost all patients are back to their normal activities within three weeks.

### Morbidity and mortality rates

The mortality rate of appendicitis has dramatically decreased over time. As of 2007, the mortality rate was estimated at one to two per 1,000,000 cases of appendicitis. **Death** is usually due to peritonitis, intra abdominal abscess, or severe infection following rupture.

### Alternatives

Appendectomies are usually carried out on an emergency basis to treat appendicitis. There are no alternatives, due to the serious consequence of not removing the inflamed appendix, which is a ruptured appendix and peritonitis, a life-threatening emergency.

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American College of Surgeons, 633 N. Saint Clair St., Chicago, IL, 60611 3211, (312) 202 5000, (800) 621 4111, (312) 202 5001, [postmaster@facs.org](mailto:postmaster@facs.org), <http://www.facs.org>.

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Appendix removal see **Appendectomy**

Arterial anastomosis see **Arteriovenous fistula**

## Arterial blood gases (ABG)

### Definition

An arterial blood gas (ABG test) measures the levels of oxygen and carbon dioxide in the blood. Additionally, it reports the level of acidity or alkalinity of the blood,

the pH. An ABG is performed in order to diagnose or monitor respiratory, kidney, or metabolic disorders.

### Purpose

An ABG may be ordered to monitor the status of a patient in surgery or after a trauma. The test may also be used to monitor how a patient is responding to **oxygen therapy**. Additionally, an ABG may also help in the evaluation of a variety of symptoms, including shortness of breath.

### Precautions

If the patient is on supplemental oxygen, no changes should be made to the setting for a full twenty to thirty minutes prior to drawing the ABG sample. If the sample needs to be drawn with the patient off of supplemental oxygen (that is, on "room air"), then the patient should be removed from oxygen and should be off of oxygen for a full twenty to thirty minutes prior to the blood draw.

If the blood will be drawn from the artery at the wrist, the radial artery, then a simple test (the Allen test) should be performed prior to the blood draw to ascertain that the patient has good blood circulation at the wrist. Pressure is applied to the two main wrist arteries (the radial and ulnar arteries) for several seconds. The pressure is then released from one and then the other, and the patient's hand is observed to verify that it turns a bit red (flushes) as blood returns through those arteries into the hand. If the flushing is not adequate, then the arteries at the other wrist should be tested the same way. If good circulation at either wrist cannot be verified, then the elbow or groin arteries should be considered.

The individual who is drawing the blood should be well-aware if the patient is on any kind of blood thinning medication, since this may make the patient more prone to bleeding or bruising after the blood draw.

### Description

Most blood tests involve blood that is drawn from a vein; however, because this test needs to look at the oxygen-carrying capacity of the blood, the sample needs to be drawn from an artery either at the wrist, the elbow crease, or the groin. If the patient has a central line (an intravenous line that goes directly into the heart), the blood sample can be drawn from that. When the radial artery (the artery at the wrist where one checks the pulse rate) is being used for the test, the sample can usually be drawn by a nurse or phlebotomist (an individual who has been trained to draw blood). When an artery at the elbow (the brachial artery), the groin (femoral artery), or a central line is involved, a doctor may be required to





(Medical-on-Line / Alamy)

draw the sample. Because arteries run deeper than veins, the needle stick of an ABG is more painful than other blood tests. In some cases, a local anesthetic may be used to numb the area around the artery to be used. The site of the needle stick is cleaned with antiseptic, and the needle is inserted. The blood is collected in vacuum tubes. After collection, the needle is withdrawn, and a cotton ball is usually pressed onto the blood draw site for about 10 minutes, to stop any bleeding and to decrease bruising. A pressure bandage is then applied over the puncture site, and should be left in place for about an hour to decrease bleeding and bruising.

In newborn babies, blood may be obtained from the umbilical artery and umbilical vein for testing, or whole blood from a heel stick may be utilized.

### Preparation

There are no restrictions on diet or physical activity, either before or after the blood test.

### Aftercare

As with any blood tests, discomfort, bruising, and/or a very small amount of bleeding is common

at the puncture site. Arteries run deeper than veins and the blood pressure within an artery is higher, therefore there is a greater chance for pain, bleeding, and bruising from an ABG than from other blood tests that draw blood from a vein. Immediately after the needle is withdrawn, it is very important to put significant pressure on the puncture site for about 10 minutes, until the bleeding has stopped. This decreases the chance of significant bruising. Warm packs may relieve minor discomfort. Some individuals may feel briefly woozy after a blood test, and they should be encouraged to lie down and rest until they feel better. For about 24 hours after an ABG is drawn, the individual should avoid vigorous **exercise** or heavy lifting.

### Risks

Basic blood tests do not carry significant risks, other than slight bruising and the chance of brief dizziness. An arterial blood draw is more painful and more inclined to bleed and bruise, so the risks of these complications are slightly higher after an ABG is drawn.



## KEY TERMS

**Brachial**—Referring to the arm; the brachial artery is an artery that runs from the shoulder to the elbow.

**Central line**—An intravenous line that goes directly into the heart.

**Femoral**—Pertaining to the thigh of the leg. The femoral artery is an artery that runs through the groin area.

**Radial**—Referring to the lower arm. The radial artery is an artery that runs from the elbow, through the wrist, and into the palm of the hand.

## Results

Results from the ABG include a measurement of the partial pressure of oxygen or  $\text{pO}_2$  (how much oxygen is dissolved in the blood), the partial pressure of carbon dioxide or  $\text{pCO}_2$  (how much carbon dioxide is dissolved in the blood), and pH. The pH is a number that indicates how acidic or alkaline the blood is. It is a measurement involving the concentration of hydrogen ions in the blood. As the  $\text{pCO}_2$  levels rise, the pH level drops and the blood becomes increasingly acidic; as the  $\text{pO}_2$  levels rise, the pH level rises, and the blood becomes increasingly alkaline.

The information obtained from an ABG also allows other important aspects of body chemistry to be evaluated, such as the  $\text{O}_2$  saturation (a measurement of the percentage of oxygen that is bound to the hemoglobin in red blood cells) and the amount of bicarbonate in the body. Bicarbonate, or  $\text{HCO}_3^-$ , is processed by the kidneys in response to the pH of the body. When the pH goes down (indicating greater acidity), the kidneys excrete  $\text{HCO}_3^-$ , in an effort to counterbalance the acidity. When the pH goes up (indicating greater alkalinity), the kidneys reabsorb more  $\text{HCO}_3^-$ , in an effort to counterbalance the alkalinity. A final calculation can help to measure the patient's base/excess or deficit. This is a measurement of the body's ability to compensate for pH abnormalities through other "buffering" agents in the blood, such as hemoglobin, proteins, phosphates, and bicarbonate.

### Normal ABG results

Normal ABG results are as follows:

- $\text{pO}_2$ : 75–100 mm Hg (millimeters of mercury)
- $\text{pCO}_2$ : 35–45 mm Hg
- pH: 7.35–7.45
- $\text{HCO}_3^-$ : 24–28 mEq/L (millequivalents per liter)

### Abnormal ABG results

Abnormal ABG results include the following:

- Respiratory acidosis is indicated by a low pH and a high  $\text{pCO}_2$ , and usually indicates respiratory depression, a situation in which the individual is not breathing in sufficient  $\text{O}_2$  and is not breathing out sufficient  $\text{CO}_2$ . Respiratory acidosis may be caused by pneumonia, emphysema, chronic bronchitis, chronic obstructive pulmonary disease, pulmonary edema, interstitial fibrosis, foreign body obstructing the airway; or slowed, shallow breathing due to disorders of the muscles of respiration (myasthenia gravis, muscular dystrophy), nervous system control of the muscles of respiration (amyotrophic lateral sclerosis, polio, Guillain-Barre syndrome, botulism, tetanus, organophosphate poisoning, spinal cord injury); conditions that depress the respiratory center in the brain (such as narcotic drugs, sedatives, anesthesia, blood clot blocking the vertebral artery or increased intracranial pressure).
- Respiratory alkalosis is indicated by a high pH and a low  $\text{pCO}_2$ , and may indicate hyperventilation (fast, shallow breathing), brought on by emotional stress, pain, anxiety, problems with the lung that do not allow normal exchange of gases (such as pneumonia, pulmonary embolus, collapsed lung); drugs (salicylates, xanthines, progesterone, epinephrine, thyroxine, nicotine); conditions involving the central nervous system (tumors, strokes, trauma, infections); liver-disease induced encephalopathy; severe infection (gram negative sepsis); low blood sodium.
- Metabolic acidosis is indicated by a low pH and a low  $\text{HCO}_3^-$ , and may indicate diabetes; shock; loss of  $\text{HCO}_3^-$  through severe diarrhea or pancreatic fistula; kidney failure; use of drugs such as amiloride, triamterene, spironolactone, and beta-blockers; exposure to toxins (paraldehyde, methanol, salicylate, ethylene glycol).
- Metabolic alkalosis is indicated by a high pH and a high  $\text{HCO}_3^-$  and may occur with abnormal electrolyte levels, such as low potassium (hypokalemia) or low magnesium (hypomagnesemia); repeated bouts of vomiting or nasogastric suction (which causes a lot of stomach acid to be lost in the vomit); loss through the stool (as in cystic fibrosis, abuse of laxatives); multiple blood transfusions; Cushing's syndrome; or an overdose of sodium bicarbonate.

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#### ORGANIZATIONS

American Association for Clinical Chemistry, 1850 K Street, NW, Suite 625, Washington, DC, 20006, (800) 892 1400, <http://www.aacc.org>.

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Arteriography see **Angiography**

## Arteriovenous fistula

### Definition

An arteriovenous fistula (AV fistula) is an abnormal connection between a vein and an artery. The connection can be congenital (present at birth). Occasionally the connection can develop because of trauma such as a knife or bullet wound. Most often, the AV fistula is created surgically to allow access to the vascular system for hemodialysis. When created surgically, the connection of a vein and an artery is usually done in the forearm.

### Purpose

Hemodialysis is the process of mechanically cleansing the blood when the kidneys have failed. The surgical creation of an AV fistula provides a long-lasting site through which blood can be removed and returned during hemodialysis. The fistula, which allows the person to be connected to a dialysis machine, must be prepared by a surgeon weeks or months before dialysis is started. When the vein and artery are joined, blood flow increases and the vein gradually becomes larger and stronger, creating a site that provides vascular access years longer than other types of access and with fewer complications. AV fistulas are for people who will need dialysis for long periods—either until a kidney becomes available for transplantation or for the rest of their life. Short-term access to the vascular system for dialysis can be had by the insertion of a venous catheter.



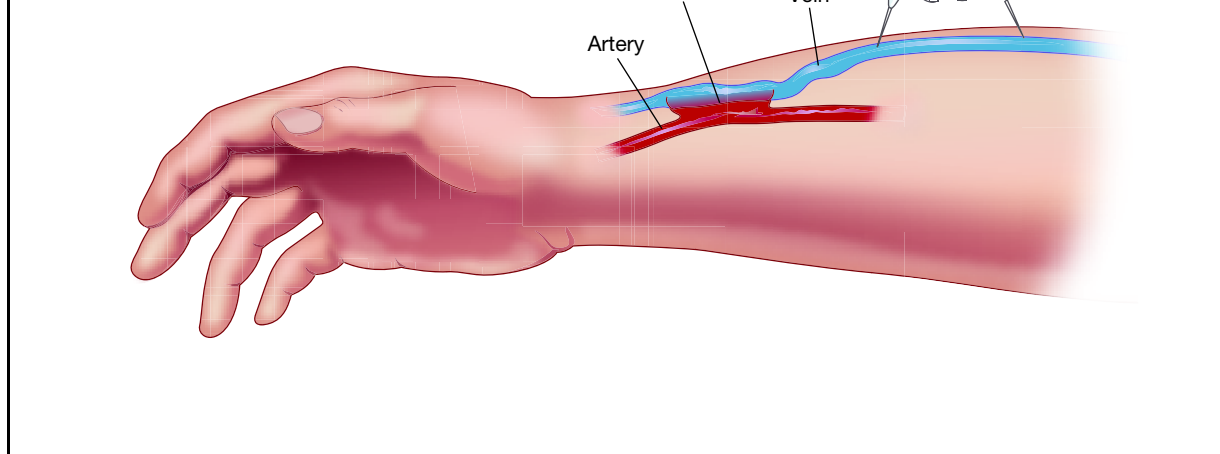
An arteriovenous fistula. (Medical-on-Line / Alamy)

### Demographics

According to the National Kidney Foundation, at the end of 2005, 336,000 Americans were receiving dialysis for kidney failure. Typically, another condition or disease caused the kidney shutdown. In the United States, kidney failure is disproportionately high among minority populations with the highest rate being found among African Americans, Hispanic Americans, and Native Americans. Among those receiving dialysis, over half will have an AV fistula as vascular access.

### Description

The kidneys are paired organs in the mid-abdomen, one on each side of the lower back. Their function is to clean the blood of wastes and to regulate fluid and electrolyte balance in the body. Dialysis performs these functions in place of the failing kidneys. Dialysis cannot restore kidney function, but it can prolong life, often for years, by preventing the build-up of waste products in the body.



(Illustration by Electronic Illustrators Group.)

Acute kidney failure usually happens in circumstances where an extra burden is placed on the renal system. For example, acute kidney failure can occur in advanced liver disease, rapidly progressing terminal illnesses such as cancer and certain severe anemias, after severe allergic reactions, as a reaction to drugs or poisons, in heart and lung diseases, during the formation of blood clots (embolism), and following heart bypass surgery. Diabetes and vascular diseases, especially those with hypertension, are the two most common underlying diseases contributing to chronic kidney failure.

Many advances in the treatment of kidney failure have been made since the first attempts at dialysis treatments in the 1920s. At one time, dialysis was thought of only as a way to keep people alive until kidney function could be restored. Often the treatment for kidney failure had to be discontinued within several days because patients' veins could not endure the trauma that occurred with frequent withdrawing and replacing of blood. The first breakthrough came in 1960 with the introduction of an implantable Teflon tube, called a shunt, that became the first effective vascular access device. Since then, the development of the AV fistula has marked another important advance, allowing effective treatment for longer periods.

### ***Hemodialysis***

Dialysis is performed as critical life support when a person experiences acute or chronic kidney failure. It is a mechanical way to cleanse the blood and balance body fluids when the kidneys are not able to perform their essential functions. Kidney failure can, in some cases, be reversible, and dialysis can provide temporary support until renal function is restored. Dialysis may also be used in irreversible or chronic kidney shutdown when transplantation is the medical goal and the patient is waiting for a donated kidney. Some critically ill patients with threatening illnesses such as cancer or severe heart disease are not candidates for transplantation and dialysis for them is the only option for treating permanent kidney failure, also called end-stage renal disease (ESRD).

There are two types of dialysis, hemodialysis and peritoneal dialysis. In hemodialysis, the blood circulates through a machine outside the body and is filtered as it circulates. In peritoneal dialysis, the blood is filtered through a membrane that has been placed in the abdomen. Blood remains in the body and waste material is filtered into an exchange fluid through an opening in the abdomen called a port. Only hemodialysis requires an AV fistula or other vascular access device.

## KEY TERMS

**Access**—The point where a needle or catheter is inserted for dialysis.

**Acute renal (kidney) failure**—Abrupt loss of kidney function, possibly temporary.

**Artery**—Blood vessel that carries blood away from the heart to the body.

**Chronic renal (kidney) failure**—Progressive loss of kidney function over several years that can result in permanent kidney failure requiring dialysis.

**Electrolyte**—Ions in the body that participate in metabolic reactions. The major human electrolytes are sodium ( $\text{Na}^+$ ), potassium ( $\text{K}^+$ ), calcium ( $\text{Ca}^{2+}$ ), magnesium ( $\text{Mg}^{2+}$ ), chloride ( $\text{Cl}^-$ ), phosphate ( $\text{HPO}_4^{2-}$ ), bicarbonate ( $\text{HCO}_3^-$ ), and sulfate ( $\text{SO}_4^{2-}$ ).

**Hypertension**—High blood pressure.

Hemodialysis circulates blood through a dialysis machine that contains a filter membrane. The blood is slowly pumped out of the body and into the machine for cleansing. After being filtered, the blood is returned to the body through the same vascular access. About one cup (235 mL) of blood is outside the body at any given moment during the continuous circulation process.

Hemodialysis is usually done three times a week, taking between three and five hours each time. Healthcare professionals perform the procedure either at independent dialysis centers or in hospitals or medical centers. Dialysis patients must go to the hemodialysis center where they will sit to receive the treatment. Although they cannot walk around, they can watch television, read, or talk to other patients. Dialysis centers offer patient education, including videos and brochures that describe treatment options and self-care. Patients can also receive advice and information about paying for this ongoing treatment through nationally sponsored programs that are available especially for those who need long-term dialysis. Often the dialysis center offers emotional support as well, letting people meet and talk with others who have kidney problems. Some people prefer to perform their own dialysis by having a home dialysis machine. This requires that the dialysis patient and another person, usually a family member, take a three- to six-week training program to learn how to do the treatment.

### *Vascular access*

An access or entry to the vascular system is needed to perform the blood-cleansing role of the kidneys

through hemodialysis. There are three types of vascular access: AV fistula, grafts, and catheters.

**ARTERIOVENOUS FISTULA.** An AV fistula has proven to be the best kind of vascular access for people whose veins are large enough, not only because it lasts longer, but also because it is less likely than other types of access to form clots or become infected. If the veins are not large enough or there is no time to wait for a fistula to develop, a graft or a catheter must be used.

**GRAFT.** Grafts are often the access of choice when a hemodialysis patient has small veins that will not likely develop properly into a fistula. This type of access uses a synthetic tube implanted under the skin of the arm that can be used repeatedly for needle placement. Unlike a fistula, which requires time to develop, a graft can be used as soon as two to three weeks after placement. Grafts are known to have more problems than fistulas, such as clots and infection, and will likely need replacement sooner.

**CATHETER.** A catheter is used to provide temporary vascular access. When kidney disease has progressed quickly, there may not be time to prepare a permanent vascular access site before dialysis treatments are started. The catheter is a tube that is inserted into a vein in the neck, chest, or in the leg near the groin. Two chambers in the tube allow blood to flow in and out. Once the catheter is in place, needle insertion is not necessary. Catheters are effective for dialysis for several weeks or months while surgery is performed and an AV fistula develops. They are not selected for permanent access because they can clog, become infected, or cause the veins to narrow. Long-term catheter access must be used in patients for whom AV fistula or graft surgery has not been successful. If more than three weeks' use is expected, catheters can be made to tunnel under the skin, which increases comfort and reduces complications.

## Diagnosis/Preparation

### *Diagnosis*

The diagnosis of kidney disease and its progression to kidney failure is typically made by a nephrologist, a specialist in kidney structure and function. The nephrologist will determine whether the patient has acute or chronic kidney failure and if dialysis is appropriate for the patient. If dialysis is recommended, the nephrologist will determine if an AV fistula is the ideal vascular access for the patient. To make these determinations, the nephrologist will need to evaluate the patient's general health, especially the presence of any underlying disease. Kidney function must be evaluated and determined to be seriously impaired before dialysis is recommended. It is typically started when kidney



function is down to about 10% of its normal level. Among other tests that will be performed, such as **urinalysis** with microscopic examination of the urine, several blood and urine tests can be used to measure a person's kidney function when chronic or acute kidney failure is suspected. Some of the tests measure electrolytes and other metabolites produced by the body that are normally excreted by the kidneys and passed through urine. The tests can measure effectively if the kidney is filtering out these materials, and how much remains in the blood. These tests include, but are not limited to:

- serum creatinine—found in higher levels in the blood if kidneys fail;
- urinary creatinine—readings are lower in kidney failure;
- urinary output—measuring both fluid intake and all urine produced;
- urinary osmolality—measures the concentration of the urine, an indicator of kidney filtering ability;
- blood urea nitrogen (BUN)—harmful nitrogen waste increases in the blood as kidney function decreases; and
- electrolytes in blood and urine—ions in the blood such as sodium, potassium, magnesium, and chloride are often out of balance when kidneys fail. Potassium, for example, increases in the blood during kidney failure and can cause heart irregularities.

## Description

Surgery to create an AV fistula is usually done using a local anesthetic that is injected into the forearm at the site of the proposed fistula. The procedure is performed in a hospital or at an **outpatient surgery** if the patient is not already hospitalized and has no serious underlying disease.

After cleaning and sterilizing the site, the surgeon makes a small incision in the forearm sufficient to allow the permanent uniting of a vein and an artery. The blood vessels will be appropriately blocked to stop blood flow while incisions are made to join them. Silk sutures, just as those used in other types of surgical incisions, are used to close incised areas as needed after the vein and artery have been joined. Once joined, blood flow increases. The vein will become thicker, and over a period of months the connection will become strong and develop into the fistula that will allow permanent vascular access.

## Aftercare

The hemodialysis patient should expect needle insertion in the AV fistula at every dialysis session. Patients who prefer to insert their own needles or who

perform dialysis at home will need training, and all patients have to learn how to avoid infection and to protect the vascular access. Because vascular access problems can lead to treatment failure, the AV fistula requires regular care to make dialysis easier and to help avoid clots, infection, and other complications.

Patients can help protect the access by:

- making sure the access is checked before each treatment;
- not allowing blood pressure to be taken on the access arm;
- checking the pulse in the access every day;
- keeping the access clean at all times;
- using the access site only for dialysis;
- taking care not to bump or cut the access;
- avoiding wearing tight jewelry or clothing near or over the access site;
- avoiding lifting heavy objects or putting pressure on the access arm; and
- sleeping with the access arm free, not under the head or body.

## Risks

The most frequent complications in hemodialysis relate to the vascular access site where needles are inserted. Complications include infection around the access area and formation of clots in the fistula. Usually, because they are in the fistula itself, these clots are not life threatening. The greatest danger is that clots may block the fistula and have to be removed surgically. Frequent clotting may require creating a back-up fistula at another site, to allow dialysis when one access is blocked.

Other complications from dialysis are not directly related to the vascular access. For example, when the kidneys have shut down, they produce very little urine. Because dialysis is the only way people with kidney failure can balance fluid levels in their bodies, hemodialysis can cause bloating and fluid overload, indicating that too much fluid remains in the body. If fluid overload occurs, patients develop swollen ankles, puffy eyes, weight gain, and shortness of breath. Fluid overload can cause heart and circulatory problems and fluctuations in blood pressure. Medications may be prescribed and changes in fluid intake or diet may be made to help balance fluids safely in conjunction with dialysis.

Other problems that can occur during or after hemodialysis include:

- low blood pressure when fluid and wastes are removed from the blood too quickly;
- nausea due to changes in blood pressure;



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The surgery to create an AV fistula for vascular access in hemodialysis is performed by a general surgeon or vascular surgeon in a hospital or outpatient surgery center.

- muscle cramps from the removal of too much fluid from the blood;
- headaches near the end of a dialysis session resulting from changes in the concentration of fluid and waste in the blood; or
- fatigue after treatment, lasting sometimes into the next day.

### Normal results

An AV fistula can usually be created and can function well with no adverse affects in a person whose veins are large enough. The amount of time it takes to develop the fistula after surgery (usually months) depends upon the size and strength of the patient's blood vessels and on the person's health and nutritional status. When the fistula develops, the thickened vein that has been joined to an artery can be seen in the arm and a pulse can be felt in it. The early development of an AV fistula as access for long-term dialysis has been shown to improve the survival of patients with chronic renal failure and to reduce the chances of being hospitalized with complications. It also gives patients a better opportunity to choose self-dialysis as their treatment.

With good nutrition and a fully functioning AV fistula, dialysis patients can be relatively comfortable and free of complications. People may become tired and uncomfortable when it is close to the time for their next dialysis session. This is to be expected because wastes are building up in the blood, and the body senses that it is time to remove them.

### Morbidity and mortality rates

Earlier use of dialysis, especially with AV fistula access, has been shown to increase survival in patients with renal failure. The AV fistula is designed to improve the effectiveness of dialysis and is reported to present fewer risks and complications, reduced incidence of clotting and infection, and longer use than other types of vascular access.

## QUESTIONS TO ASK THE DOCTOR

- Why are you recommending an AV fistula instead of another kind of access?
- How will an AV fistula make dialysis easier or better for me?
- How often do you perform this procedure?
- What will the fistula look like? Feel like?
- Should I treat my fistula arm in any special way?
- Are there activities I should avoid?
- How long will the AV fistula last?

Kidney failure is reported to account for 1% of hospital admissions in the United States. It occurs in 2–5% of patients hospitalized for other conditions, surgeries, or diseases. In patients undergoing cardiac bypass surgery, 15% are reported to require dialysis for kidney failure. Overall, deaths in people undergoing dialysis are reported to be about 50% because of the multi-organ dysfunction that has influenced kidney failure.

### Resources

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Offer, Daniel, Marjorie K. Offer, and Susan O. Szafir. *Dialysis without Fear: A Guide to Living Well on Dialysis for Patients and Their Families*. New York: Oxford University Press, 2007.

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#### ORGANIZATIONS

National Kidney and Urologic Diseases, 3 Information Way, Bethesda, MD, 20892 3580, (800) 891 5390, <http://kidney.niddk.nih.gov>.

National Kidney Foundation, 30 East 33rd Street, New York, NY, 10016, (800) 622 9010, <http://www.kidney.org>.

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## Arthrography

### Definition

Arthrography is a procedure involving multiple x rays of a joint using a fluoroscope, a special piece of x-ray equipment that shows an immediate x-ray image. A contrast medium (in this case, a contrast iodine solution) injected into the joint area helps highlight structures of the joint.

### Purpose

Frequently, arthrography is ordered to determine the cause of unexplained joint pain. This fluoroscopic procedure can show the internal workings of specific joints and outline soft tissue structures. The procedure may also be conducted to identify problems with the ligaments, cartilage, tendons, or the joint capsule of the hip, shoulder, knee, ankle, wrist, or other joints. An arthrography procedure may locate cysts in the joint area, evaluate problems with the joint's arrangement and function, indicate the need for joint replacement, or show problems with existing joint replacement (prostheses). The most commonly studied joints are the knee and shoulder.

### Description

Arthrography may be referred to as “joint radiography” or “x rays of the joint.” The term arthrogram may be used interchangeably with arthrography. The joint area will be cleaned and a local anesthetic will be injected into the tissues around the joint to reduce pain. Next, if fluids are present in the joint, the physician may suction them out (aspirate) with a needle. These fluids may be sent to a laboratory for further study. Contrast agents are then injected into the joint through the same location by attaching the aspirating needle to a syringe containing the contrast medium. The purpose of contrast agents in x-ray procedures is to help highlight details of areas under study by making them opaque. Agents for arthrography are generally air- and water-soluble dyes, the most common containing iodine. Air and iodine may be used together or independently. After the contrast agent is administered, the site of injection will be sealed, and the patient may be asked to bend and flex the joint to distribute the contrast.

Before the contrast medium can be absorbed by the joint itself, several films will be quickly taken under the guidance of the fluoroscope. The patient will be asked to move the joint into a series of positions, keeping still between positioning. Sometimes, the patient will experience some tingling or discomfort during the

## KEY TERMS

**Aspirate**—Remove fluids by suction, often through a needle.

**Contrast (agent, medium)**—A substance injected into the body that outlines certain structures that would otherwise be hard to see on the radiograph (film).

**Fluoroscope**—A device used in some radiology procedures that provides immediate images and motion on a screen much like those seen at airport baggage security stations.

**Radiologist**—A medical doctor specially trained in radiology (x ray) interpretation and its use in the diagnosis of diseases and injuries.

**X ray**—A form of electromagnetic radiation with shorter wavelengths than normal light. X rays can penetrate most structures.

procedure, which is normal and due to the contrast. Following fluoroscopic tracking of the contrast, standard x rays of the area may also be taken. The entire procedure will last about one hour.

Generally, a joint is evaluated first by MRI (**magnetic resonance imaging**) instead of an arthrogram, or by MRI combined with the arthrogram. Gadolinium, an MRI contrast agent, is injected if the arthrogram is performed as part of an MRI procedure. If the arthrogram is performed as part of a MRI arthrogram, the MRI scan will then be obtained immediately afterward.

### Preparation

It is important to discuss any known sensitivity to local anesthetics or iodine prior to this procedure. A physician should explain the procedure and the risks associated with contrast agents and ask the patient to sign an **informed consent**. If iodine contrast will be administered, the patient may be instructed not to eat or drink anything for a period of hours before the exam. The timeframe of fasting may range from only 90 minutes prior to the exam up to the night before. There is no other preparation necessary.

### Aftercare

The affected joint should be rested for approximately 12 hours following the procedure. The joint may be wrapped in an elastic bandage, and the patient should receive instructions on the care and changing of the bandage. Noises in the joint such as cracking or

clicking are normal for a few days following arthrography. These noises are the result of liquid in the joints. Swelling may also occur and can be treated with application of ice or cold packs. A mild pain reliever can be used to lessen pain in the first few days. However, if any of these symptoms persist for more than a few days, patients are advised to contact their physician.

### Risks

In some patients iodine can cause allergic reactions, ranging from mild nausea to severe cardiovascular or nervous system complications. Since the contrast dye is put into a joint, rather than into a vein, allergic reactions are rare. Facilities licensed to perform contrast exams should meet requirements for equipment, supplies, and staff training to handle a possible severe reaction. Infection or joint damage are possible, although not frequent, complications of arthrography.

### Normal results

A normal arthrography exam will show proper placement of the dye or contrast medium throughout the joint structures, joint space, cartilage, and ligaments.

The abnormal placement of dye may indicate rheumatoid arthritis, cysts, joint dislocation, tear of the rotator cuff, tears in the ligament, and other conditions. The entire lining of the joint becomes opaque from the technique, which allows the radiologist to see abnormalities in the intricate workings of the joint. In the case of recurrent shoulder dislocations, arthrography results can be used to evaluate damage. Patients with hip prostheses may receive arthrography to evaluate proper placement or function of their prostheses.

### Resources

#### BOOKS

Juhl, John H., and Andrew B. Crummy. *Paul and Juhl's Essentials of Radiologic Imaging*, 7th edition. Philadelphia: Lippincott Williams & Wilkins, 1998.

#### ORGANIZATIONS

American College of Radiology. 1891 Preston White Drive, Reston, VA 22091. (800) 227 5463. <http://www.acr.org>.  
Arthritis Foundation. 1300 W. Peachtree St., Atlanta, GA 30309. (800) 283 7800. <http://www.arthritis.org>.

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## Arthroplasty

### Definition

Arthroplasty is surgery performed to relieve pain and restore range of motion by realigning or reconstructing a dysfunctional joint.

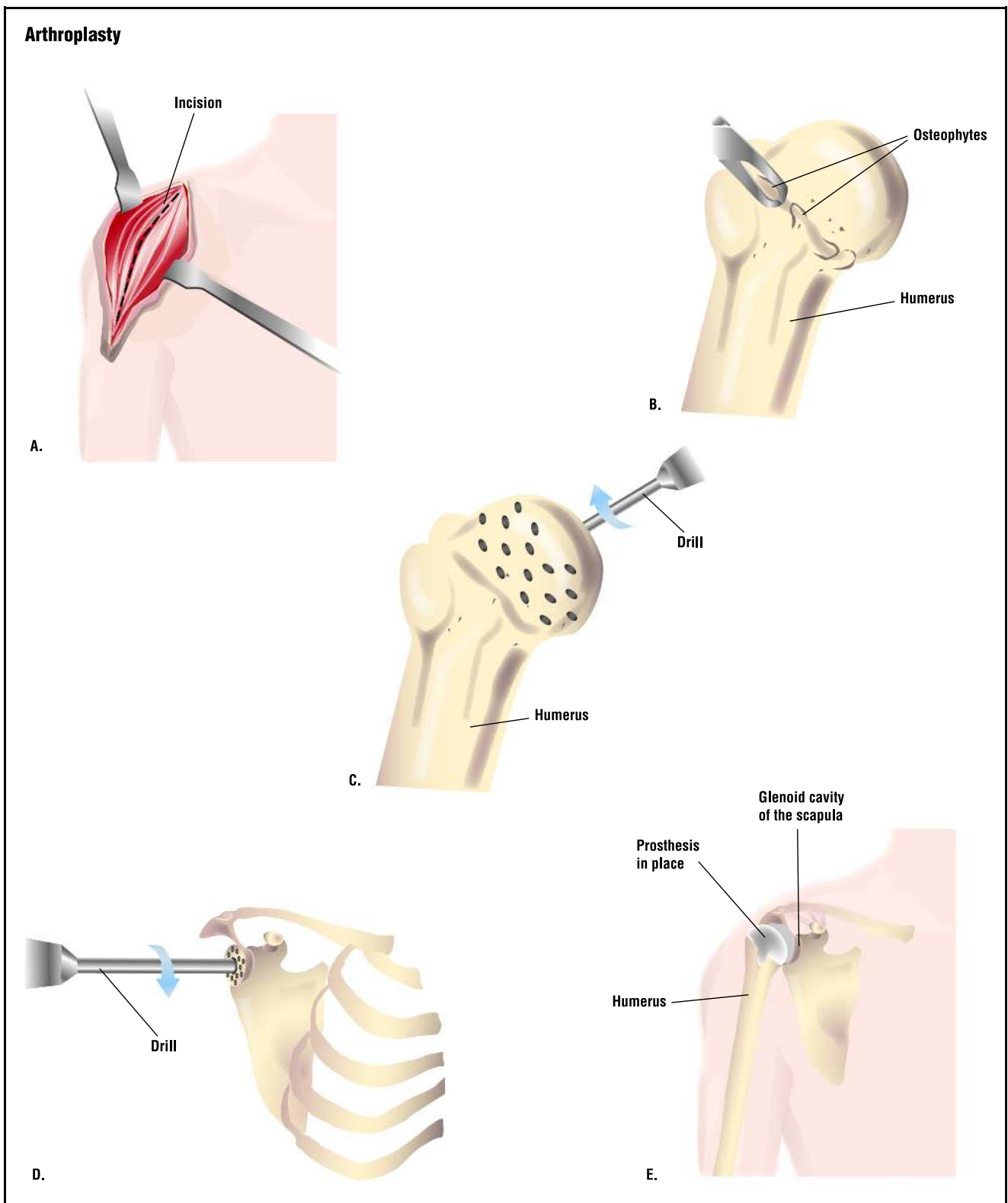
### Purpose

The goal of arthroplasty is to relieve pain and restore function in a stiffened joint. This surgery is usually performed when physical therapy or nonsurgical medical treatment have not improved function in the affected joint. There are two types of arthroplastic surgery: joint resection and interpositional reconstruction. Joint resection involves removing a portion of the bone from a stiffened joint. This increases the space between the bones forming the joint and improves the range of motion. Pain is relieved and motion is restored, but the joint is less stable. Scar tissue may eventually develop, filling the space and narrowing the gap between the bones.

Interpositional reconstruction is surgery to reshape the joint and add a prosthetic disk between the bones forming the joint. The prosthesis can be made of plastic, metal, ceramic material, or formed from body tissue such as skin, muscle, or fascia. When interpositional reconstruction fails, total joint replacement may be necessary. Joint replacement is also called total joint arthroplasty.

In recent years, total joint arthroplasty has become the operation of choice for most chronic knee and hip problems because of advances in the type and quality of prostheses (artificial joints). Elbow, shoulder, ankle, and finger joints are more likely to be treated with joint resection or interpositional reconstruction.

Arthroplasty is performed on people experiencing severe pain and disabling joint stiffness. Osteoarthritis (OA), a degenerative joint disease, is the most common condition causing joint destruction with pain and impaired movement. Other causes include rheumatoid arthritis (RA), hemophilia, synovitis, and rare bone diseases, all of which are known to destroy cartilage. Joint resection, rather than joint replacement, is more likely to be performed on people with rheumatoid arthritis, especially when the elbow joint is involved. Joint replacement is usually reserved for older patients, because of the limited life of the replacement joint. The younger the patient, the greater the reliance on non-surgical treatment.



In this shoulder arthroplasty procedure, an incision is made into the shoulder (A). The head of the humerus (upper arm bone) is removed from the shoulder joint, and bone growths, or osteophytes, are removed (B). Small holes are drilled into the head to accept the prosthesis (C). Similar holes are drilled in the glenoid cavity (shoulder joint) (D). The final prosthesis improves shoulder function (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Cartilage**—The slippery tissue that covers the ends of joint bones.

**Fascia**—Thin connective tissue covering or separating the muscles and internal organs of the body.

**Osteoarthritis**—A degenerative “wear-and-tear” joint disease related to aging.

**Prosthesis**—An artificial joint, part of a joint, or limb.

**Rheumatoid arthritis**—A chronic autoimmune disease characterized by inflammation of multiple joints and crippling pain and stiffness.

**Synovial fluid**—A fluid that lubricates the joint and helps prevent wear on the bones.

**Synovitis**—Inflammation of the synovium, the thin membrane in the joint.

**Thrombophlebitis**—A condition in which blood clots form in veins near surgery site, causing swelling and pain; clots may travel via veins to the heart or lungs causing serious complications.

## Demographics

The American Academy of Orthopaedic Surgeons reports that in 2004 in the United States about 478,000 were total **knee replacement** surgeries and 234,000 were **hip replacement** surgeries were performed. Additional sites for arthroplastic surgery include the ankle, shoulder, elbow, wrist, hand, and big toe. Surgery on smaller joints, such as the toe, have become more common in the 2000s as smaller artificial joints have improved in functionality and reliability.

Because the primary underlying condition in patients undergoing arthroplasty is osteoarthritis, a common cause for disability among older adults, the majority of patients who have arthroplastic surgery fit the demographic profile for osteoarthritis. Osteoarthritis is the most common disease of the elderly worldwide. In the United States in 2006, about 20 million people had diagnosed osteoarthritis. It is estimated that about half of all individuals over age 65 have osteoarthritis. Both men and women develop the disease; under age 45, men are more often affected, although more women than men are affected after age 45. Younger people can have the disease after a traumatic joint injury.

Arthroplasty is reserved for the most severely afflicted—approximately 3% of all patients with

osteoarthritis. In addition, approximately 1% of the population worldwide has rheumatoid arthritis, which can strike people of all ages. Few of these people have arthroplastic surgery because this chronic crippling disease affects not only multiple joints but other parts of the body as well, including the immune system. Patients weakened by rheumatoid arthritis (RA) are more subject to infection and less likely to enjoy positive surgical results.

## Description

Arthroplasty is performed under **general anesthesia** (affecting the entire body) or regional anesthesia (numbing a specific large area of the body) in a hospital by an orthopedic surgeon. Although many hospitals and medical centers perform common types of joint surgery, orthopedic hospitals that specialize in joint surgery tend to have higher success rates and fewer complications than less specialized centers.

In joint resection, the surgeon makes an incision at the joint, then carefully removes the minimum amount of bone necessary to allow free movement of the joint. The more bone that remains, the more stable the joint. Ligament attachments are preserved as much as possible. In interpositional reconstruction, both bones of the joint are reshaped, and a disk of material is placed between the bones to prevent their rubbing together. **Length of hospital stay** depends on the joint affected. In the absence of complications, a typical stay is brief. For total joint replacement, the entire joint is removed and replaced with an artificial joint. The hospital stay and rehabilitation period for total joint replacement tends to be longer than for joint resection or interpositional reconstruction.

## Diagnosis/Preparation

Significant disabling pain, deformity, and reduced quality of life are the primary indications for arthroscopic procedures. Patients at this stage of discomfort and disability will most likely have already been diagnosed with a form of arthritis. Pain and stiffness on weight-bearing joints are the major symptoms that patients report; some experience night pain as well. Other symptoms may include stiffness, swelling, and locking of the joint. The joint may even give way, particularly when the knees or hips are affected.

To determine the extent of disabling, the referring physician and/or the surgeon will ask about walking distance, sporting ability, the need for walking aids, and the ability to perform self-care tasks such as dressing and bathing. Besides evaluation of the joint itself and level of mobility, the clinical examination will



include evaluation of the patient's general health, the condition of the ligaments and muscles around the affected joint, and an assessment of the patient's mental outlook and social circumstances to help develop the most effective postoperative rehabilitation plan.

Diagnostic testing will typically include:

- X rays of the affected joint (and often other joints as well) to determine loss of joint space and to differentiate between OA and RA.
- Imaging studies, such as computed tomography (CT) scans, magnetic resonance (MRI), and bone densitometry to assess bone loss or bone infection.
- Cardiac tests, such as an electrocardiogram, to evaluate the heart and circulatory system.
- Blood tests to rule out infection and possibly to confirm arthritis.

Before arthroplastic surgery, standard preoperative blood and urine tests are performed to rule out such conditions as anemia and infection. If a patient has a history of bleeding, the surgeon will ask that clotting tests be performed. The patient will meet with the anesthesiologist to discuss any special conditions that may affect the administration of anesthesia. Surgery will not be performed if infection is present anywhere in the body or if the patient has certain heart or lung diseases. Smokers will be asked to stop smoking. Weight loss may also be recommended for overweight patients. If surgery involves deep tissue and muscle, such as total hip arthroplasty, the surgeon may order units of blood to be prepared in case **transfusion** is needed to replace blood lost during the surgery. Healthy patients may be asked to donate their own blood, which will be returned to them at the time of surgery (autologous transfusion). Certain pain medications may have to be discontinued in the weeks just prior to surgery.

### Aftercare

Immediately after surgery, while still in the hospital, patients will be given pain medications for the recovery period and **antibiotics** to prevent infection. When patients are discharged after joint surgery, they must be careful not to overstress or destabilize the joint. Normally, this requires rest at home for a period of days to weeks. Physical therapy will begin almost immediately to improve strength and range of motion. Physical therapy is the most important aid to recovery and may continue for several months. Activity may be resumed gradually, using devices such as walkers or crutches, as recommended by the physical therapist. Lifestyle changes may include the use of special seating or sleeping surfaces and employing **home care** assistance for help with shopping, cooking, and household tasks.

## WHO PERFORMS ARTHROSCOPY SURGERIES AND WHERE ARE THEY PERFORMED?

An orthopedic surgeon performs arthroplasty, including joint resection, interpositional reconstruction, and total joint arthroplasty (joint replacement). Orthopedic surgeons are board certified in their specialty and members of the American Academy of Orthopedic Surgeons (AAOS).

Orthopedic hospitals specialize in treating orthopedic conditions and performing orthopedic surgery. Although some orthopedic surgery may be performed in other hospitals and medical centers, better surgical results have been reported in the specialized centers.

### Risks

Joint resection and interpositional reconstruction do not always produce successful results, especially in patients with rheumatoid arthritis, a chronic inflammatory disease that may continue to narrow the joint space and accelerate the formation of scar tissue. Repeat surgery or total joint replacement may be necessary. As with any major surgery, there are always risks of an allergic reaction to anesthesia, postoperative infection, or the formation of blood clots (thrombophlebitis) that may cause pain and swelling near the surgery site and travel through the veins to other parts of the body. A joint that has undergone surgery is less stable than a healthy joint, and dislocation or loosening of the resected joint may occur, especially with inappropriate physical activity.

### Normal results

Most patients enjoy an improved range of motion in the joint and relief from pain. Younger people may be able to return to some form of low-impact sports activity. However, people who have degenerative or inflammatory diseases must understand that they will not suddenly have a normal joint, even while they will gain pain relief and improved function.

### Morbidity and mortality rates

The number of deaths for all arthroplasty surgeries is less than 1%, with **death** more likely to occur among elderly patients and those with other serious medical conditions.

## QUESTIONS TO ASK THE DOCTOR

- Is surgery my only option? What alternatives might work?
- How many surgeries like mine have you performed?
- What can I do after surgery to improve the result and avoid more surgery?
- Will joint replacement be inevitable in time even if I have resection or reconstruction?
- What changes can I make in my lifestyle to slow the progress of arthritis?

### Alternatives

**Pain management** alone, particularly with the availability of more effective pain medicines that have fewer side effects, is the primary nonsurgical option when the underlying diagnosis is a form of arthritis. **Nonsteroidal anti-inflammatory drugs** (NSAIDs) are commonly prescribed for patients with arthritis. Those with RA are given drugs that suppress immune system activity, shown to be a factor in this type of arthritis. A range of nutritional supplements and vitamins are reported to offer health benefits to people with OA. Among them, glucosamine and chondroitin sulfate have been shown to offer some relief for pain and stiffness. Weight loss is often recommended as well.

Because immobility of the affected joint can increase pain and stiffness, patients with joint disease are usually encouraged to continue some type of physical activity. Keeping the muscles strong through modest **exercise**, such as stretching or swimming, is often recommended to help support the joint and maintain mobility. Various devices, such as braces or orthopedic shoes, may be recommended, as well as walking aids. Safety rails, special elevated toilet-seat extensions, and bath and shower seats can make the patient more comfortable in daily life. Movement therapy, such as yoga, Pilates, tai chi, and dance, may help maintain joint flexibility and slow chronic arthritis symptoms. Occupational therapy, massage therapy, and physiotherapy may help improve range of motion and overall comfort, as well as patient confidence.

### Resources

#### BOOKS

Grelsamer, Ronald P. *What Your Doctor May Not Tell You about Hip and Knee Replacement Surgery: Everything*

*You Need to Know to Make The Right Decisions.* New York: Warner Books, 2004.

#### ORGANIZATIONS

American Academy of Orthopaedic Surgeons(AAOS). 6300 North River Rd. Rosemont, Illinois 60018. (847) 823 7186. Fax: (847) 823 8125. <http://www.aaos.org> (accessed March 6, 2008).

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Arthroplasty, shoulder see **Shoulder resection arthroplasty**

Arthroscopic knee surgery see **Knee arthroscopic surgery**

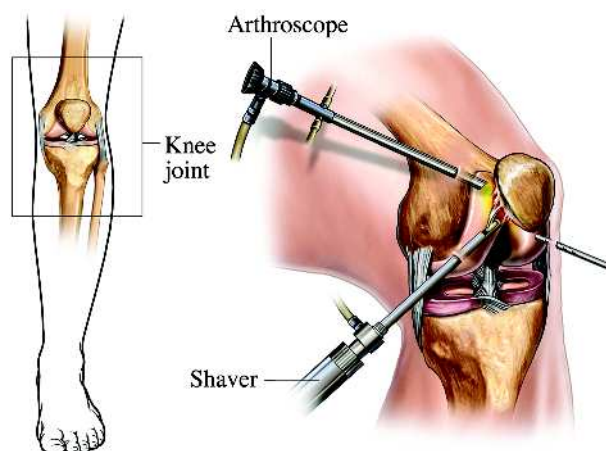
## Arthroscopic surgery

### Definition

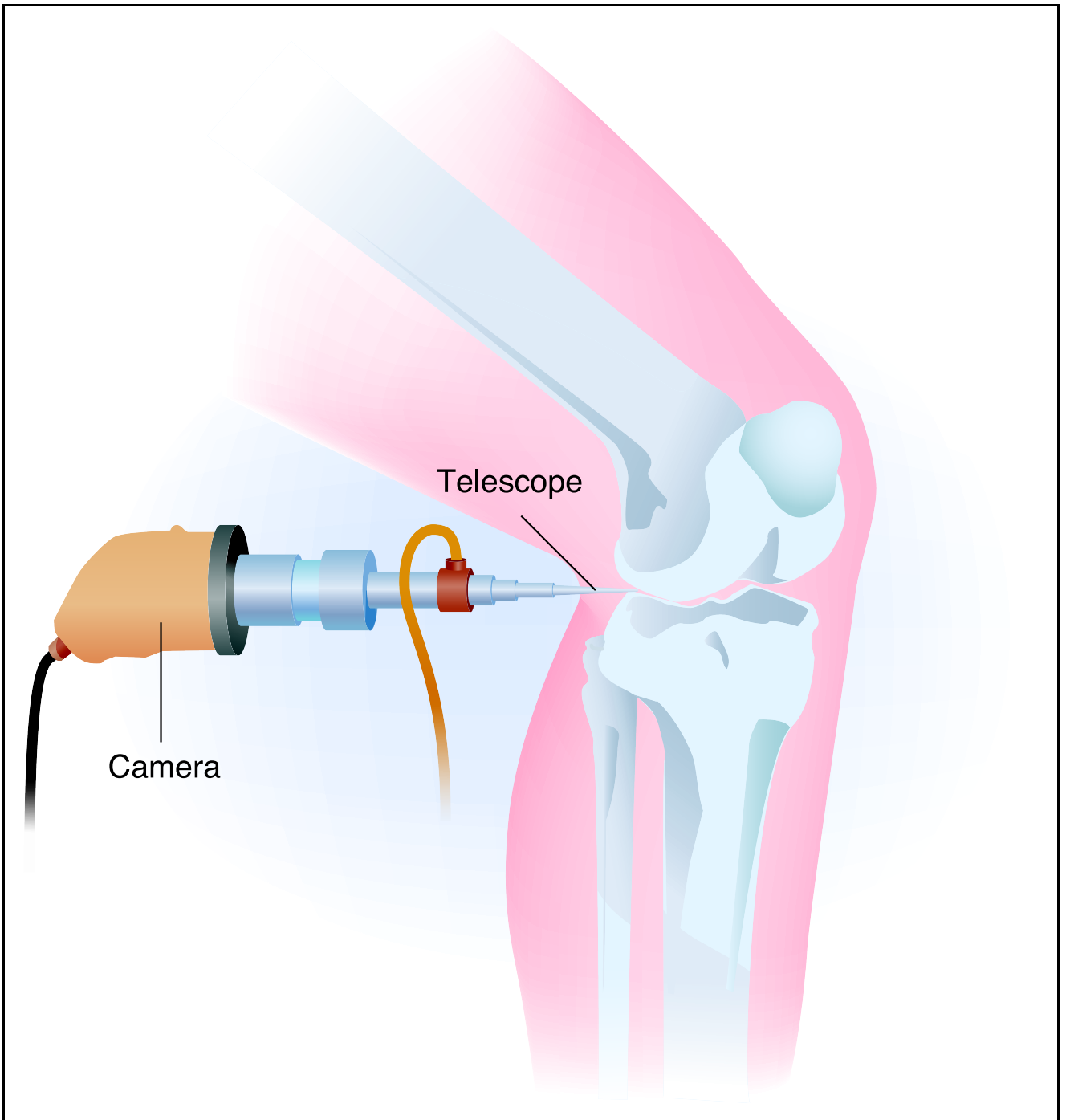
Arthroscopic surgery is a procedure that allows surgeons to visualize, diagnose, and treat joint problems. The name is derived from the Greek words *arthron*, joint, and *skopein*, to look at. Arthroscopy is performed using an arthroscope, a small fiber-optic instrument that enables a close look at the inside of a joint through a small incision.

### Purpose

Arthroscopic surgery is used to diagnose, treat, and monitor joint injuries and diseases that affect the joints. Diagnostic arthroscopic surgery is performed



Arthroscopic knee surgery. (PHOTOTAKE, Inc./Alamy)



**An arthroscope uses optical fibers to form an image of the damaged cartilage, which it sends to a television monitor that helps the surgeon perform surgery.** (Illustration by Argosy Inc. Cengage Learning, Gale.)

when the medical history, physical exam, x rays, and bone scanning examinations, such as MRI or CT, do not provide a definitive diagnosis. Corrective arthroscopic surgery is used primarily to remove bone or cartilage or repair tendons or ligaments.

### Precautions

Diagnostic arthroscopic surgery is not recommended unless nonsurgical treatment does not fix the problem.

## Description

Arthroscopic surgery is performed most commonly on the knees, and also on ankles, shoulders, wrists, elbows, and hips. Knee joints are large enough to allow free movement of arthroscopic instruments and therefore are ideal for the benefits of this type of examination and treatment. The technique is valued because it allows surgeons to see inside the joint through incisions as tiny as a quarter of an inch (about 1 cm) rather than the large incisions that open surgery procedures require. The accuracy of arthroscopy is said to be 100% for diagnosis compared to diagnostic imaging such as MRI. Arthroscopic surgery may be used to relieve mechanical joint problems, such as buckling, stiffness, or locking, and can preclude or delay the need for more aggressive surgery such as a joint replacement.

In arthroscopic surgery, an orthopedic surgeon uses a pencil-sized arthroscope—a fiber-optic instrument fitted with a lens, a light source, and a miniature video camera—to see inside a joint. Advanced fiber optics allow even more detail to be seen than in open surgery, often identifying problems that may have been difficult to diagnose with other methods. The arthroscope transmits highlighted images of the structures to a television monitor in the **operating room**. The surgeon is able to view the entire examination, getting a full view of the joint, its cartilage, and surrounding tissue. The type and extent of the injury can be determined and repair or correction can be performed if necessary. Some of the most common joint problems diagnosed and treated with arthroscopic surgery are:

- synovitis (inflamed joint lining) of the knee, shoulder, elbow, wrist, or ankle
- injuries to the shoulder, such as rotator cuff tendon tears, impingement syndrome, and dislocations
- injuries to the knee, such as meniscal (cartilage) tears, wearing down of or injury to the cartilage cushion, and anterior cruciate ligament tears with instability
- injuries to the wrist, such as carpal tunnel syndrome
- loose bodies of bone and/or cartilage in the knee, shoulder, elbow, ankle, or wrist
- joint damage caused by rheumatoid arthritis or osteoarthritis

Arthroscopic procedures are performed in a hospital or outpatient surgical facility by an orthopedic surgeon. The type of anesthesia used (local, spinal, or general) varies, as does the length of the procedure; both depend on the joint that will be operated on, the type and extent of the suspected joint injury, and/or

## KEY TERMS

**Arthroscope**—A pencil-sized fiber-optic instrument fitted with a lens, light source, and camera, used for detailed examination of joints.

**Cartilage**—The slippery tissue that covers the ends of joint bones.

**Meniscal**—Pertaining to cartilage.

**Open surgery**—Surgery using a large incision to lay open area for examination or treatment; in joint surgery, the whole joint is exposed.

**Osteoarthritis**—A degenerative “wear-and-tear” joint disease related to aging.

**Rheumatoid arthritis**—A chronic autoimmune disease characterized by inflammation of multiple joints and crippling effects.

**Synovitis**—Inflammation of the synovium, the thin membrane lining the joint.

the complexity of the anticipated repair. Arthroscopic surgery rarely takes more than an hour. Most patients who have arthroscopic surgery, whether diagnostic or corrective, are discharged the same day of the procedure; some patients, depending on the complexity of the surgery or their postoperative condition, may stay in the hospital one or two days.

Considered the most important orthopedic development in the twentieth century, arthroscopic surgery is widely used. The American Association of Orthopedic Surgeons reports that it is performed by 80% of all orthopedic surgeons. The use of arthroscopic surgery on famous athletes has been well publicized. Although arthroscopic surgery was initially only a diagnostic tool used prior to open surgery, the availability of better instruments and techniques has encouraged its use to actually treat a variety of joint problems, often avoiding more complicated surgeries with longer recovery times. New techniques under development are likely to lead to other joints being treated with arthroscopic surgery in the future. Laser technology has been introduced as a treatment option in arthroscopic surgery and other advanced technologies are being explored.

### *Surgical procedure*

After making two small incisions about the size of a buttonhole in the skin near the joint, the surgeon injects sterile sodium chloride solution through one incision into the joint to expand it for better viewing and movement of the instruments. The surgeon will

also use this access to irrigate (flood with fluid) the joint area during surgery and to suction blood and debris away from the joint. This irrigation, or “washing” part of the procedure, is believed to be of value in itself, improving joint function. The arthroscope is then inserted into the second incision. While looking at the interior of the joint on the television monitor, the surgeon can determine the extent or type of injury and, if necessary, take a biopsy specimen or repair or treat the problem. A third tiny incision may be made in order to see other parts of the joint or to insert additional instruments, such as laser or tiny scalpels, when repairs or corrections need to be made. Arthroscopic surgery can be used to remove floating bits of cartilage, to debride (clean by removing tissue or bone), and to treat minor tears and other disorders. When the procedure is finished, the arthroscope is removed and the joint is once again irrigated. The site of the incision is dressed with compression **bandages** (ace bandages).

### Diagnosis/Preparation

Prior to arthroscopy, the patient’s medical history will be reviewed and the patient will have a complete **physical examination**. Standard preoperative blood and urine tests will be done as well as scans of the affected joint, such as MRI (**magnetic resonance imaging**), CT (computed tomography), and arthrogram (an x ray using dye). In some cases, an **exercise** regimen or muscle stimulation treatment (TENS) may be recommended to strengthen muscles around the joint prior to surgery. Surgeons may recommend preoperative guidelines, such as:

- Discontinue aspirin and anti-inflammatory medications two weeks before surgery.
- Stop smoking to encourage postoperative healing.
- Inform the surgeon if any fever or other illness occurs, or if cuts, scratches, or bruises appear near the surgical site before the scheduled surgery.
- Do not eat, drink, or chew gum for 12 hours prior to surgery.
- Bring crutches or a walker if hip, knee, or ankle arthroscopy is being performed.
- Wear loose fitting clothing to allow for bulky dressings over the surgical site.

### Aftercare

Immediately after the procedure, the patient will spend up to two hours in a recovery area before being discharged. Some patients may be transferred to a hospital room if the surgeon determines overnight care is necessary. The surgical site will be dressed with a compression bandage (ace bandage) or a tightly

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Arthroscopic surgery is performed in a hospital operating room or an outpatient surgical facility by an orthopedic surgeon.

fitting stocking (support hose). An ice pack will be placed on the joint that was examined or treated by arthroscopy. This treatment may continue for up to 72 hours after surgery to keep swelling down and help prevent the formation of clots. Pain medication will be administered if needed, although most patients require little or no medicine for pain. **Dressings** can usually be removed the morning after surgery and replaced by adhesive strips. The surgeon should be notified if the patient experiences any increase in pain, swelling, redness, drainage or bleeding at the site of the surgery, signs of infection (headache, muscle aches, dizziness, fever), and nausea or vomiting.

It takes several days for the puncture wounds to heal, and several weeks for the joint to fully recover. Many patients can resume their daily activities, including going back to work, within a few days of the procedure. Muscle strength must be regained as soon as possible after surgery to help support the affected joint. A rehabilitation program, including physical therapy, may be suggested to speed recovery and improve the functioning of the joint. The surgeon’s recommendations for recovery may include:

- Keep the surgical site and the dressings clean and dry.
- Use ice packs for up to 72 hours to reduce pain and swelling.
- Elevate the affected joint (wrist, elbow, ankle, knee) on pillows; exercise gently to encourage circulation.
- Use a knee brace or shoulder sling temporarily.
- Allow weight-bearing exercise as able.

### Risks

Few complications are to be expected with arthroscopy. Those that may occur occasionally (fewer than 1% of all arthroscopies, according to the American Academy of Orthopedic Surgeons) are infection, blood clot formation, swelling or bleeding, or damage to blood vessels or nerves. Rare instrument breakage during procedures has also been reported.



## QUESTIONS TO ASK THE DOCTOR

- Why is arthroscopy necessary for me?
- What kind of anesthesia will I have?
- How often do you perform this procedure? What results are typical?
- How much discomfort can I expect short term? Long term?
- Will physical therapy be necessary after the surgery?
- Will this procedure correct my joint problem?

### Normal results

Most patients undergo arthroscopic surgery as an outpatient and are home within hours or at most a day or two. Pain and complications are rare, and most patients will enjoy improved mobility as they recover over a period of days, possibly with the aid of physical therapy and gentle exercise.

Some people undergoing arthroscopy may have preexisting conditions and diseases that will affect the surgical result. Recovery times will vary depending on each patient's overall condition. Certain problems may need to be treated with a combination of arthroscopic and open surgical procedures.

### Alternatives

Alternatives to arthroscopic surgery include:

- changing activities to those less strenuous or demanding
- anti-inflammatory medications
- physical therapy and appropriate, gentle exercise such as yoga
- wearing a brace or using a walking aid
- glucosamine sulfate and chondroitin to reduce pain and stiffness
- therapeutic massage, acupuncture, or other body work

### Resources

#### BOOKS

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- DeLee, J. C., and D. Drez. *DeLee and Drez's Orthopaedic Sports Medicine*. 2nd ed. Philadelphia: Saunders, 2005.

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- Committee on Ethics and Standards of the Arthroscopy Association of North America. "Suggested guidelines for the practice of arthroscopic surgery." *Arthroscopy* (June 2005): A3668.

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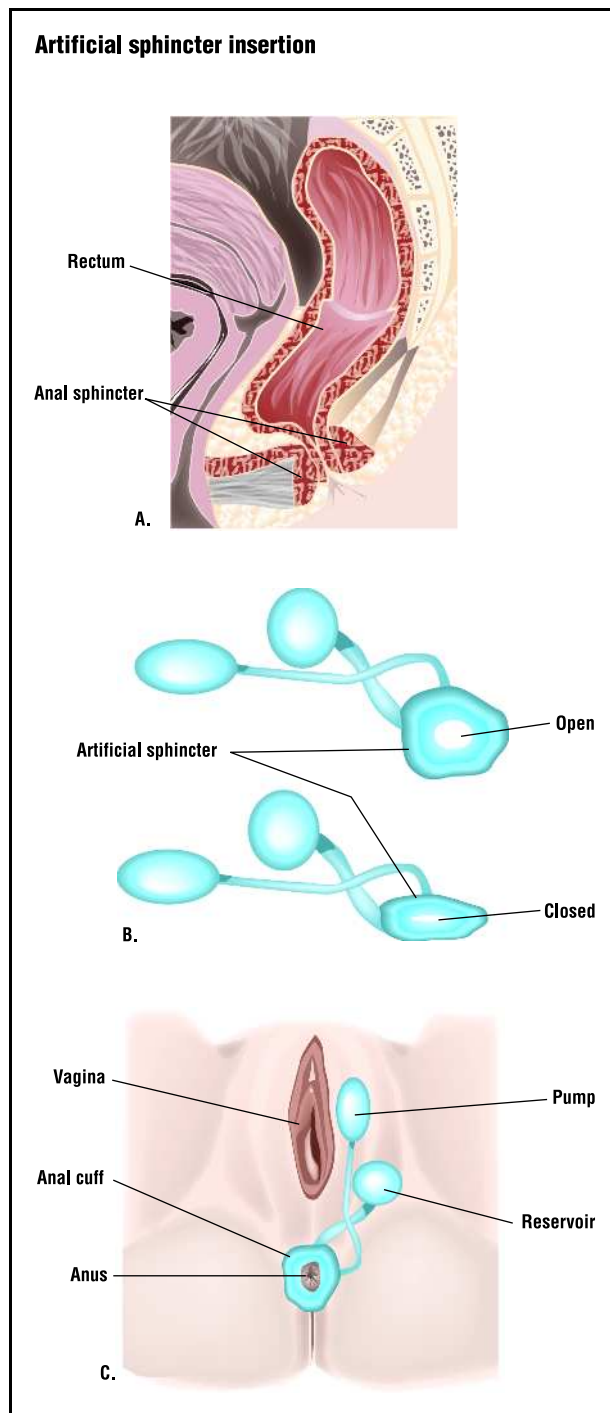
## Artificial sphincter insertion

### Definition

Artificial sphincter insertion surgery is the implantation of an artificial valve in the genitourinary tract or in the anal canal to restore continence and psychological well being to individuals with urinary or anal sphincter insufficiency that leads to severe urinary or fecal incontinence.

### Purpose

This procedure is useful for adults and children who have severe incontinence due to lack of muscle contraction by either the urethral sphincter or the bowel sphincter. The primary work of the lower urinary tract and the colon is the storage of urine and waste, respectively, until such time as the expulsion of urine or feces is appropriate. These holding and expelling functions in each system require a delicate balance of tension and relaxation of muscles, especially those related to conscious control of the act of urination or defecation through the valve-like sphincter in each system. Both types of incontinence have mechanical causes related to reservoir adequacy and sphincter, or "gatekeeper" control, as well as mixed etiologies in the chemistry, neurology, and psychology of human makeup. The simplest bases of incontinence lie in the mechanical components of reservoir mobility



Normally, the anal sphincter muscles maintain fecal continence (A). In cases of incontinence, an artificial sphincter may be inserted, which can open and close to mimic the function of the natural sphincter (B). Once implanted, the patient uses a pump under the skin to inflate and deflate the anal cuff (C).

(Illustration by GGS Information Services. Cengage Learning, Gale.)

and sphincter muscle tone. These two factors receive the most surgical attention for both urinary and fecal incontinence.

### *Urinary sphincter surgery*

There are four sources of urinary incontinence related primarily to issues of tone in pelvic, urethral, and sphincter muscles. Most urinary incontinence is caused by leakage when stress is applied to the abdominal muscles by coughing, sneezing, or exercising. Stress incontinence results from reduced sphincter adequacy in the ability to keep the bladder closed during movement. Stress incontinence can also be related to the mobility of the urethra and whether this reservoir for urine tilts, causing spilling of urine. The urethral cause of stress incontinence is treated with other surgical procedures. A second form of incontinence is urge incontinence. It relates to sphincter overactivity, or sphincter hyperflexia, in which the sphincter contracts uncontrollably, causing the patient to urinate, often many times a day. Finally, there is urinary incontinence due to an inadequately small urethra that causes urine overflow. This is known as overflow incontinence and can often be treated with augmentation to the urethra to increase its size.

Only severe stress incontinence related to sphincter adequacy can benefit from the artificial urinary sphincter. This includes conditions that result in the removal of the sphincter. Sphincter deficiency can result directly from pelvic fracture; urethral reconstruction; prostate surgeries; spinal cord injury; neurogenic bladder conditions that include sphincter dysfunction; and some congenital conditions. Each can warrant consideration for a sphincter implant.

Implantation surgery related to urinary sphincter incompetence is also called artificial sphincter insertion or inflatable sphincter insertion. The artificial urinary sphincter (AUS) is a small device placed under the skin that keeps pressure on the urethra until there is a decision to urinate, at which point a pump allows the urethra to open and urination commences. Since the 1990s, advances in prostate cancer diagnosis and surgery have resulted in radical prostatectomies being performed, with urinary incontinence rates ranging from 3–60%. The AUS has become a reliable treatment for this main source of urinary incontinence in men. Women with intrinsic sphincter deficiency, or weakened muscles of the sphincter, also benefit from the AUS. However, the use of AUS with women has declined with advances in the use of the sub-urethral sling due to its useful “hammock” effect on the sphincter and its high rates of continence success. Women with neurologic incontinence can benefit from the AUS.

## KEY TERMS

**Artificial sphincter**—An implanted device that functions to control the opening and closing of the urethral or anal canal for the expelling of urine or feces, respectively.

**Fascia**—Connective tissue separating the muscles and internal organs.

**Fecal incontinence**—The inability to control bowel movement.

**Sphincter deficiency**—A term related both to urinary and fecal incontinence in which the inability of the sphincter to keep the reservoir closed is a source of severe incontinence.

**Urinary incontinence**—The inability to control urination.

### *Artificial anal sphincter surgery*

Fecal incontinence is the inability to control bowel function. The condition can be the result of a difficult childbirth, colorectal disease such as Crohn's disease, accidents involving neurological injuries, surgical resection for localized cancer, or by other neurological disorders. Severe fecal incontinence may, depending upon the underlying disease, require surgical intervention that can include repair of the anal sphincter, **colostomy**, or replacement of the anal sphincter. Artificial anal sphincter is a very easy-to-use device implanted under the skin that mimics the function of the anal sphincter.

## Demographics

### *Artificial urinary sphincter surgery*

According to the Agency for Health Care Policy and Research, urinary incontinence affects approximately 13 million adults. Men have incontinence rates that are much lower than women, with a range of 1.5–5%, compared to women over 65 with rates of almost 50%. In older men, prostate problems and their treatments are the most common sources of incontinence. Incontinence is a complication in nearly all male patients for the first three to six months after radical prostatectomy. A year after the procedure, most men regain continence. Stress incontinence occurs in 1–5% of men after the standard treatment for severe benign prostatic hyperplasia.

### *Artificial anal sphincter surgery*

According to the National Institute of Diabetes & Digestive & Kidney Diseases (NIDDK), more than

6.5 million Americans have fecal incontinence. Fecal incontinence affects people of all ages. It is estimated that over 2% of the population is affected by fecal incontinence. Many cases are never reported. Community-based studies reveal that 30% of patients are over the age of 65, and 63% are female. According to one study published in the *American Journal of Gastroenterology*, only 34% of incontinent patients have ever mentioned their problem to a physician, even though 23% wear absorbent pads, 12% are on medications, and 11% lead lives restricted by their incontinence. Women are more than five times as likely as men to have fecal incontinence, primarily due to obstetric injury, especially with forceps delivery and anal sphincter laceration. Fecal incontinence is frequent in men who have total and subtotal prostatectomies. Fecal incontinence is not a part of aging, even though it affects people over 65 in higher numbers than other populations.

## Description

### *Artificial urinary sphincter surgery*

The artificial urinary sphincter is an implantable device that has three components:

- an inflatable cuff
- a fluid reservoir (balloon)
- a semiautomatic pump that connects the cuff and balloon

Open surgery is the major form of surgery for the implant. Infections are minimized by sterilization of the urine preoperatively and preoperative bowel preparation. The pelvic space is entered from the abdomen or from the vagina, with **general anesthesia** for the patient. Broad-spectrum **antibiotics** are given intravenously and at the site of small incisions for the device. A urinary catheter is put into place. The cuff is implanted around the bladder neck and secured and passed through the rectus muscle and anterior fascia to be connected later to the pump. A space is fashioned to hold the balloon in the pubic region, and a pump is placed in a pouch below the abdomen. The artificial urinary sphincter is activated only after six to eight weeks to allow healing from the surgery. The patient is trained in the use of the device by understanding that the cuff remains inflated in its “resting state,” and keeps the urethra closed by pressure, allowing continence. Upon the decision to urinate, the patient temporarily deflates the cuff by pressing the pump. The urethra opens and the bladder empties. The cuff closes automatically.

### *Artificial anal sphincter surgery*

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In open abdominal surgery, the implant device is placed beneath the skin through small incisions within the pelvic space. One incision is placed between the anus and the vagina or scrotum, and the inflatable cuff is put around the neck of the anal sphincter. A second incision at the lower end of the abdomen is used to make a space behind the pubic bone for placement of the balloon. The pump is placed in a small pocket beneath the labia or scrotum, using two incisions. The artificial anal sphincter is activated only after six to eight weeks to allow healing from the surgery. The patient is trained in the use of the device by understanding that the anal cuff remains inflated in its “resting state,” and keeps the anal canal closed by pressure, allowing continence. Upon the decision to have a bowel movement, the patient temporarily deflates the cuff by pressing the pump and fecal matter is released. The balloon re-inflates after the movement.

## Diagnosis/Preparation

### *Artificial urinary sphincter surgery*

Patients must be chosen carefully, exhibit isolated sphincter deficiency, and be motivated and able to work with the device and its exigencies. To characterize the condition to be treated and to determine outcomes, full clinical, urodynamic, and radiographic evaluations are necessary. The ability to distinguish mobility of the urethra as the cause of incontinence from sphincter insufficiency is difficult, but very important in the decision for surgery. A combination of pelvic examination for urethral hypermobility and a leak-point pressure as measured by coughing or other abdominal straining has been shown to be very effective in identifying the patient who needs the surgical implant. Visual examination of the bladder with a cystoscope is very important in the preoperative evaluation for placement of the sphincter. Urethral and bladder conditions found by the examination should be addressed before implantation. Previous reconstruction or repair of the urethra may prevent implantation of the cuff. In open abdominal surgery, the implant surgery uses preventive infection measures that are very important, including sterilization of the urine preoperatively with antibiotics, the cleansing of the intestines from fecal matter and

secretions through **laxatives** immediately prior to surgery, and antibiotic treatment and vigorous irrigation of the wound sites.

### *Artificial anal sphincter surgery*

Since only a limited number of patients with fecal incontinence would benefit from an artificial sphincter, it is very important that a thorough examination be performed to distinguish the causes of the incontinence. A medical history and physical, as well as documented entries or an incontinence diary are crucial to the diagnosis of fecal incontinence. The physical exam usually includes a visual inspection of the anus and the area lying between the anus and genitals for hemorrhoids, infections, and other conditions. The strength of the sphincter is tested by the doctor probing with a finger to test muscle strength.

Medical tests usually include:

- Anorectal manometry. This is a long tube with a balloon on the end that is inserted in the anus and rectum to measure the tightness of the anal sphincter and the ability to respond to nerve firings.
- Anorectal ultrasonography. This test also includes an insertion of a small instrument into the anus with a video screen that produces sound waves, picturing the rectum and anus.
- X rays. A substance called barium is used to make the rectum walls visible to x ray. This liquid is swallowed by the patient before the test.
- Anal electromyography. This test uses the insertion of tiny needle electrodes into muscles around the anus and tests for nerve damage.

## Aftercare

### *Artificial urinary sphincter surgery*

Surgery requires a few days of hospitalization. Oral and intravenous pain medications are administered, along with postoperative antibiotics. A general diet is available, usually on the evening of surgery. When the patient is able to walk, the urethral catheter is removed. Patients are discharged on the second day postoperatively, unless they have had other procedures and need extra recovery time. Patients may not lift heavy objects or engage in strenuous activity for approximately six weeks. After six to eight weeks, the patient returns to the physician for training in the use of the implant device.

### *Artificial anal sphincter surgery*

Surgery hospitalization requires a few days with dietary restrictions and anti-diarrheal medicine to



bind the bowels. Antibiotics are administered to lower the risk of infection, and skin incisions are cleaned frequently. Patients may not lift heavy objects or engage in strenuous activity for approximately six weeks. After the body has had time to heal over six to eight weeks, the patient returns to the physician for training in the use of the pump. Two or three sessions are required and after the training, the patient is encouraged to lead as normal a life as possible.

## Normal results

### *Artificial urinary sphincter surgery*

One problem with the urinary sphincter implant is failure. If the device fails, or the cuff erodes, the surgery must be repeated. In a study published in 2001, 37% of women had the implant after an average of seven years, but 70% had the original or a replacement and 82% were continent. Studies on men report similar findings. Malfunction has improved with advances in using a narrower cuff. In one large study encompassing one surgeon over 11 years, the re-operative rate of AUS related to malfunction in men was 21%. Over 90% of patients were alive with a properly functioning device.

Another problem with the surgery is urinary voiding. This may be difficult initially due to post-operative edema caused by bruising of the tissue. In the majority of cases, urination occurs after swelling has receded.

AUS is a good alternative for children. The results of AUS in children range from 62–90%, with similar rates for both girls and boys.

### *Artificial anal sphincter surgery*

Anal sphincter implant surgery has been successfully performed for many years. The device most often used has a cumulative failure rate of 5% over 2.5 years. The long-term functional outcome of artificial anal sphincter implantation for severe fecal incontinence has not been determined. However, adequate sphincter function is recovered in most cases, and the removal rate of the device is low. Most of the good results are dependent upon careful patient selection and appropriate surgical and operative management with a highly experienced **surgical team**.

## Morbidity and mortality rates

### *Artificial urinary sphincter surgery*

Infection has been a frequent and serious complication of surgery, not only because of the infection per

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Implantation surgery is performed in a hospital operating room by urologic surgeons specially trained for implantation of the artificial sphincter in the urinary or anal tracts. Successful surgery depends upon very experienced surgeons.

se, but also because infection can cause erosion of the urethra or bladder neck under the implant. The infection may actually worsen the incontinence. The overall infection rate with AUS implants is 1–3%. Because of interactions between the host and the foreign body represented by the implant, infections can occur soon after the surgery, or months and even years later. New techniques using antibiotics and skin preparations have improved infection rates considerably.

### *Artificial anal sphincter surgery*

This surgery is for a limited number of patients who have isolated sphincter deficiency. Patients must be chosen who have little co-morbidity (serious illnesses) and can be trained in the use of the pump. Although it is a fairly simple operation, some researchers report a 30% infection rate.

## Alternatives

### *Artificial urinary sphincter surgery*

Milder forms of urinary incompetence can be treated with changes in diet, evaluation of medications, and the use of antidepressants and estrogen replacement, as well as bladder training and pelvic muscle strengthening. However, sphincter deficiency, unlike incontinence caused by urethral mobility, requires a substitute for the sphincter contraction by implant or by auxiliary tissue. If AUS cannot treat sphincter deficiency, the sling or “hammock” procedure is a good second choice. It brings tightness to the sphincter by using tissue under the urethra to increase contractual function. The **sling procedure** is already preferred over the AUS for women.

### *Artificial anal sphincter surgery*

Milder forms of fecal incontinence are being treated by changes in diet and the use of certain bowel-binding medications. For some forms of mild



## QUESTIONS TO ASK THE DOCTOR

- How many implantation surgeries have you performed?
- What is your rate of device removal in the patients you have treated?
- How likely is infection after surgery?
- How likely is infection to occur long term?

fecal incontinence, special forms of **exercise** can help to strengthen and tone the pelvic floor muscles, along with providing **biofeedback** to train the muscles to work with an appropriate schedule. Only after these measures have been tried, including the use of pads, is the patient counseled on the benefits of an anal sphincter implant.

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Ascending contrast phlebography see

**Phlebography**

Ascites shunt see **Peritoneovenous shunt**

## Aseptic technique

### Definition

Aseptic technique is a set of specific practices and procedures performed by health-care personnel under carefully controlled conditions with the goal of minimizing contamination by pathogens.

### Purpose

Aseptic technique is employed to maximize and maintain asepsis, the absence of pathogenic organisms, in the clinical setting. The goals of aseptic technique are to protect the patient from infection and to prevent the spread of pathogens. Often, practices that clean (remove dirt and other impurities), sanitize (reduce the number of microorganisms to safe levels), or disinfect (remove most microorganisms but not highly resistant ones) are not sufficient to prevent infection.

The Centers for Disease Control and Prevention (CDC) estimates that over 27 million surgical procedures are performed in the United States each year. Surgical site infections are the third most common nosocomial (hospital-acquired) infection and are responsible for longer hospital stays and increased costs to the patient and hospital. Aseptic technique is vital in reducing the morbidity and mortality associated with surgical infections.

### Description

Aseptic technique can be applied in any clinical setting. Pathogens may introduce infection to the patient through contact with the environment, personnel, or equipment. All patients are potentially vulnerable to infection, although certain situations further increase vulnerability, such as extensive burns or immune disorders that disturb the body's natural

## KEY TERMS

**Clean**—To remove dirt and other impurities.

**Contamination**—A breach in the preservation of a clean or sterile object or environment.

**Disinfect**—To remove most microorganisms but not highly resistant ones.

**Host**—A living organism that harbors or potentially harbors infection.

**Immunocompromised**—Lacking or deficient in defenses provided by the immune system, usually due to disease state or a side effect of treatment.

**Invasive**—Involving entry into the body.

**Nosocomial**—Occurring in the hospital or clinical setting.

**Pathogen**—A disease-causing organism.

**Resistant organisms**—Organisms that are difficult to eradicate with antibiotics.

**Sanitize**—To reduce the number of microorganisms to safe levels.

**Sterile**—Completely free of pathogens.

defenses. Typical situations that call for aseptic measures include surgery and the insertion of intravenous lines, urinary catheters, and drains.

### *Asepsis in the operating room*

Aseptic technique is most strictly applied in the **operating room** because of the direct and often extensive disruption of skin and underlying tissue. Aseptic technique helps to prevent or minimize postoperative infection.

**PREOPERATIVE PRACTICES AND PROCEDURES.** The most common source of pathogens that cause surgical site infections is the patient. While microorganisms normally colonize parts in or on the human body without causing disease, infection may result when this endogenous flora is introduced to tissues exposed during surgical procedures. In order to reduce this risk, the patient is prepared or prepped by shaving hair from the surgical site; cleansing with a disinfectant containing such chemicals as iodine, alcohol, or chlorhexidine gluconate; and applying sterile drapes around the surgical site.

In all clinical settings, handwashing is an important step in asepsis. The “2002 Standards, Recommended Practices, and Guidelines” of the Association of Perioperative Registered Nurses (AORN) states that

proper handwashing can be “the single most important measure to reduce the spread of microorganisms.” In general settings, hands are to be washed when visibly soiled, before and after contact with the patient, after contact with other potential sources of microorganisms, before invasive procedures, and after removal of gloves. Proper handwashing for most clinical settings involves removal of jewelry, avoidance of clothing contact with the sink, and a minimum of 10–15 seconds of hand scrubbing with soap, warm water, and vigorous friction.

A surgical scrub is performed by members of the **surgical team** who will come into contact with the sterile field or sterile instruments and equipment. This procedure requires use of a long-acting, powerful, antimicrobial soap on the hands and forearms for a longer period of time than used for typical handwashing. Institutional policy usually designates an acceptable minimum length of time required; the CDC recommends at least two to five minutes of scrubbing. Thorough drying is essential, as moist surfaces invite the presence of pathogens. Contact with the faucet or other potential contaminants should be avoided. The faucet can be turned off with a dry paper towel, or, in many cases, through use of a foot pedal. An important principle of aseptic technique is that fluid (a potential mode of pathogen transmission) flows in the direction of gravity. With this in mind, hands are held below elbows during the surgical scrub and above elbows following the surgical scrub. Despite this careful scrub, bare hands are always considered potential sources of infection.

Sterile surgical clothing or protective devices such as gloves, face masks, goggles, and transparent eye/face shields serve as barriers against microorganisms and are donned to maintain asepsis in the operating room. This practice includes covering facial hair, tucking hair out of sight, and removing jewelry or other dangling objects that may harbor unwanted organisms. This garb must be put on with deliberate care to avoid touching external, sterile surfaces with nonsterile objects including the skin. This ensures that potentially contaminated items such as hands and clothing remain behind protective barriers, thus prohibiting inadvertent entry of microorganisms into sterile areas. Personnel assist the surgeon to don gloves and garb and arrange equipment to minimize the risk of contamination.

Donning sterile gloves requires specific technique so that the outer glove is not touched by the hand. A large cuff exposing the inner glove is created so that the glove may be grasped during donning. It is essential to avoid touching nonsterile items once sterile

gloves are applied; the hands may be kept interlaced to avoid inadvertent contamination. Any break in the glove or touching the glove to a nonsterile surface requires immediate removal and application of new gloves.

Asepsis in the operating room or for other invasive procedures is also maintained by creating sterile surgical fields with drapes. Sterile drapes are sterilized linens placed on the patient or around the field to delineate sterile areas. Drapes or wrapped kits of equipment are opened in such a way that the contents do not touch nonsterile items or surfaces. Aspects of this method include opening the furthest areas of a package first, avoiding leaning over the contents, and preventing opened flaps from falling back onto contents.

Equipment and supplies also need careful attention. Medical equipment such as **surgical instruments** can be sterilized by chemical treatment, radiation, gas, or heat. Personnel can take steps to ensure sterility by assessing that sterile packages are dry and intact and checking sterility indicators such as dates or colored tape that changes color when sterile.

**INTRAOPERATIVE PRACTICES AND PROCEDURES.** In the operating room, staff have assignments so that those who have undergone surgical scrub and donning of sterile garb are positioned closer to the patient. Only scrubbed personnel are allowed into the sterile field. Arms of scrubbed staff are to remain within the field at all times, and reaching below the level of the patient or turning away from the sterile field are considered breaches in asepsis.

Other “unscrubbed” staff members are assigned to the perimeter and remain on hand to obtain supplies, acquire assistance, and facilitate communication with outside personnel. Unscrubbed personnel may relay equipment to scrubbed personnel only in a way that preserves the sterile field. For example, an unscrubbed nurse may open a package of forceps in a sterile fashion so that he or she never touches the sterilized inside portion, the scrubbed staff, or the sterile field. The uncontaminated item may either be picked up by a scrubbed staff member or carefully placed on to the sterile field.

The environment contains potential hazards that may spread pathogens through movement, touch, or proximity. Interventions such as restricting traffic in the operating room, maintaining positive-pressure airflow (to prevent air from contaminated areas from entering the operating room), or using low-particle generating garb help to minimize environmental hazards.

Other principles that are applied to maintain asepsis in the operating room include:

- All items in a sterile field must be sterile.
- Sterile packages or fields are opened or created as close as possible to time of actual use.
- Moist areas are not considered sterile.
- Contaminated items must be removed immediately from the sterile field.
- Only areas that can be seen by the clinician are considered sterile (i.e., the back of the clinician is not sterile).
- Gowns are considered sterile only in the front, from chest to waist and from the hands to slightly above the elbow.
- Tables are considered sterile only at or above the level of the table.
- Nonsterile items should not cross above a sterile field.
- There should be no talking, laughing, coughing, or sneezing across a sterile field.
- Personnel with colds should avoid working while ill or apply a double mask.
- Edges of sterile areas or fields (generally the outer inch) are not considered sterile.
- When in doubt about sterility, discard the potentially contaminated item and begin again.
- A safe space or margin of safety is maintained between sterile and nonsterile objects and areas.
- When pouring fluids, only the lip and inner cap of the pouring container is considered sterile; the pouring container should not touch the receiving container, and splashing should be avoided.
- Tears in barriers and expired sterilization dates are considered breaks in sterility.

### *Other clinical settings*

A key difference between the operating room and other clinical environments is that the operating area has high standards of asepsis at all times, while most other settings are not designed to meet such standards. While clinical areas outside of the operating room generally do not allow for the same strict level of asepsis, avoiding potential infection remains the goal in every clinical setting. Observation of medical aseptic practices will help to avoid nosocomial infections. The application of aseptic technique in such settings is termed medical asepsis or clean technique (rather than surgical asepsis or sterile technique required in the operating room).

Specific situations outside of the operating room require a strict application of aseptic technique. Some of these situations include:

- wound care
- drain removal and drain care
- intravascular procedures
- vaginal exams during labor
- insertion of urinary catheters
- respiratory suction

For example, a surgical dressing change at the bedside, though in a much less controlled environment than the operating room, will still involve thorough handwashing, use of gloves and other protective garb, creation of a sterile field, opening and introducing packages and fluids in such a way as to avoid contamination, and constant avoidance of contact with non-sterile items.

General habits that help to preserve a clean medical environment include:

- safe removal of hazardous waste, i.e., prompt disposal of contaminated needles or blood-soaked bandages to containers reserved for such purposes
- prompt removal of wet or soiled dressings
- prevention of accumulation of bodily fluid drainage, i.e., regular checks and emptying of receptacles such as surgical drains or nasogastric suction containers
- avoidance of backward drainage flow toward patient, i.e., keeping drainage tubing below patient level at all times
- immediate clean-up of soiled or moist areas
- labeling of all fluid containers with date, time, and timely disposal per institutional policy
- maintaining seals on all fluids when not in use

The isolation unit is another clinical setting that requires a high level of attention to aseptic technique. Isolation is the use of physical separation and strict aseptic technique for a patient who either has a contagious disease or is immunocompromised. For the patient with a contagious disease, the goal of isolation is to prevent the spread of infection to others. In the case of respiratory infections (i.e., tuberculosis), the isolation room is especially designed with a negative pressure system that prevents airborne flow of pathogens outside the room. The severely immunocompromised patient is placed in reverse isolation, where the goal is to avoid introducing any microorganisms to the patient. In these cases, attention to aseptic technique is especially important to avoid spread of infection in the hospital or injury to the patient unprotected by sufficient immune defenses. Entry and exit from the isolation unit involves careful handwashing, use of protective barriers like gowns and gloves, and care not to introduce or remove potentially contaminated items. Institutions supply specific guidelines that

direct practices for different types of isolation, i.e., respiratory versus body fluid isolation precautions.

In a multidisciplinary setting, all personnel must constantly monitor their own movements and practices, those of others, and the status of the overall field to prevent inadvertent breaks in sterile or clean technique. It is expected that personnel will alert other staff when the field or objects are potentially contaminated. Health care workers can also promote asepsis by evaluating, creating, and periodically updating policies and procedures that relate to this principle.

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## Aspartate aminotransferase test

### Definition

The aspartate aminotransferase test measures levels of AST, an enzyme released into the blood when certain organs or tissues, particularly the liver and heart, are injured. Aspartate aminotransferase (AST) is also known as serum glutamic oxaloacetic transaminase (SGOT).

### Purpose

The determination of AST levels aids primarily in the diagnosis of liver disease. In the past, the AST test was used to diagnose heart attack (myocardial infarction or MI) but more accurate blood tests have largely replaced it for cardiac purposes.

### Demographics

The number of AST tests administered each year can only be estimated. Since statins are the most prescribed drugs in the United States and standards of care call for quarterly **liver function tests**, the number of ASTs can easily exceed 500 million per year.

### Description

AST is determined by analysis of a blood sample, usually taken from a venipuncture site at the bend of the elbow.

AST is found in the heart, liver, skeletal muscle, kidney, pancreas, spleen, lung, red blood cells, and brain tissue. When disease or injury affects these tissues, the cells are destroyed and AST is released into the bloodstream. The amount of AST is directly related to the number of cells affected by the disease or injury, but the level of elevation depends on the length of time that the blood is tested after the injury. Serum AST levels become elevated eight hours after cell injury, peak at 24–36 hours, and return to normal in three to seven days. If the cellular injury is chronic (ongoing), AST levels will remain elevated.

One of the most important uses for AST determination has formerly been in the diagnosis of a heart attack, or MI. AST can assist in determining the timing and extent of a recent MI, although it is less specific than **creatinine phosphokinase (CPK)**, CK-MB, myoglobin, troponin, and lactic dehydrogenase (LDH). Assuming no further cardiac injury occurs, the AST level rises within 6–10 hours after an acute attack, peaks at 12–48 hours, and returns to normal in three to four days.

## KEY TERMS

**Cirrhosis**—Disease of the liver caused by chronic damage to its cells.

**Myocardial infarction**—Commonly known as a heart attack. Sudden death of part of the heart muscle characterized, in most cases, by severe, unremitting chest pain.

Myocardial injuries such as angina (chest pain) or pericarditis (inflammation of the pericardium, the membrane around the heart) do not increase AST levels.

AST is also a valuable aid in the diagnosis of liver disease. Although not specific for liver disease, it can be used in combination with other enzymes to monitor the course of various liver disorders. Chronic, silent hepatitis (hepatitis C) is sometimes the cause of elevated AST. In alcoholic hepatitis, caused by excessive alcohol ingestion, AST values are moderately elevated; in acute viral hepatitis, AST levels can rise to over 20 times normal. Acute extrahepatic (outside the liver) obstruction, such as gallstones, produces AST levels that can quickly rise to 10 times normal, and then rapidly fall. In cases of cirrhosis, the AST level is related to the amount of active inflammation of the liver. Determination of AST also assists in early recognition of toxic hepatitis that results from exposure to drugs toxic to the liver, like **acetaminophen** and cholesterol-lowering medications.

Other disorders or diseases in which the AST determination can be valuable include acute pancreatitis, muscle disease, trauma, severe burn, and infectious mononucleosis.

### Preparation

The physician may require discontinuation of any drugs that might affect the test. These types include such drugs as antihypertensives (for treatment of high blood pressure), coumarin-type anticoagulants (blood-thinning drugs), digitalis, erythromycin (an antibiotic), oral contraceptives, and opiates, among others. The patient may also need to cut back on strenuous activities temporarily, because **exercise** can also elevate AST for a day or two.

### Aftercare

This test involves blood being drawn, usually from a vein in the elbow. The person being tested should keep the wound from the needle puncture covered



(with a bandage) until the bleeding stops. Individuals should report any unusual symptoms to their physician.

### Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, fainting or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

### Normal results

Normal ranges for the AST are laboratory-specific, but can range from 3–45 units/L (units per liter).

### Abnormal results

Striking elevations of AST (400–4000 units/L) are found in almost all forms of acute hepatic necrosis, such as viral hepatitis and carbon tetrachloride poisoning. In alcoholics, even moderate doses of the analgesic acetaminophen have caused extreme elevations (1,960–29,700 units/L). Moderate rises of AST are seen in jaundice, cirrhosis, and metastatic carcinoma. Approximately 80% of patients with infectious mononucleosis show elevations in the range of 100–600 units/L.

### Morbidity and mortality rates

Morbidity rates are excessively miniscule. The most common problems are minor bleeding and bruising. Since neither are reportable events, morbidity can only be estimated. Mortality is essentially zero.

### Alternatives Resources

There are no alternatives to an aspartate aminotransferase test.

### Precautions

The only precaution needed is to clean the venipuncture site with alcohol.

### Side effects

The most common side effects of an AST test are minor bleeding and bruising.

### Interactions

There are no known interactions with an AST test.

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- American Society for Clinical Laboratory Science, 6701 Democracy Blvd., Suite 300, Bethesda, MD, 20817, (301) 657 2768, <http://www.ascls.org/>.
- American Society for Clinical Pathology, 1225 New York Ave., NW, Suite 250, Washington, DC, 20005, (202) 347 4450, <http://www.ascp.org/>.

College of American Pathologists, 325 Waukegan Rd.,  
Northfield, IL, 60093 2750, (800) 323 4040, <http://www.cap.org/apps/cap.portal>.

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## Aspirin

### Definition

Aspirin is a medication given to relieve pain and reduce fever. The name “aspirin” was originally a trademark, first used when the drug was introduced in Europe in 1899. Aspirin was developed by a German chemist named Felix Hoffman as a treatment for his father’s arthritis.

### Purpose

Aspirin is still used to relieve many kinds of minor aches and pains—headaches, toothaches, muscle pain, menstrual cramps, joint pains associated with arthritis, and the general achiness that many people experience with colds and flu. Some people take aspirin daily to reduce the risk of stroke, heart attack, or other heart problems.

### Description

Aspirin, also known as acetylsalicylic acid, is not a prescription drug. It is sold over the counter in many forms, from the familiar white tablets to chewing gum and rectal suppositories. Coated, chewable, buffered, and extended-release forms are available. Many other over-the-counter (OTC) medications contain aspirin. Alka-Seltzer Original Effervescent Antacid Pain Reliever (R), for example, contains aspirin for pain relief as well as sodium bicarbonate to relieve acid indigestion, heartburn, and sour stomach.

Aspirin belongs to a group of drugs called salicylates. Other members of this group include sodium salicylate, choline salicylate, and magnesium salicylate. These drugs are more expensive and no more effective than aspirin; however, they are preferred by some patients who find that aspirin upsets their stomach. Aspirin is quickly absorbed into the bloodstream and provides rapid and relatively long-lasting pain relief. Aspirin in high doses also reduces inflammation. Researchers believe these effects are due to aspirin’s ability to block the production of pain-producing chemicals called prostaglandins.

In addition to relieving pain and reducing inflammation, aspirin also lowers fever by acting on the

## KEY TERMS

**Diuretic**—A type of medication that increases the amount of urine produced and relieves excess fluid buildup in body tissues. Diuretics may be used in treating high blood pressure, lung disease, premenstrual syndrome, and other conditions.

**Inflammation**—A response to injury or illness characterized by pain, redness, swelling, and warmth.

**Nonsteroidal anti-inflammatory drugs (NSAIDs)**—Drugs that relieve pain and reduce inflammation but are not related chemically to cortisone. Common drugs in this class are aspirin, ibuprofen (Advil, Motrin), naproxen (Aleve, Naprosyn), ketoprofen (Orudis), and several others.

**Polyp**—Any mass of tissue that grows out of a mucous membrane in the digestive tract, uterus, or elsewhere in the body.

**Prostaglandin**—A hormonelike chemical produced in the body that has a variety of effects. Prostaglandins may be responsible for the production of some types of pain and inflammation.

**Reye’s syndrome**—A life-threatening disease that affects the liver and the brain and sometimes occurs after a viral infection, such as flu or chickenpox. Children or teenagers who are given aspirin for flu or chickenpox are at increased risk of developing Reye’s syndrome.

**Rhinitis**—Inflammation of the membranes inside the nose.

**Salicylates**—A group of drugs that includes aspirin and related compounds. Salicylates are used to relieve pain, reduce inflammation, and lower fever.

**Stroke**—An event that impairs the circulation of the brain. Ischemic stroke is caused by a blood clot in the brain. Hemorrhagic stroke is caused by bleeding into the brain.

hypothalamus, which is the part of the brain that regulates temperature. The brain then signals the blood vessels to dilate (widen), which allows heat to leave the body more quickly.

### Recommended dosage

#### Adults

**PAIN RELIEF OR FEVER REDUCTION.** The usual dosage is one to two tablets every three to four hours, up to six times per day.

**RISK REDUCTION FOR STROKE.** One tablet four times a day or two tablets twice a day.

**RISK REDUCTION FOR HEART ATTACK.** Aspirin may be used as a first-line treatment for a heart attack. The patient should chew a single uncoated aspirin tablet, since chewing makes it easier for the body to absorb the medication rapidly. Aspirin will not stop a heart attack, and proper emergency care is essential; however, an aspirin tablet may reduce the amount of damage done by the heart attack.

Patients should check with a physician for the proper dose and number of times per week they should take aspirin to reduce the risk of a heart attack. The most common dose for this purpose is a single baby aspirin tablet taken daily. Enteric-coated aspirin is often used, since it reduces the risk of stomach irritation.

### Children

Parents should consult the child's physician about the proper dosage for their child's condition.

### Precautions

Aspirin—even children's aspirin—should never be given to children or teenagers with flu-like symptoms or chickenpox. Aspirin can cause Reye's syndrome, a life-threatening condition that affects the nervous system and liver. As many as 30% of children and teenagers who develop Reye's syndrome die. Those who survive may have permanent brain damage.

Parents should consult a physician before giving aspirin to a child under 12 years of age for arthritis, rheumatism, or any condition that requires long-term use of the drug.

No one should take aspirin for more than 10 days in a row unless instructed to do so by a physician. Anyone with fever should not take aspirin for more than three days without a physician's advice. In addition, no one should take more than the recommended daily dosage.

People in the following categories should not use aspirin without first checking with their physician:

- Pregnant women. Aspirin can cause bleeding problems in both the mother and the developing fetus. Aspirin can also cause the infant's weight to be too low at birth.
- Women who are breastfeeding. Aspirin can pass into breast milk and affect the baby.
- People with a history of bleeding problems.

- People who are taking such blood-thinning drugs as warfarin (Coumadin).
- People who have had recent surgery. Aspirin increases the risk of bleeding from an incompletely healed incision.
- People with a history of stomach ulcers.
- People with a history of asthma, nasal polyps, or both. Patients with these disorders are more likely to be allergic to aspirin.
- People who are allergic to fenoprofen, ibuprofen, indomethacin, ketoprofen, meclofenamate sodium, naproxen, sulindac, tolmetin, or an orange food coloring known as tartrazine. They may also be allergic to aspirin.
- People with AIDS or AIDS-related complex who are taking AZT (zidovudine). Aspirin can increase the risk of bleeding in these patients.
- People taking any of the drugs listed below under Interactions.
- People with liver damage or severe kidney failure.

Aspirin should not be taken before a surgical procedure, as it can increase the risk of excessive bleeding during surgery. People scheduled for an operation should check with their surgeon to find out when they should discontinue taking aspirin.

Aspirin can cause stomach irritation. Taking aspirin with food or milk, or drinking an eight-ounce glass of water with it may help to prevent damage to the stomach lining. Some patients find that using coated or buffered aspirin reduces the risk of stomach upset. Patients should be aware, however, that drinking alcoholic beverages can make the stomach irritation worse.

Patients with any of the following symptoms should stop taking aspirin immediately and call their physician:

- a sensation of ringing or buzzing in the ears
- hearing loss
- dizziness
- stomach pain that does not go away

Patients should discard any aspirin that has developed a vinegary smell. That is a sign that the medication is too old and ineffective.

### Side effects

The most common side effects of aspirin include upset stomach, heartburn, loss of appetite, and small amounts of blood in the stool. Less common side effects are rashes, hives, fever, vision problems, liver damage,

thirst, stomach ulcers, and bleeding. People with asthma, rhinitis, polyps in the nose, or allergies to aspirin may have trouble breathing after taking the drug.

### Interactions

Aspirin may increase, decrease, or change the effects of many drugs. Aspirin can increase the toxicity of such drugs as methotrexate (Rheumatrex) and valproic acid (Depakote, Depakene). Taken with such blood-thinning drugs as warfarin (Coumadin) and dicumarol, aspirin can increase the risk of excessive bleeding. Aspirin counteracts the effects of certain other drugs, including angiotensin-converting enzyme (ACE) inhibitors and beta blockers, which lower blood pressure, and medicines used to treat gout (probenecid and sulfinpyrazone). Blood pressure may drop unexpectedly and cause fainting or dizziness if aspirin is taken along with nitroglycerin tablets. Aspirin may also interact with **diuretics**, diabetes medications, other **nonsteroidal anti-inflammatory drugs** (NSAIDs), seizure medications, and steroids. Anyone who is taking these drugs should ask his or her physician whether they can safely take aspirin.

### Resources

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Atrial fibrillation surgery see **Maze procedure for atrial fibrillation**

Atrial septal defect surgery see **Heart surgery for congenital defects**

Autograft see **Skin grafting**

## Autologous blood donation

### Definition

Autologous **blood donation** is the process of donating one's own blood prior to an elective surgical or medical procedure to avoid or reduce the need for an allogeneic blood **transfusion** (from a volunteer blood donor).

### Purpose

Blood transfusions are given to restore lost blood, to improve clotting time, and to improve the ability of the blood to deliver oxygen to the body's tissues. There are some disadvantages to traditional allogeneic blood transfusions. Although strict regulations are in place to ensure correct matching by blood type, errors in this process can lead to the transfusion of mismatched blood, which can cause a serious and sometimes fatal adverse reaction called transfusion reaction. In addition, while donated blood is rigorously tested for infectious agents such as human immunodeficiency virus (HIV) and hepatitis, there is always a chance that an infectious disease may be transmitted via allogeneic transfusion.

The donation and transfusion of autologous blood has arisen as an alternative to allogeneic blood transfusion. Autologous donation is indicated for an elective surgical or medical procedure in which the likelihood of a blood transfusion is high. Such procedures include surgery on the heart, blood vessels, bones, and chest.

Some of the advantages of autologous blood donation include:



## KEY TERMS

**Allogeneic blood transfusion**—Blood that has originated from volunteer blood donor (i.e., not the patient).

**Directed donation**—Blood donated by a patient's family member or friend, to be used by the patient.

**Vasovagal reaction**—A collection of symptoms that includes dizziness, fainting, profuse sweating, hyperventilation, and/or low blood pressure that occurs in a small percentage of individuals who donate blood.

- The patient is assured that the blood is an exact match to his or her blood type, thereby avoiding transfusion reaction.
- There is no risk of inadvertently transmitting infectious agents.
- Autologous blood donations supplement the community blood supply.
- The process of donating blood promotes blood cell production by bone marrow.
- The patient is often reassured by the knowledge that his or her own blood will be used if a blood transfusion becomes necessary.

Some disadvantages to autologous blood donation do exist, which include:

- Contamination of autologous blood with infectious agents is possible during the donation process.
- There is a possibility that a patient's blood will be mislabeled or that allogeneic blood will be inadvertently transfused.
- Autologous blood donation costs more to process and store.
- Blood may be transfused unnecessarily because an autologous blood supply exists.
- Unused units of autologous blood are usually disposed of; approximately 44% of autologous donations remain unused after surgery.

## Demographics

Autologous blood donations account for approximately 5% of all blood donated in the United States each year.

## Description

The most common form of autologous donation is called preoperative autologous blood donation (PABD). PABD is generally indicated when there is a

reasonable chance that a blood transfusion will become necessary, when the patient is in adequate health to donate blood, and when there is sufficient preoperative time for the patient to donate. As the shelf life of liquid blood is approximately 42 days, the patient may begin donating up to six weeks before the scheduled procedure. It is generally recommended that a patient donate no more than once or twice a week, and no later than 72 hours before surgery.

The PABD process is similar to the process of donating allogeneic blood. A tourniquet is placed on the upper arm to increase the pressure in the arm veins and make them swell and become more accessible. Once a suitable vein is identified, the area where the needle will be inserted is sterilized by washing with soap solution or an iodine-containing antiseptic. The donor lies on a bed or cot during the procedure, which takes about 10 minutes. Blood is collected in sterile plastic bags that hold one pint (450 ml). The bags contain an anticoagulant to prevent clotting and preservatives to keep the blood cells alive.

The collected blood may then be transfused during and/or after surgery in a similar manner to allogeneic blood. If the amount transfused is less than anticipated or if no blood was necessary, then the autologous blood is generally disposed of (since the restrictions placed on volunteer donors are stricter than those on autologous donors). If the patient's surgery is postponed, the donated blood may be frozen and stored until the procedure is rescheduled.

Acute normo-volemic hemodilution (ANH) is a variant of autologous donation in which a volume of the patient's blood is removed directly before surgery and replaced with fluids so that any blood lost during surgery has a lower red blood cell count (i.e., the red blood cells have been diluted). The removed blood is then reinfused after surgery. Advantages to ANH are that no processing and storage costs are necessary and the risk of contamination during processing is reduced.

Blood may also be collected during surgery (intraoperative **blood salvage**, or IBS) or after surgery (postoperative blood salvage, PBS). IBS is commonly used during cardiac, bone, transplant, and trauma surgery and involves the use of specialized equipment to collect and process the blood before reinfusion. PBS involves the collection of blood from drainage tubes, although generally this volume is small.

## Diagnosis/Preparation

Patients must meet certain selection criteria before donating their own blood for future use. In the case of



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Blood may be donated at a hospital or a blood donor center. The procedure of blood donation is generally performed by a nurse or phlebotomist (a person trained to draw blood).

PABD, there must be sufficient time before the procedure to safely collect enough blood. A patient must be medically stable, have no active infection, and have a close-to-normal red blood cell count to qualify for PABD.

### Aftercare

Individuals who donate blood are generally given fluids and/or light refreshments to prevent possible side effects such as dizziness and nausea. Iron supplements may be prescribed to prevent or treat anemia (low red blood cell count).

### Risks

Complications associated with autologous blood donation are similar to those associated with allogeneic blood donation. These include dizziness, fainting, profuse sweating, hyperventilation, and/or low blood pressure. (This collection of symptoms is called a vasovagal response.) Among patients with heart disease, there is an increased risk of cardiac complications after donating blood.

Risks associated with autologous blood transfusion include transfusion reaction if an allogeneic blood transfusion was inadvertently given and transmission of infectious agents if the blood became contaminated. Symptoms of transfusion reaction include general discomfort, anxiety, breathing difficulties, dizziness, itching, fever, headache, rash, and swelling. Patients who are given too much blood can develop high blood pressure, which is a concern for people who have heart disease. Very rarely, an air embolism is created when air is introduced into a patient's veins through the tubing used for intravenous infusion.

### Normal results

If a patient loses enough blood during a surgical or medical procedure to warrant a blood transfusion, a transfusion of autologous blood will under normal circumstances confer the same benefits as a transfusion

## QUESTIONS TO ASK THE DOCTOR

- What is the chance that I will require a blood transfusion for my upcoming surgical procedure?
- Do I qualify to be an autologous blood donor?
- Where will blood collection take place and how many units should I donate?
- What will happen to my donated blood if my surgery is postponed or cancelled?

of allogeneic blood with none of the associated risks (i.e., transfusion reaction or transmission of infectious agents).

### Morbidity and mortality rates

One study found the risk of a complication requiring hospitalization to be one in approximately 17,000 among autologous blood donors, and one in approximately 200,000 among volunteer blood donors. The most common complication is a vasovagal reaction, although approximately 12% of patients requiring hospitalization have angina (chest pain resulting from inadequate supply of oxygen to the heart). There is a higher chance of a vasovagal reaction with autologous blood donation than with allogeneic blood donation.

### Alternatives

Allogeneic blood is a more commonly used alternative to autologous blood and accounts for 95% of all blood donations in the United States. Patients may also choose to have blood donated by family or friends, a process called directed donation. For patients who are interested in avoiding a blood transfusion, alternatives include:

- Volume expanders. Certain fluids (saline, Ringer's lactate solution, dextran, etc.) may be used to increase the volume of blood.
- Blood substitutes. Much research is currently being done into compounds that can replace some or all of the functions of blood components. One such compound, called HBOC-201, or Hemopure, is derived from bovine (cow) blood and is showing promise as a substitute for red blood cell transfusion.
- Bloodless surgery. It may be possible to avoid excessive blood loss through careful planning prior to surgery. Specialized instruments can minimize the amount of blood lost during a procedure.

## Resources

### BOOKS

AABB Perioperative Standards Unit. Standards for Perioperative Autologous Blood Collection and Administration, 3rd Edition. Amer Assn of Blood Banks, 2007.

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American Association of Blood Banks. 8101 Glenbrook Rd., Bethesda, MD 20814. (301) 907 6977. <http://www.aabb.org/content>.

American Red Cross. 431 18th St., NW, Washington, DC 20006. (202) 639 3520. <http://www.redcross.org>.

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Automatic implantable cardioverter-defibrillator see **Implantable cardioverter-defibrillator**

## Axillary dissection

### Definition

Axillary dissection is a surgical procedure that incises (opens) the armpit (axilla or axillary) to identify, examine, or remove lymph nodes (small glands, part of the lymphatic system, which filters cellular fluids).

### Purpose

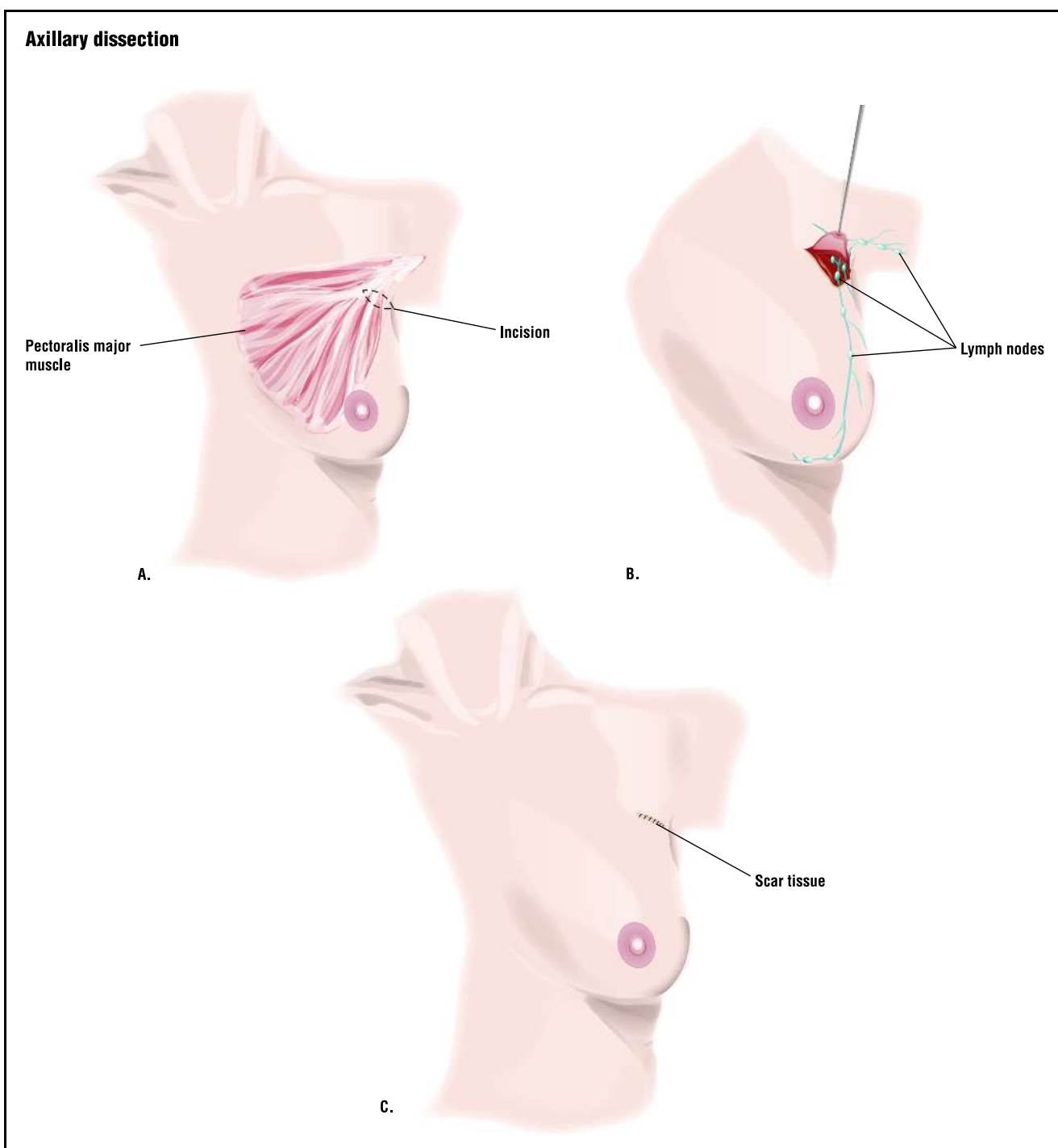
Axillary dissection is utilized to stage breast cancer in order to determine the necessity of further treatment based on cancer cell spread. Additionally, axillary dissection includes removal and pathological examination of axillary lymph nodes for persons having operable breast cancer. The anatomy of the axilla is complex and composed of several critical nerves, arteries, and muscles. Because of this complex anatomy and connection with the breast, the axilla is a common route for possible metastatic (cancer cell spread to distant areas within the body) involvement from breast cancer. The absence or presence of cancer cells in axillary lymph nodes is the most powerful prognostic (outcome) indicator for breast cancer. Axillary dissection is an accurate procedure for axillary node assessment (removal and pathological examination). Clinical examination of the breast (more specifically palpation, or feeling the affected area for lumps) for the axillary region is inaccurate and unreliable. The only method to identify whether or not a lymph node has cancer cells, is to surgically remove the node and perform examination with a microscope to detect abnormal cancer cells.

### Demographics

If axillary dissection is not performed, recurrence of cancer in the armpit is common even after breast surgery. Recent evidence suggests that persons who underwent **lumpectomy** alone without axillary dissection had a 10-year average recurrence rate of 28% in the axilla. Generally, recent evidence also suggests that the more nodes and tissues removed in the axilla, the lower the risk of recurrence of cancer. Research also indicates that 10-year axillary cancer recurrence rates are low (10% for node negative and 3% for node positive) for women who have **mastectomy** and axillary node removal. The recurrence rate for breast cancer is approximately 17% for women who did not have axillary node removal.

### Description

Lymph nodes (or lymph glands) are filtering centers for the lymphatic system (a system of vessels that collects fluids from cells for filtration and reentry into the blood). Additionally, there is a complex arrangement of muscles, tissues, nerves and blood vessels. Axillary dissection is surgically explained in terms of three levels. Level I axillary dissection is also called lower axillary dissection because it is the removal of all tissue below the axillary vein and extending to the side where the axillary vein crosses the tendon of a muscle called the latissimus dorsi. Level II dissection is continuous—it includes the removal of level tissues and further extensive removal of



To determine the advancement of breast cancer, lymph nodes in the armpit are removed. An incision is made (A), and lymph nodes are removed and tested (B), leaving a small scar (C). (Illustration by GGS Information Services. Cengage Learning, Gale.)

cancerous tissues. Level II dissection removes diseased tissues deeper in the middle (medial) area of another muscle called the pectoralis minor. Level III dissection

is the most aggressive breast cancer axillary surgery, and it entails the removal of all nodal tissue (tissues related to the lymphatic system) from the axilla.

## KEY TERMS

**Axillary vein**—A blood vessel that takes blood from tissues back to the heart to receive oxygenated blood.

**Latissimus dorsi**—In Latin, this muscle literally means “widest of the back.” This is a large fan-shaped muscle that covers a wide area of the back.

**Lymph nodes**—Small masses of lymphoid tissue that are connected to lymphatic vessels.

**Lymphatic system**—Part of the cardiovascular system, lymphatic vessels will bring fluids from cells (cellular debris) for filtration in lymph nodes. Filtered fluid is returned back to the blood circulation.

**Lymphedema**—Retention of lymph fluid in an affected (affected by surgery or disease) area.

**Pectoralis minor**—A triangular-shaped muscle in front of (anterior) the axilla.

**Tendon**—Connective tissue that attaches muscle to bone.

## Diagnosis/Preparation

Operable breast cancer is the primary indication for axillary dissection. Persons receiving this surgery have been diagnosed with breast cancer and are undergoing surgical removal of the breast. Diagnosis of breast cancer typically involves palpation of a lump (mass), and other tests such as **mammography** (special type of x ray used to visualize deep into breast tissues) and biopsy. The specific diagnosis to estimate the extent of axillary (cancerous) involvement can be made by performing a sentinel node biopsy. The sentinel node is the first lymph node that drains fluid from the primary tumor site. If there is no presence of cancerous cells in the sentinel node, the likelihood that higher echelon lymph nodes have cancer is very small. Conversely, if cancerous cells are detected in the sentinel node, then axillary dissection is recommended.

Preparation for axillary dissection is the same as that for **modified radical mastectomy**. This includes but is not limited to preoperative assessments (special tests and blood analysis), patient education, **postoperative care**, and follow-up consultations with surgeon and cancer specialist (medical hematologist/oncologist). Psychotherapy and/or community-centered support group meetings may also be beneficial to treatment.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The procedure is performed in a hospital equipped to perform major surgery. A general surgeon usually performs the operation with specialized formal training in surgical oncology (the specialty of surgery that provides surgical treatment for operable cancers).

## Aftercare

One of the major problems that can result from axillary lymph node removal is lymphedema (fluid accumulation in the arm). Postoperative aftercare should include the use of compression garments, pneumatic compression pumps, and massage to combat fluid retention. Additionally, persons may have pain and should discuss this with the attending surgeon. Other surgical measures for aftercare should be followed similar to persons receiving a modified radical mastectomy. Skin care is important and caution should be exercised to avoid cuts, bites, and skin infections in the affected area. Further measures to control lymphedema can include arm exercises and maintenance of normal weight.

## Risks

There are several direct risks associated with axillary surgery. A recent study indicated that approximately 31% of persons may have numbness and tingling of the hand and 10% develop carpal tunnel syndrome. In females who have had a previous breast surgery before the axillary surgery, recurrent wound infections and progression of lymphedema can occur. Additionally, persons may also feel tightness and heaviness in the arm as a result of lymphedema.

## Normal results

Normal results can include limited but controlled lymphedema and adequate wound healing. Persons receiving axillary dissection due to breast cancer require several weeks of postoperative recovery to regain full strength.

## Morbidity and mortality rates

Sickness and/or **death** are not necessarily related to axillary surgery per se. Rather, breast cancer outcome is related to breast cancer staging. Staging determined by axillary surgery can yield valuable information concerning

## QUESTIONS TO ASK THE DOCTOR

- How do I prepare for the procedure?
- How long does it take to know the results?
- What postoperative care will be needed?
- What are the possible risks involved in this procedure?

disease progression. Early stage (stage I) breast cancer usually has a better outcome, whereas advance stage cancer (stage 4) is correlated with a 10-year survival rate.

### Alternatives

Currently research does not support other therapies. Further study is required but other therapies are currently not recommended. There are no adequate alternatives to axillary surgery in breast cancer persons. The most recent evidence suggests that removal of lymph nodes and tissues in the armpit is correlated with elevated survival rates.

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# B

Balloon angioplasty see **Angioplasty**

## Balloon valvuloplasty

### Definition

Balloon valvuloplasty, also called percutaneous balloon valvuloplasty, is a surgical procedure used to open a narrowed heart valve. The procedure is sometimes described as balloon enlargement of a narrowed heart valve.

### Purpose

Balloon valvuloplasty is performed on children and adults who have a narrowed heart valve, a condition called stenosis. The goal of the procedure is to improve valve function and blood flow by enlarging the valve opening. It is sometimes used to avoid or delay open heart surgery and valve replacement.

There are four valves in the heart: aortic valve, pulmonary valve, mitral valve, and tricuspid valve. Each is located at the exit of one of the heart's four chambers. These valves open and close to regulate the blood flow from one chamber to the next and are vital to the efficient functioning of the heart and circulatory system. Balloon valvuloplasty is used primarily to treat pulmonary, mitral, and aortic valves when narrowing is present and medical treatment has not corrected or relieved the related problems. With mitral stenosis, for example, medical solutions are typically tried first, such as diuretic therapy (reducing excess fluid), anticoagulant therapy (thinning the blood and preventing blood clots), or blood pressure medications. Valvuloplasty is recommended for those patients whose symptoms continue to progress even after taking such medications for a period of time.

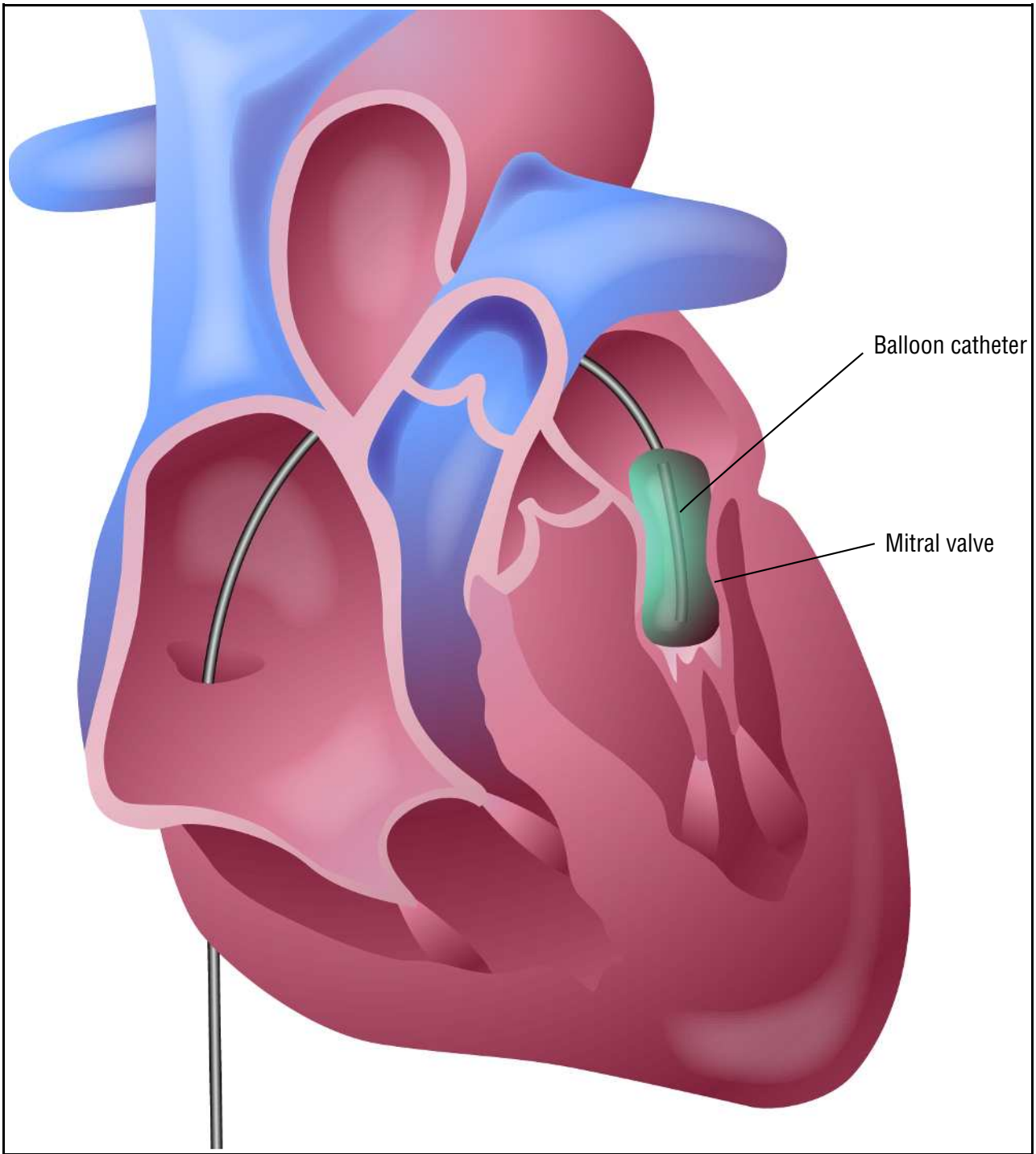
Valvular stenosis can be a congenital defect (develops in the fetus and is present at birth) or can

be acquired, that is, it stems from other conditions. Mitral valve stenosis in adults, for example, is rarely congenital and is usually acquired, either a result of having rheumatic fever as a child or developing calcium obstruction in the valve later in life. Pulmonary stenosis is almost entirely congenital. Aortic stenosis usually does not produce symptoms until the valve is 75% blocked; this occurs over time and is consequently found in people between the ages of 40 and 70. Tricuspid stenosis is usually the result of rheumatic fever; it occurs less frequently than other valve defects.

Childhood symptoms of valve narrowing may include heart dysfunction, heart failure, blood pressure abnormalities, or a murmur. Adult symptoms will likely mimic heart disease and may include blood pressure abnormalities, shortness of breath, chest pain (angina), irregular heart beat (arrhythmia), or fainting spells (syncope). **Electrocardiogram** (EKG), x ray, and **angiography** (a special x-ray examination using dye in the vascular system) may be performed to identify valvular heart problems. Depending on the severity of symptoms, **cardiac catheterization** may also be performed to examine heart valve function prior to recommending a surgical procedure. Valvular **angioplasty** is performed in children and adults to relieve stenosis. While it offers relief, it does not always cure the problem, particularly in adults, and often valvotomy (cutting the valve leaflets to correct the opening) or valve replacement is necessary at a later date.

### Demographics

Congenital heart-valve disease occurs in one of every 1,000 newborns and is thought to be caused by inherited factors. In 2–4% of valve problems, health or environmental factors affecting the mother during pregnancy are believed to contribute to the defect. Pulmonary valve stenosis represents about 10% of all congenital heart problems. About 5% of all cardiac defects is stenosis of the aortic valve. Valve abnormalities are diagnosed in children and adults of both sexes;



**The balloon at the end of the catheter spreads open the mitral valve, relieving the obstruction.** (Illustration by GGS Information Services. Cengage Learning, Gale.)

80% of adult patients with stenosis are male, while most adults with mitral stenosis are women who had rheumatic fever as a child. Tricuspid stenosis is rarely found in North America or Europe.

### Description

In balloon valvuloplasty, a thin tube (catheter) with a small deflated balloon at its tip (balloon-tipped

## KEY TERMS

**Cardiac catheterization**—A minimally invasive technique that runs a catheter through veins into the heart to evaluate heart function. Fluoroscopy is used to observe the catheterization.

**Dilate**—To expand or open a valve or blood vessel.

**Electrocardiography (EKG)**—A method to measure the variations in the actions of the heart. An EKG machine produces wave-like patterns either on paper or on a monitor that can be used to diagnose irregularities in rhythm.

**Stenosis**—The narrowing of any valve, especially one of the heart valves or the opening into the pulmonary artery from the right ventricle.

**Valve**—Flaps (leaflets) of tissue in the passageways between the heart's upper and lower chambers.

catheter) is inserted through an incision in the skin in the groin area into a vein, and then is threaded up to the opening of the narrowed heart valve. The balloon is inflated to stretch the valve open and relieve the valve obstruction.

The procedure, which takes up to four hours, is performed in a cardiac catheterization laboratory that has a special x-ray machine and an x-ray monitor that looks like a regular TV screen. The patient will be placed on an x-ray table and covered with a sterile sheet. An area on the inside of the upper leg will be washed and treated with an antibacterial solution to prepare for the insertion of a catheter. The patient is given **local anesthesia** to numb the insertion site and will usually remain awake, able to watch the procedure on the monitor. After the insertion site is prepared and anesthetized, the cardiologist inserts a catheter into the appropriate blood vessel, and then passes the smaller balloon-tipped catheter through the first catheter. Guided by the x-ray monitor that allows visualization of the catheter in the blood vessel, the physician slowly threads the catheter up into the coronary artery to the heart. The deflated balloon is carefully positioned in the opening of the valve that is being treated, and then is inflated repeatedly, which applies pressure to dilate the valve. The inflated balloon widens the valve opening by splitting the valve leaflets apart. Once the valve is widened, the balloon-tipped catheter is removed. The other catheter remains in place for 6–12 hours because, in some cases, the procedure must be repeated. A double-balloon valvuloplasty procedure is often performed on certain high-

risk patients because it is considered more effective in restoring blood flow.

## Preparation

For at least six hours before balloon valvuloplasty, the patient will have to avoid eating or drinking anything. An intravenous line is inserted so that medications (anticoagulants to prevent clot formation and radioactive dye for x rays) can be administered. The patient's groin area is shaved and cleaned with an antiseptic. About an hour before the procedure, the patient is given an oral sedative such as diazepam (Valium) to ensure that he or she will relax sufficiently for the procedure.

## Aftercare

After balloon valvuloplasty, the patient will spend several hours in the **recovery room** to be monitored for **vital signs** (such as heart rate and breathing) and heart sounds. During this time, electrical leads attached to an EKG machine will be placed on the patient's chest and limbs, and a monitor will display the electrical impulses of the heart continuously, alerting nurses quickly if any abnormality occurs. For at least 30 minutes after removal of the catheter, direct pressure is applied to the site of insertion; after this, a pressure dressing will be applied. The skin condition is monitored. The insertion site will be observed for bleeding until the catheter is removed. The leg in which the catheter was inserted is temporarily prevented from moving. Intravenous fluids will be given to help eliminate the x-ray dye; intravenous anticoagulants or other medications may be administered to improve blood flow and to keep coronary arteries open. Pain medication is administered as needed. Some patients will continue to take anticoagulant medications for months or years after the surgery and will have regular blood tests to monitor the effectiveness of the medication.

Following **discharge from the hospital**, the patient can usually resume normal activities. After balloon valvuloplasty, lifelong follow-up is necessary because valves sometimes degenerate or narrowing recurs, a condition called restenosis, which will likely require repeat valvuloplasty, valvotomy, or valve replacement.

## Risks

Balloon valvuloplasty can have serious complications. For example, the valve can become misshapen so that it does not close completely, which makes the condition worse. Embolism, where either clots or

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Balloon valvuloplasty is performed in a hospital cardiac catheterization laboratory, a special room much like an operating room. The procedure is performed by a cardiologist or vascular surgeon.

pieces of valve tissue break off and travel to the brain or the lungs causing blockage, is another possible risk. If the procedure causes severe damage to the valve leaflets, immediate valve replacement is required. Less frequent complications are bleeding and hematoma (a local collection of clotted blood) at the puncture site, abnormal heart rhythms, reduced blood flow, heart attack, heart puncture, infection, and circulatory problems. Because restenosis is frequent in adult patients with valvular disease, particularly when underlying heart disease or other conditions are present, the procedure is recommended only as an emergency rescue for high-risk patients who are not candidates for valve replacement.

### Normal results

Balloon valvuloplasty is considered a safe, effective treatment in children with congenital stenosis, improving heart function and blood flow. In adults, balloon valvuloplasty may give temporary relief and improve heart function and blood flow, but underlying coronary artery disease or other disease conditions may encourage restenosis, making valve replacement eventually necessary. The most successful valvuloplasty results are achieved in treating narrowed pulmonary valves, although the treatment of mitral valve stenosis is also generally good. The aortic valve procedure is more difficult to perform and is generally less successful.

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## QUESTIONS TO ASK THE DOCTOR

- Why do I need this procedure?
- What will I gain by having the procedure?
- What kind of anesthesia will I have?
- Will I be uncomfortable during or after the procedure?
- Will I be able to continue all my normal activities when I go home? How soon after the surgery can I return to school/work?
- Will I need any follow-up care or tests after the surgery?
- How often do you perform this procedure?
- Do most people who have this procedure feel better afterwards?

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## Bandages and dressings

### Definition

Bandages and dressings are both used in wound management. A bandage is a piece of cloth or other material used to bind or wrap a diseased or injured part of the body. Usually shaped as a strip or pad, bandages are either placed directly against the wound or used to bind a dressing to the wound. A dressing can consist of a wide range of materials, sometimes containing medication, placed directly against the wound.

### Purpose

The purposes served by dressings include protecting wounds; promoting healing; and providing, retaining, or removing moisture. Bandages can be used to hold dressings in place, to relieve pain, and generally to make the patient comfortable. Elastic bandages are useful to provide ongoing pressure on wounds such as varicose veins, fractured ribs, and swollen joints.

## Description

In recent years, there have been tremendous advances in the design and composition of bandages and dressings. The field is becoming increasingly complex, and there are numerous reports of health care workers applying inappropriate products. Wound-care materials come in a wide variety of product classes, including the following:

- **Alginate dressings.** These are derived from brown seaweed and contain calcium alginate, which turns into a sodium alginate gel when it comes in contact with wound fluid. They are available as pads or ropes.
- **Biosynthetic dressings.** These are composites of biological (often animal-derived) and synthetic materials such as polymers.
- **Collagen dressings.** These are made from collagen, a protein obtained from cowhide, cattle tendons, or birds. They are available as particles or gels.
- **Composite dressings.** These are similar to plastic adhesive strips and include an adhesive border, a non-adhesive or semi-adhesive surface that is applied to the wound, an absorbent layer, and a bacterial barrier.
- **Contact layers.** A low-adherent layer of perforated or woven polymer material designed to stop a secondary absorbent dressing from sticking to the surface of a wound.
- **Gauze.** This woven fabric of absorbent cotton is available in a number of formats and materials, including cotton or synthetic, non-impregnated, and impregnated with water, saline, or other substances. Gauze is sold as surgical swabs, sheets, rolls, pads, sponges, and ribbon.
- **Growth factors.** These short-chain proteins affect specific target cells. They exist naturally in humans, and can be transplanted from one part of the body to another or manufactured outside the body.
- **Hydrocolloid dressings.** Used for leg ulcers, minor burns, pressure sores and traumatic injuries, these self-adhesive dressings form a gel as they absorb fluid from the wound. They consist of materials such as sodium carboxymethylcellulose (an absorbent), pectin, and gelatin that are attached to a foam sheet or a thin polyurethane film.
- **Hydrofibers.** Similar in appearance to cotton, carboxymethylcellulose fibers turn into a gel when they come into contact with wound fluid. They are available as ribbons or pads and are highly absorbent.
- **Hydrogels.** These are sold as sheets and in gel form, and are primarily used to supply moisture to wounds. Depending on the state of the tissue, they can either absorb fluid or moisten the wound. An electrically

conductive aloe vera gel is available to provide electrotherapy to wounds.

- **Hydropolymers.** These foamed-gel products consist of multiple layers. The surface layer is designed to expand to fill the contours of a wound and, at the same time, draw away fluids.
- **Leg compression/wrapping products.** These are designed to apply external pressure to improve blood flow and resolve chronic edema in the feet and legs. They are available in a broad range of formats, including stockings, compression bandages, or pneumatic pump.
- **Polyurethane foam dressings.** These are sheets of foamed polymer solutions with small open chambers that draw fluids away from the wound. Some of these foam products offer adhesive surfaces. They are available as sheets and rolls, as well as in various other formats suitable for packing wounds.
- **Skin substitutes.** Also known as allografts or skin equivalents, these are obtained from human cells cultured and expanded in vitro from neonatal foreskins.
- **Superabsorbents.** These are particles, hydropolymers, or foams that act like the material inside diapers, with a high capacity for rapid absorption.
- **Transparent films.** These consist of a thin, clear polyurethane sheet that, on one side, has a special adhesive that does not stick to moist surfaces like those found on a wound. They prevent bacteria and fluids from entering the wound through the dressing, but allow limited circulation of oxygen.
- **Wound fillers.** These can be bought as powders or pastes, or in strands or beads. They are used to fill wounds and also absorb wound fluid.
- **Wound pouches.** Equipped with a special collection system for wounds that have a high flow of secretion, they are designed to contain odors and to be easily drained.
- **Other assorted wound-care products.** These include adhesive bandages, surgical tapes, adhesive skin closures, surgical swabs, paste bandages, specialty absorptive dressings, support bandages, retention bandages, elasticized tubular bandages, lightweight elasticized tubular bandages, foam-padded elasticized tubular bandages, and plain stockinettes.

Just as there is a large selection of bandage and dressing products to choose from, there is also a broad range of applications for these products:

- **Alginate dressings** are used on wounds that exude moderate to heavy amounts of fluid. They are useful for packing wounds, although strip-packing gauze may be preferable for deeper wounds because it is easier to retrieve. Common applications of alginate



dressings include treatment of acute surgical wounds, leg ulcers, sinuses, and pressure sores. These dressings should not be used on third-degree burns. Neither are they advisable for wounds that are dry or are secreting only small amounts of fluid, because their powerful absorbing capability may dry out the wound. These are primary dressings that need be covered by a secondary dressing.

- Biosynthetic dressings are used on burns and other wounds. Another application is as a temporary dressing for skin autograft sites. Some persons may be allergic to these dressing materials.
- Collagen dressings are believed to hasten wound repair and are often used on stubborn wounds. They are most effective on wounds that contain no dead tissue. Collagen dressings should not be used in dry wounds, third-degree burns, or on any patient who is sensitive to bovine (cow) products.
- Composite dressings are sometimes used alone, sometimes in combination with other dressings. Deep wounds should first be packed with wound-filler material. These dressings should not be cut, and are not recommended for use on third-degree burns.
- Contact layers are designed for use in clean wounds that contain no dead tissue. They are not recommended for infected, shallow, dry, or infected wounds, or on third-degree burns.
- Gauze is used to pack wounds, and also for debridement and wicking. It is especially desirable for packing deep wounds. When using gauze to pack wounds, a loose packing technique is preferred.
- Growth factors. These have highly specific applications against such conditions as diabetic foot ulcers involving disease of the peripheral nerves. Growth factors are heat sensitive and often require refrigeration. These are not recommended for persons with benign or malignant tumors.
- Hydrocolloid dressings are used for leg ulcers, minor burns, pressure sores, and traumatic injuries. Because they are not painful to remove, hydrocolloid dressings are often employed in pediatric wound management. Because of their absorbent capabilities, they are used on wounds that are secreting light to moderate amounts of fluid.
- Hydrofibers are highly absorbent, so they are particularly useful for wounds that are draining heavily. For this reason, they are not recommended for dry wounds or wounds with little secretion, because they may result in dehydration. Hydrofibers should not be used as surgical sponges or on third-degree burns.
- Hydrogels are often used on wounds that contain dead tissue, on infected surgical wounds, and on painful wounds. They should not be used on wounds with moderate to heavy secretions. As with all dressings, it is important to check and follow the directions of the manufacturer. In the case of hydrogels, directions on some products indicate they are not to be used on third-degree burns.
- Hydropolymers are typically used on wounds with minimal to moderate drainage. They are not indicated for dry wounds or third-degree burns.
- Leg compression/wrapping products are used to increase blood flow and reduce edema in the lower extremities of the body. A medical doctor should be consulted before using these products on people with edema. In many cases, topical dressings are used under these products.
- Polyurethane foam dressings are very absorbent and are typically used on wounds with moderate to heavy secretions. They should not be used on third-degree burns or on wounds that are not draining or that have sinuses or tunneling.
- Skin substitutes are a relatively new product category, approved for treating venous leg ulcers. It is often advisable to cut slits in the artificial skin, so that wound secretions underneath do not lift the newly applied skin.
- Superabsorbents are employed on wounds that are secreting heavily, or in applications requiring extended wear. A packing material is commonly employed under this product. Superabsorbents should not be used on third-degree burns or wounds that are either dry or have minimal secretions.
- Transparent films are often employed as a secondary cover for another, primary dressing. They are used on superficial wounds and on intact skin at risk of infection. It is important to remove transparent films very carefully to avoid damaging fragile skin.
- Wound fillers are primary dressings that are usually used in conjunction with other, secondary dressings. Wound fillers are considered appropriate for shallow wounds with little or moderate secretions. They are not appropriate for use in third-degree burns or in dry wounds. They are similarly not recommended for wounds with tunnels or sinuses.
- Wound pouches are useful in treating wounds with high volumes of secretion. They are not suitable for dry wounds.

Recommended intervals between dressing changes vary widely among product classes. The materials used in some dressings require that they be changed several times a day. Others can remain in place for one week. Manufacturer's directions should be consulted and followed.

## KEY TERMS

**Debridement**—Removing dead or non-viable tissue from a wound.

**Edema**—Swelling of body tissues, caused by collection of excess fluid.

**Electrotherapy**—The treatment of body tissues by passing electrical currents through them, stimulating the nerves and muscles.

**Sinus**—In the context of wound management, a narrow hollow in the body extending from an infected area to the surface of the skin.

**Stockinette**—A soft elastic material used for bandages and clothing for infants.

## Preparation

Wounds require appropriate cleaning, **debridement**, closure, and medication before bandages and dressings are applied.

Determining the cause of wounds is often very important, especially the cause of chronic wounds such as skin ulcers. A physician should be advised of any signs of infection or other changes in a wound. Signs of infection may include redness around the wound site, fever, red streaks extending from the wound, yellow drainage from the wound, or a mal odor noted at the wound site.

Wound-care nursing is a rapidly advancing field that requires considerable training, clinical experience, and judgment, causing some observers to predict that it will eventually develop into an advanced practice nursing or a specialty-based practice. Increasingly, the demands on wound-care nurses are expected to require that they undertake graduate studies. For all nurses working in the field, ongoing education is a must to keep up with new knowledge, technologies, and techniques. Numerous organizations and institutions offer continuing education courses in **wound care** management.

## Results

Wounds that receive appropriate and timely care are most likely to heal in an acceptable manner.

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American Academy of Family Physicians. 11400 Tomahawk Creek Parkway, Leawood, KS 66211 2672. (913) 906 6000. Email: [fp@aafp.org](mailto:fp@aafp.org). <http://www.aafp.org>.

American College of Physicians. 190 N. Independence Mall West, Philadelphia, PA 19106 1572. (800) 523 1546, x2600, or (215) 351 2600. <http://www.acponline.org>.

American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464 5000. <http://www.ama-assn.org>.

American Nurses Association. 600 Maryland Avenue, SW, Suite 100 West, Washington, DC 20024. (800) 274 4262. <http://www.nursingworld.org>.

American Red Cross National Headquarters. 2025 E St. NW, Washington DC 20006. (202) 303 4498. <http://www.redcross.org>.

Wound, Ostomy, and Continence Nurses Society. 1550 South Coast Highway, Suite #201, Laguna Beach, CA 92651. (888) 224 9626. <http://www.wocn.org>.

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## Bankart procedure

### Definition

A Bankart procedure, also known as a Broca-Perthes-Bankart procedure, is a surgical technique for the repair of recurrent shoulder joint dislocations. In the procedure, the torn ligaments are re-attached to the proper place in the shoulder joint, with the goal of restoring normal function.

### Purpose

The shoulder is the junction of three bones: the upper arm bone (humerus), the collarbone (clavicle), and the shoulder blade (scapula). The shoulder joint (glenohumeral joint) is the result of the head of the humerus bone fitting in the cavity of the shoulder blade (glenoid cavity), the joint being held together by the labrum, a rim of soft tissue that surrounds the glenoid. As a result of excessive force being applied to the arm, the head of the humerus may be forced out of the glenoid cavity (dislocation), and the supporting ligaments of the shoulder joint may be torn. These ligaments may heal so that the shoulder regains its stability. However, sometimes the ligaments do not heal, making the shoulder unstable and painful. This condition is referred to as traumatic instability of the shoulder, traumatic glenohumeral instability, or a Bankart lesion.

The goal of a Bankart procedure for traumatic glenohumeral instability is the safe and secure re-attachment of the torn ligaments to the tip of the glenoid from which they were detached. The surgery has the advantage of allowing patients to resume many of their activities of daily living while the repair is healing. The surgery also minimizes the unwanted joint stiffness associated with such injuries.

### Demographics

The shoulder is the most commonly dislocated major joint following severe trauma, such as an auto collision or a fall onto an outstretched arm. Some 96% of dislocations involve the front of the shoulder (anterior), with 1–3% occurring in the back (posterior). Falls and car accidents are common causes of first-time dislocations, but recurrent dislocations are often due to seemingly inoffensive activities such as raising the arm over the head, or combing hair. Shoulder dislocations are more common in males than females, and in young adults.

### Description

In general, shoulder surgery can be performed in two fundamentally different ways: either using closed surgical techniques (**arthroscopic surgery**) or using open surgical techniques.

An open surgery Bankart procedure is performed under **general anesthesia**. The patient is placed in a 30-degree inclined chair position with the arm free over the edge of the operating table. A bag is placed under the center of the shoulder blade of the shoulder being operated on to support the shoulder and to push the shoulder blade forward. Prepping and draping allow the arm to be freely moveable and allow a good view of the surgical field.

The whole upper limb is prepared with antiseptic. An examination under anesthesia is performed to confirm the exact nature of the instability. The surgeon makes a long incision to gain access to the joint, often cutting through the deltoid muscle to operate on the internal structures of the shoulder, and proceeds to sew the joint capsule to the detached labrum tissues.

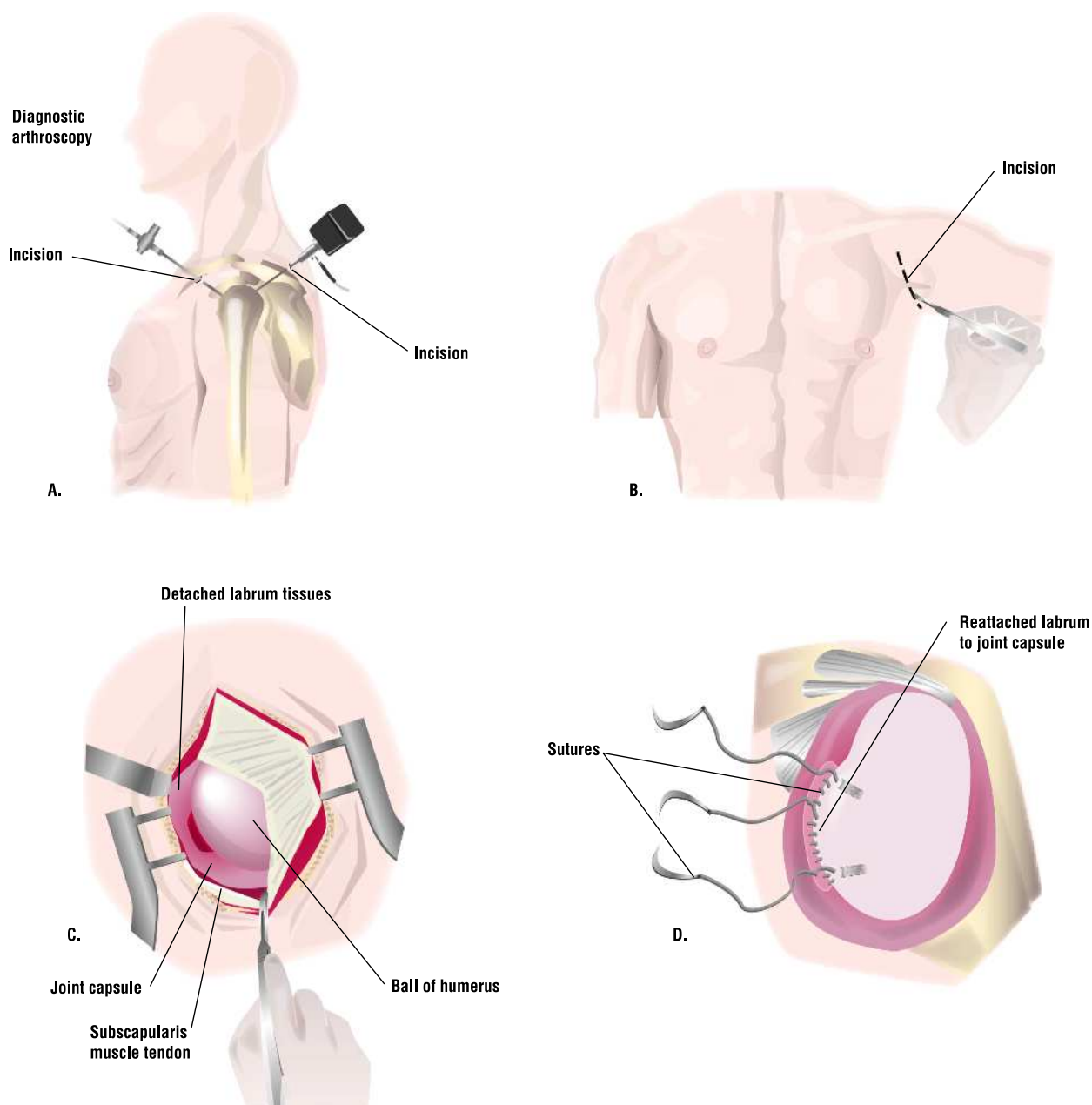
The arthroscopic Bankart procedure tries to imitate the open Bankart procedure. Arthroscopy is a microsurgical technique by which the surgeon can use an endoscope to look through a small hole into the shoulder joint. The endoscope is an instrument the size of a pen, consisting of a tube fitted with a light and a miniature video camera, which transmits an image of the joint interior to a television monitor. The detached part of the labrum and the associated ligaments are reattached to bone along the rim of the glenohumeral cavity through a small “keyhole” incision. This is done with little disruption to the other shoulder structures and without the need to detach and reattach the overlying shoulder muscle (subscapularis).

### Diagnosis/Preparation

The physician diagnoses a Bankart lesion from the patient’s history, by performing a thorough **physical examination** of the joint, and taking the proper x rays. The examination often reveals that the head of the humerus slips easily out of the joint socket, even when it is pressed into it. This is called the “load and shift test.” X rays may also reveal that the bony lip of the glenoid socket is rounded or deficient, or that the head of the humerus is not centered in the glenoid cavity.

A diagnostic arthroscopy is also often used to confirm the presence and extent of the shoulder instability. In this procedure, a thin fiberoptic scope is inserted into the shoulder joint space to allow direct visualization of its internal structures. An electromyogram may also be obtained if the treating physician suspects the possibility of nerve injury.

## Bankart procedure



A Bankart procedure may be performed laparoscopically (A), or through an open incision in the shoulder (B). In the open procedure, the surgeon exposes the joint capsule and labrum, a rim of soft tissue that surrounds the cavity, which has become detached (C). Sutures reattach the labrum to the joint capsule (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

Patients should attend to any health problem so as to be in the best possible condition for this procedure. Smoking should be stopped a month before surgery and not resumed for at least three months afterwards. Any heart, lung, kidney, bladder, tooth,

or gum problems should be managed before surgery. The orthopedic surgeon needs to be informed of all health issues, including allergies and the non-prescription and prescription medications being used by the patient.



## KEY TERMS

**Arthroscopy**—The introduction of a thin fiberoptic scope (arthroscope) into a joint space to allow direct visualization of internal structures. In some cases, surgical repair can also be performed using the arthroscope.

**Coracoid process**—A long curved projection from the scapula overhanging the glenoid cavity; it provides attachment to muscles and ligaments of the shoulder and back region.

**Electromyography**—A test that measures muscle response to nerve stimulation. It is used to evaluate muscle weakness and to determine if the weakness is related to the muscles themselves or to a problem with the nerves that supply the muscles.

**General anesthesia**—A form of anesthesia that results in putting the patient to sleep.

**Glenoid cavity**—The hollow cavity in the head of the scapula that receives the head of the humerus to make the glenohumeral or shoulder joint.

**Glenohumeral joint**—A ball-and-socket synovial joint between the head of the humerus and the glenoid cavity of the scapula. Also called the glenohumeral articulation or shoulder joint.

**Humerus**—The bone of the upper part of the arm.

**Scapula**—A large, flat, triangular bone that forms the back portion of the shoulder. It articulates with the clavicle (at the acromion process) and the humerus (at the glenoid). Also called the shoulder blade.

## Aftercare

Exercises are usually started on the day following surgery with instructions from a physical therapist, five times daily, including assisted flexion and external rotation of the arm. The other arm is used to support the arm that underwent surgery until it can perform the exercises alone. The patient is allowed to perform many activities of daily living as tolerated, but without lifting anything heavier than a glass or plate. If a patient can not comply with restricted use of the shoulder, the arm is kept in a sling for three weeks. Otherwise, a sling is used only for comfort between **exercise** sessions and to protect the arm when the patient is out in public and at night while sleeping. Driving is allowed as early as two weeks after surgery, if the shoulder can be used comfortably, especially if the patient's car has automatic transmission. At eight

to 10 weeks, the patient can usually resume light, low-risk activities, such as swimming and jogging. If involved in sports, the patient may return to training at three months. Hospital physiotherapy is rarely prescribed and only in cases of delayed rehabilitation or shoulder stiffness.

## Risks

The following risks are associated with a Bankart procedure:

- Perioperative: Nerve damage during surgery and poor placement of anchor sutures.
- Within six weeks after surgery: Wound infection and rupture of the repair.
- Between six weeks and six months: Shoulder stiffness, recurrence of instability, failure of the repair resulting in shoulder weakness, failure of the anchor sutures.

## Normal results

Normal results for a Bankart procedure include:

- good control of pain and inflammation
- normal upper arm strength and endurance
- normal shoulder range of motion

According to the American Academy of Family Physicians, the classic treatment of recurrent shoulder dislocations remains open surgical Bankart repair. This approach has a success rate as high as 95% in effectively removing shoulder instabilities. In a recent study of young athletes, Bankart repair was compared with three weeks of immobilization for the treatment of an initial anterior shoulder dislocation. The group treated surgically had fewer episodes of recurrent instability than the group managed with immobilization.

## Morbidity and mortality rates

Surgery for anterior dislocation of the shoulder fails in one out of 10 to one out of 20 cases, with a higher incidence of failure in arthroscopic Bankart procedures when compared to the open surgical approach. There is also a higher incidence of failure in patients who smoke, those who start using their shoulder vigorously very early after the repair, and those with very loose ligaments.

## Alternatives

### Surgical

The Bristow procedure is an alternative surgical procedure used to treat shoulder instability. In this technique, the coracoid process (a long, curved projection



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A Bankart procedure is performed in a hospital setting by an orthopedic surgeon specializing in shoulder instability problems.

from the scapula) with its muscle attachments is transferred to the neck of the scapula and creates a muscle sling at the front of the glenohumeral joint.

### Non-surgical

Shoulders can be stabilized and strengthened with special exercises. During the early phases of such physical therapy programs, the patient is taught to use the shoulder only in the most stable positions—those in which the humerus is elevated in the plane of the scapula. As coordination and confidence improve, progressively less stable positions are attempted.

## Resources

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Massoud, S. N., O. Levy, and S. A. Copeland. "The vertical apical suture Bankart lesion repair for anteroinferior glenohumeral instability." *Journal of Shoulder and Elbow Surgery* 11 (September October 2002): 481–485.

## QUESTIONS TO ASK THE DOCTOR

- How long will it take to recover from the surgery?
- What are the different types of surgery available for shoulder instability?
- Specifically, how will my shoulder be improved by a Bankart procedure?
- Will surgery cure my shoulder condition so that I may resume my activities?
- Can medications help?
- Are there any alternatives to surgery?
- How many Bankart procedures do you perform each year?

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### ORGANIZATIONS

American Academy of Orthopedic Surgeons. 6300 North River Road, Rosemont, IL 60018 4262. (847) 823 7186; (800) 346 AAOS. [www.aaos.org](http://www.aaos.org).

### OTHER

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## Barbiturates

### Definition

Barbiturates are medicines that act on the central nervous system. They cause drowsiness and can control seizures.

### Purpose

Barbiturates are in the group of medicines known as central nervous system depressants (CNS). Also known as sedative-hypnotic drugs, barbiturates make people very relaxed, calm, and sleepy. These drugs are sometimes used to help patients relax before surgery. Some may also be used to control seizures (convulsions). Although barbiturates have been used to treat nervousness and sleep problems, they have generally been replaced by other medicines for these purposes.

## KEY TERMS

**Adrenal glands**—Two glands located next to the kidneys. The adrenal glands produce the hormones epinephrine and norepinephrine and the corticosteroid (cortisone-like) hormones.

**Anemia**—A lack of hemoglobin. Hemoglobin is the compound in blood that carries oxygen from the lungs throughout the body and brings waste carbon dioxide from the cells to the lungs, where it is released.

**Central nervous system**—The brain, spinal cord, and nerves throughout the body.

**Hallucination**—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

**Hypnotic**—A medicine that causes sleep.

**Porphyria**—A disorder in which porphyrins build up in the blood and urine.

**Porphyrin**—A type of pigment found in living things, such as chlorophyll which makes plants green and hemoglobin which makes blood red.

**Sedative**—Medicine that has a calming effect and may be used to treat nervousness or restlessness.

**Seizure**—A sudden attack, spasm, or convulsion.

**Withdrawal symptoms**—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug on which he or she has become dependent.

Although barbiturates have largely been replaced by other classes of drugs, some are still used in anesthesiology to induce anesthesia and lower the dose of inhaled anesthetics required for surgical procedures. Barbiturates used for anesthesia may be classified as ultrashort, short, intermediate, and long-acting. Ultrashort-acting barbiturates such as methohexital (Brevital) and thiopental (Pentothal) produce anesthesia within about one minute after intravenous administration. Short and intermediate acting barbiturates include amobarbital (Amytal), secobarbital (Seconal), and butabarbital (Butisol). They are taken orally and may begin their effects in about 15 to 45 minutes after administration and last for about 6 hours. Long-acting barbiturates such as phenobarbital (Luminal) may last for up to 12 hours and are used primarily for treatment of seizure disorders.

Pentobarbital (Nembutal) has been used in **neurosurgery** to reduce blood flow to the brain. This reduces

swelling and pressure in the brain, making brain surgery safer.

Secobarbital (Seconal) may be given by mouth or as a suppository to induce sleepiness and relaxation before **local anesthesia** or the insertion of a tube into the nose or throat.

These medicines may become habit-forming and should not be used to relieve everyday anxiety and tension or to treat sleeplessness over long periods.

## Description

Barbiturates are available only with a physician's prescription and are sold in capsule, tablet, liquid, and injectable forms. Some commonly used barbiturates are phenobarbital (Barbita) and secobarbital (Seconal).

## Recommended dosage

Recommended dosage depends on the type of barbiturate and other factors such as the patient's age and the condition for which the medicine is being taken. The patient should consult with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

The following recommendations do not apply when barbiturates are given as a single oral or intravenous dose prior to or during surgery. The recommendations should be considered if the drugs are used for treatment of anxiety or seizures.

Patients should always take barbiturates exactly as directed. Larger or more frequent doses should never be taken, and the drug should not be taken for longer than directed. If the medicine does not seem to be working, even after taking it for several weeks, the patient should *not* increase the dosage. Instead, the physician who prescribed the medicine should be consulted.

People taking barbiturates should not stop taking them suddenly without first checking with the physician who prescribed the medication. It may be necessary to taper the dose gradually to reduce the chance of withdrawal symptoms. If it is necessary to stop taking the drug, the patient should check with the physician for instructions on how to stop.

## Precautions

People taking barbiturates must see a physician regularly. The physician will check to make sure the medicine is working as it should and will note unwanted side effects.

Because barbiturates work on the central nervous system, they may add to the effects of alcohol and other drugs that slow the central nervous system, such as antihistamines, cold medicine, allergy medicine, sleep aids, medicine for seizures, tranquilizers, some pain relievers, and **muscle relaxants**. They may also add to the effects of anesthetics, including those used for dental procedures. The combined effects of barbiturates and alcohol or other CNS depressants (drugs that slow the central nervous system) can be very dangerous, leading to unconsciousness or even **death**. Anyone taking barbiturates should not drink alcohol and should check with his or her physician before taking any medicines classified as CNS depressants.

Taking an overdose of barbiturates or combining barbiturates with alcohol or other central nervous system depressants can cause unconsciousness and even death. Anyone who shows signs of an overdose or a reaction to combining barbiturates with alcohol or other drugs should get emergency medical help immediately. Signs include:

- severe drowsiness
- breathing problems
- slurred speech
- staggering
- slow heartbeat
- severe confusion
- severe weakness

Barbiturates may change the results of certain medical tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

People may feel drowsy, dizzy, lightheaded, or less alert when using these drugs. These effects may even occur the morning after taking a barbiturate at bedtime. Because of these possible effects, anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect him or her.

Barbiturates may cause physical or mental dependence when taken over long periods. Anyone who shows these signs of dependence should check with his or her physician right away:

- the need to take larger and larger doses of the medicine to get the same effect
- a strong desire to keep taking the medicine
- withdrawal symptoms, such as anxiety, nausea or vomiting, convulsions, trembling, or sleep problems, when the medicine is stopped

Children may be especially sensitive to barbiturates. This sensitivity may increase the chance of side effects such as unusual excitement.

Older people may also be more sensitive than others to the effects of this medicine. In older people, barbiturates may be more likely to cause confusion, depression, and unusual excitement. These effects are also more likely in people who are very ill.

### *Special conditions*

People with certain medical conditions or who are taking certain other medicines can have problems if they take barbiturates. Before taking these drugs, be sure to let the physician know about any of these conditions:

**ALLERGIES.** Anyone who has had unusual reactions to barbiturates in the past should let his or her physician know before taking the drugs again. The physician should also be told about any allergies to foods, dyes, preservatives, or other substances.

**PREGNANCY.** Taking barbiturates during pregnancy increases the chance of birth defects and may cause other problems such as prolonged labor and withdrawal effects in the baby after birth. Pregnant women who must take barbiturates for serious or life-threatening conditions should thoroughly discuss with their physicians the benefits and risks of taking this medicine.

**BREASTFEEDING.** Barbiturates pass into breast milk and may cause problems such as drowsiness, breathing problems, or slow heartbeat in nursing babies whose mothers take the medicine. Women who are breastfeeding should check with their physicians before using barbiturates.

**OTHER MEDICAL CONDITIONS.** Before using barbiturates, people with any of these medical problems should make sure their physicians are aware of their conditions:

- alcohol or drug abuse
- depression
- hyperactivity (in children)
- pain
- kidney disease
- liver disease
- diabetes
- overactive thyroid
- underactive adrenal gland
- chronic lung diseases such as asthma or emphysema
- severe anemia
- porphyria

**USE OF CERTAIN MEDICINES.** Taking barbiturates with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

### Side effects

The most common side effects are dizziness, lightheadedness, drowsiness, and clumsiness or unsteadiness. These problems usually go away as the body adjusts to the drug and do not require medical treatment unless they persist or interfere with normal activities.

More serious side effects are not common, but may occur. If any of the following side effects occur, the physician who prescribed the medicine should be contacted immediately:

- fever
- muscle or joint pain
- sore throat
- chest pain or tightness in the chest
- wheezing
- skin problems, such as rash, hives, or red, thickened, or scaly skin
- bleeding sores on the lips
- sores or painful white spots in the mouth
- swollen eyelids, face, or lips

In addition, if confusion, depression, or unusual excitement occur after taking barbiturates, a physician should be contacted as soon as possible.

Patients who take barbiturates for a long time or at high doses may notice side effects for some time after they stop taking the drug. These effects usually appear within eight to 16 hours after the patient stops taking the medicine. If these or other troublesome symptoms occur after stopping treatment with barbiturates, a physician should be contacted:

- dizziness, lightheadedness or faintness
- anxiety or restlessness
- hallucinations
- vision problems
- nausea and vomiting
- seizures (convulsions)
- muscle twitches or trembling hands
- weakness
- sleep problems, nightmares, or increased dreaming

Other side effects may occur. Anyone who has unusual symptoms during or after treatment with barbiturates should consult with his or her physician.

### Interactions

Birth control pills may not work properly when taken while barbiturates are being taken. To prevent pregnancy, additional methods of birth control are advised while taking barbiturates.

Barbiturates may also interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes barbiturates should let the physician know all other medicines he or she is taking. Among the drugs that may interact with barbiturates are:

- other central nervous system (CNS) depressants such as medicine for allergies, colds, hay fever, and asthma; sedatives; tranquilizers; prescription pain medicine; muscle relaxants; medicine for seizures; sleep aids; barbiturates; and anesthetics
- blood thinners
- adrenocorticoids (cortisone-like medicines)
- antiseizure medicines such as valproic acid (Depakote and Depakene), and carbamazepine (Tegretol)

The list above does not include every drug that may interact with barbiturates. A physician or pharmacist should be consulted before combining barbiturates with any other prescription or nonprescription (over-the-counter) medicine.

### Resources

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## Barium enema

### Definition

A barium enema, also known as a lower GI (gastrointestinal) exam, is a test that uses x-ray examination to view the large intestine. There are two types of tests: the single-contrast technique, where barium sulfate is injected into the rectum to gain a profile view of the large intestine, and the double-contrast (or “air contrast”) technique, where air and barium are inserted into the rectum.

### Purpose

A barium enema may be performed for a variety of reasons. One reason may be to help in the diagnosis of colon and rectal cancer (or colorectal cancer), and inflammatory disease. Detection of polyps (benign growths in the tissue lining the colon and rectum), diverticula (pouches pushing out from the colon), and structural changes in the large intestine can also be confirmed by the barium enema. The double-contrast barium enema is the best method for detecting small tumors (such as polyps), early inflammatory disease, and bleeding caused by ulcers.

A doctor’s decision to perform a barium enema is based on a patient’s history of altered bowel habits. These can include diarrhea, constipation, lower abdominal pain, or patient reports of blood, mucus, or pus in the stools. It is recommended that healthy people have a colorectal cancer screening **colonoscopy** every five to 10 years, because this form of cancer is the second most deadly type in the United States. Those who have a close relative with colorectal cancer, or who have had a precancerous polyp, are considered to be at an increased risk for the disease and should be screened more frequently by their doctor for possible abnormalities.

### Description

To begin a barium enema, the doctor will have the patient lie with their back down on a tilting radiographic table so that x rays of the abdomen can be taken. The film is then reviewed by a radiologist, who assesses if the colon has been adequately cleansed of stool during the prep process. After being assisted into a different position, a well-lubricated rectal tube is inserted through the anus. This tube allows the physician or the assisting health care provider to slowly administer the barium into the intestine. While this filling process is closely monitored, the patient must keep the anus tightly contracted against the rectal tube

## KEY TERMS

**Barium sulfate**—A barium compound used during a barium enema to block the passage of x rays during the exam.

**Bowel lumen**—The space within the intestine.

**Colonoscopy**—An examination of the colon performed with a colonoscope.

**Diverticula**—A diverticulum of the colon is a sac or pouch in the colon wall which is usually asymptomatic (without symptoms) but may cause difficulty if it becomes inflamed. Diverticula is the plural of diverticulum.

**Diverticulitis**—A condition of the diverticulum of the intestinal tract, especially in the colon, where inflammation may cause distended sacs extending from the colon and pain.

**Diverticulosis**—The development of diverticula.

**Megacolon**—Abnormally large colon associated with some chronic intestine disorders.

**Proctosigmoidoscopy**—A visual examination of the rectum and sigmoid colon using a sigmoidoscope, also known as sigmoidoscopy.

**Sigmoidoscopy**—Endoscopic examination of the lower colon.

**Ulcerative colitis**—An ulceration or erosion of the lining of the colon.

so that the position is maintained and the barium is prevented from leaking. This step is emphasized to the patient because inaccuracy may occur if the barium leaks. A rectal balloon may also be inflated to help the patient retain the barium. The table may be tilted or the patient may be moved to different positions to aid in the filling process.

As the barium fills the intestine, x rays of the abdomen are taken to distinguish significant findings. There are many ways to perform a barium enema. One way is that shortly after filling, the rectal tube is removed and the patient expels as much of the barium as possible. Alternatively, the tube will remain in place, and the barium will move through that tube. A thin film of barium remains in the intestine, and air is then slowly injected through the rectum and to expand the bowel lumen. Usually no films will be taken until after the air is injected. Multiple films are generally obtained by a radiologist; then, additional films are made by a technologist.



## Preparation

To conduct the most accurate barium enema test, the patient must follow a prescribed diet and bowel preparation instructions prior to the test. This preparation commonly includes restricted intake of dairy products and a liquid diet for 24 hours prior to the test, in addition to drinking large amounts of water or clear liquids 12–24 hours before the test. Patients may also be given **laxatives**, and asked to give themselves a cleansing enema.

In addition to the prescribed diet and bowel preparation prior to the test, the patient can expect the following during a barium enema:

- They will be well draped with a gown as they are placed on a tilting x-ray table.
- As the barium or air is injected into the intestine, they may experience cramping pains or the urge to defecate.
- The patient will be instructed to take slow, deep breaths through the mouth to ease any discomfort.

## Aftercare

Patients should follow several steps immediately after undergoing a barium enema, including:

- Drinking plenty of fluids to help counteract the dehydrating effects of bowel preparation and the test.
- Taking time to rest. A barium enema and the bowel preparation taken before it can be exhausting.
- A cleansing enema may be given to eliminate any remaining barium. Lightly colored stools will be prevalent for the next 24–72 hours following the test.

## Risks

While a barium enema is considered a safe screening test used on a routine basis, it can cause complications in certain people. The following indications should be kept in mind before a barium enema is performed:

- Those who have a rapid heart rate, severe ulcerative colitis, toxic megacolon, or a presumed perforation in the intestine should not undergo a barium enema.
- The test can be performed cautiously if the patient has a blocked intestine, ulcerative colitis, diverticulitis, or severe bloody diarrhea.
- Complications that may be caused by the test include perforation of the colon, water intoxication, barium granulomas (inflamed nodules), and allergic reaction. However, these conditions are all very rare.

## Normal results

When patients undergo single-contrast enemas, their intestines are steadily filled with barium to differentiate markings of the colon markings. Normal results display uniform filling of the colon.

As the barium is expelled, the intestinal walls collapse. A normal result on the x ray after defecation will show the intestinal lining as having a standard, feathery appearance.

The double-contrast enema expands the intestine, which is already lined with a thin layer of barium, using air to display a detailed image of the mucosal pattern. Varying positions taken by the patient allow the barium to collect on the dependent walls of the intestine by way of gravity.

A barium enema allows abnormalities to appear on an x ray that may aid in the diagnosis of several different conditions. Most colon cancers occur in the rectosigmoid region, or on the upper part of the rectum and adjoining portion of the sigmoid colon. However, they can also be detected with a proctosigmoidoscopy (usually referred to as a **sigmoidoscopy**). Further, an enema can identify other early signs of cancer.

Identification of polyps, diverticulosis, and inflammatory disease (such as **diverticulitis** and ulcerative colitis) is attainable through a barium x ray. Some cases of acute appendicitis may also be apparent by viewing this x ray, though acute appendicitis is usually diagnosed clinically, or by CT scan.

## Resources

### BOOKS

### PERIODICALS

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### ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329 4251. (800) 227 2345. <http://www.cancer.org>.

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Barium swallow see **Upper GI exam**

Beating heart surgery see **Minimally invasive heart surgery**

Beclomethasone see **Corticosteroids**

Bedside monitors see **Cardiac monitor**

## Bedsore

### Definition

Bedsore is also called decubitus ulcer, pressure ulcer, or pressure sore. They begin as tender, inflamed patches that develop when a person's weight rests against a hard surface, exerting pressure on the skin and soft tissue over bony parts of the body. For example, bedsore is common when skin covering a weight-bearing part of the body, such as a knee or hip, is pressed between a bone and a bed, chair, another body part, splint, or other hard object. This is most likely to happen when the person is confined to a bed or wheelchair for long periods and is relatively immobile. Usually, mobile individuals receive pain signals from the compressed part of the body and will automatically move to relieve the pressure, thus bedsore does not usually develop in people with normal mobility and mental alertness. However, people compromised through spinal cord injury, acute illness, heavy sedation, unconsciousness, or diminished mental functioning, may not receive signals to move, and as a result of the constant pressure, tissue damage often progresses to bedsore in these individuals.

### Demographics

Each year, about 1.8 million people in the United States develop bedsore at a treatment cost of \$1.3 billion. In 2004, 17,000 lawsuits resulted from treatment related to bedsore. Pressure sores are most common in elderly patients; records show that 70% of all bedsore occur in people over age 70. People who are neurologically impaired, such as those with spinal injuries or paralysis, have a 5–8% chance annually of developing a bedsore. This translates into a 25–85% lifetime risk. Complications from pressure sores are the direct cause of **death** in about 8% of nursing home residents.

The National Pressure Ulcer Advisory Panel (NPUAP) estimates that bedsore afflict:

- 9–13% of all hospital patients
- up to 23.9% of nursing home residents
- at least 60% of elderly individuals with hip and femur (thigh bone) fractures

### Description

Bedsore range from mild inflammation to ulceration (breakdown of tissue) and deep wounds that involve muscle and bone. This painful condition usually starts with shiny red skin that quickly blisters and

## KEY TERMS

**Debridement**—Cutting away tissue from a wound.

**Gangrene**—Tissue death resulting from lack of nutrients and oxygen.

**Inflammation (inflamed)**—Pain, heat, redness, swelling, and reduced function of tissue, often leading to infection.

**Ischemia**—Localized anemia, or lack of blood flow and oxygen delivery to a specific area, such as the skin.

**Soft tissue**—Layers of cells that form the skin.

**Ulceration**—Death of tissue cells in a specific area, such as skin.

deteriorates into open sores. These sores leave the body open to bacterial and fungal contamination and can harbor life-threatening infection. Bedsore are not contagious or cancerous, although the most serious complication of chronic bedsore is the development of malignant degeneration, which is a type of cancer.

Bedsore develop because of pressure that cuts off the flow of blood and oxygen to tissue. Constant pressure pinches off capillaries, the tiny blood vessels that deliver oxygen and nutrients to the skin. If the skin is deprived of oxygen and essential nutrients (a condition known as ischemia) for as little as one hour, tissue cells can die (anoxia) and bedsore can form. Even the slightest rubbing or friction between a hard surface and skin stretched over bones can cause minor pressure ulcers. They can also develop when a patient stretches or bends blood vessels by slipping into a different position in a bed or chair.

Urine, feces, or other moisture increase the risk of skin infection, so people who are incontinent (unable to control bladder or bowel movements), as well as those who are immobile or have nerve damage that prevents them from feeling pain, have a high risk of developing bedsore.

Bedsore are difficult to successfully treat and recurrence is common. People who have experienced bedsore have a 90% chance of developing them again, even when the bedsore have been successfully treated. While mild pressure sores themselves can usually be cured, complications from pressure ulcers are the direct cause of death in about 8% of paraplegic individuals. Pressure sores can be slow to heal, particularly when the patient's overall physical status may

be weakened. Without proper treatment, bedsores can lead to:

- gangrene (tissue death)
- osteomyelitis (infection of the bone beneath the bed sore)
- sepsis (a poisoning of tissue or the whole body from bacterial infection)
- other localized or systemic infections that slow the healing process, increase the cost of treatment, lengthen hospital or nursing home stays, or cause death

About 93% of bedsores develop below the waist. Bedsores are most apt to develop on bony parts of the body, including:

- ankles
- heels
- hips and buttocks
- knees
- lower back
- shoulder blades
- back of the head

Although impaired mobility is a leading factor in the development of pressure sores, the risk is also increased by illnesses and conditions that weaken muscle and soft tissue or that affect blood circulation and the delivery of oxygen to body tissue, leaving skin thinner and more vulnerable to breakdown and subsequent infection. These conditions include:

- atherosclerosis (hardening of arteries) that restricts blood flow
- diabetes
- diminished sensation or lack of feeling or inability to feel pain
- heart problems
- incontinence
- malnutrition
- obesity
- paralysis
- poor circulation
- infection
- prolonged bed rest, especially in unsanitary conditions or with wet or wrinkled sheets
- spinal cord injury

## Diagnosis/Preparation

**Physical examination**, medical history, and patient and caregiver observations are the basis of diagnosis. Special attention must be paid to physical or mental

problems, such as an underlying disease, incontinence, or confusion that could complicate a patient's recovery. Nutritional status and smoking history should also be noted.

The National Pressure Ulcer Advisory Panel recommends classification of bedsores in four stages of ulceration based primarily on the depth of a sore at the time of examination. This helps to create standardized descriptive language and encourages effective communication of medical personnel caring for patients with bedsores. The NPUAP advises that not all bedsores follow the stages directly from I to IV. The four most widely accepted stages are described as:

- Stage I: intact skin with redness (erythema) and sometimes with warmth. In people with dark skin, rather than appearing red, the area may appear blue or purple or sometimes lighter than the rest of the skin.
- Stage II: tissue damage has occurred. The outermost layer of skin has been lost and the sore shows abrasion, swelling, and possible blistering or peeling.
- Stage III: all skin has been lost; damage has reached the tissue below the skin. The bed sore appears as a deep open wound (crater).
- Stage IV: extensive skin loss with damage to the underlying tissue that extends into muscle, bone, tendon, or joint. These bedsores can be fatal.

In addition to observing the depth of the wound, the caregiver should note the presence or absence of wound drainage, foul odors, or any debris in the wound, such as pieces of dead skin tissue or other material. Any condition that could likely contaminate the wound and cause infection, such as the presence of urine or feces from incontinence, should be noted as well.

A physician should be notified whenever a person:

- will be bedridden or immobilized for an extended time period.
- is very weak or unable to move.
- develops redness (inflammation) and warmth or peeling on any area of skin.

Immediate medical attention is required whenever:

- skin turns black or becomes inflamed, tender, swollen, or warm to the touch.
- the patient develops a fever during treatment.
- a bed sore contains pus or has a foul-smelling discharge.

Prompt medical attention can prevent surface pressure sores from deepening into more serious infections. The first step is always to reduce or eliminate the pressure that is causing bedsores. For minor bedsores,

stages I and II, treatment involves relieving pressure, keeping the wound clean and moist, and keeping the area around the ulcer clean and dry. This is often accomplished with saline (salt water) washes and the use of sterile medicated gauze **dressings** that both absorb the wound drainage and fight infection-causing bacteria. **Antiseptics**, harsh soaps, and other skin cleansers can damage new tissue and should be avoided. Only sterile saline solution should be used to cleanse bedsores whenever fresh non-stick dressings are applied.

The patient's doctor may prescribe infection-fighting **antibiotics**, special dressings or drying agents, and/or lotions or ointments to be applied to the wound in a thin film three or four times a day. Warm whirlpool treatments are sometimes recommended for sores on the arm, hand, foot, or leg.

Typically, with the removal or reduction of pressure in conjunction with proper treatment and attention to the patient's general health, including good nutrition, bedsores should begin to heal two to four weeks after treatment begins.

A 2006 peer-reviewed clinical trial of 89 residents in 23 **nursing homes** reinforced the concept that good nutrition will aid in treatment. The trial reported that patients receiving the protein supplement, Pro-Stat, along with standard pressure sore care, showed a 96% improvement in healing over patients receiving a placebo (supplement with no protein) and standard care.

Surgical options are often considered for non-healing wounds. When deep wounds are not responding well to standard medical procedures, consultation with a plastic surgeon may be needed to determine if **reconstructive surgery** is the best possible treatment. In a procedure called debridement, a scalpel may be used to remove dead tissue or other debris from stage III and IV wounds. A surgical procedure called urinary (or fecal) diversion may also be used with incontinent patients to divert the flow of urinary or fecal material. This keeps the wound clean and encourages wound healing. Reconstruction involves the complete removal of the ulcerated area and surrounding damaged tissue (excision), debridement of the bone, and reducing the amount of bacteria in the area with vigorous flushing (lavage) with saline solution. The surgical wound is then drained for a period of days until it is clear that no infection is present and that healing has begun. **Plastic surgery** may follow to close the wound with a flap (skin from another part of the body), providing a new tissue surface over the bone. For surgery to succeed, infection must not be present. High rates of complications tend to occur after reconstructive surgery. These include bleeding under the skin (hematoma), wound infection, and the recurrence of pressure

sores. Infection in deep wounds can progress to life-threatening systemic infection. **Amputation** may be required when a wound will not heal or when reconstructive surgery is not an option for a particular patient.

## Alternatives

Zinc and vitamins A, C, E, and B complex provide necessary nutrients for the skin and help it to repair injuries and stay healthy. Large doses of vitamins or minerals should not be used without a doctor's approval.

A poultice made of equal parts of powdered slippery elm (*Ulmus fulva*), marsh mallow (*Althaea officinalis*), and echinacea blended with a small amount of hot water can relieve minor inflammation. An infection-fighting rinse of two drops of essential tea tree oil (*Melaleuca*) to every 8 oz (0.23 g) of water can also be administered. An herbal tea made from calendula (*Calendula officinalis*) is also an effective antiseptic and wound-healing agent. Calendula cream can also be used.

Contrasting hot and cold compresses applied to the bedsore site can increase circulation to the area and help flush out waste products, speeding the healing process. The temperatures should be extreme (very hot and ice cold), yet tolerable to the skin. Hot compresses should be applied for three minutes, followed by 30 seconds of cold compress application, repeating the cycle three times. The cycle should always end with a cold compress.

## Prevention

It is easier to prevent bedsores from developing than to cure them once they have occurred. Good nutrition plays an important role in keeping the skin intact and in promoting wound healing; the diet of bedridden individuals should not be ignored. All patients recovering from illness or surgery or confined to a bed or wheelchair long term should be inspected at least daily, but preferably more often. They should be bathed or should shower every day using warm water and mild soap, and should avoid cold or dry air. Bedridden patients who are either mentally unaware or physically unable to turn themselves must be repositioned regularly by caregivers at minimum once every two hours while awake and preferably more frequently. People who use a wheelchair should be encouraged to shift their weight every 10–15 minutes or be repositioned by caregivers at least once an hour.

It is important to lift, rather than to drag, a person being repositioned. Bony parts of the body should not



be massaged. Even slight friction can remove the weakened top layer of skin and damage blood vessels beneath it. Sensitive body parts can be protected by:

- sheepskin pads
- special cushions placed on top of a mattress
- a water-filled mattress
- a variable-pressure mattress with individually inflatable sections to redistribute pressure

Pillows or foam wedges can prevent the ankles of a bedridden patient from rubbing on each other, and pillows placed under the legs from mid-calf to ankle can raise the heels off the bed. Raising the head of the bed slightly and briefly can provide relief, but raising the head of the bed more than 30° can cause the patient to slide, thereby causing damage to skin and tiny blood vessels.

A person who uses a wheelchair should be encouraged to sit up as straight as possible. Pillows behind the head and between the legs can help prevent bedsores, as can a special cushion placed on the chair seat. Donut-shaped cushions should not be used because they restrict blood flow and cause tissues to swell.

Special support surfaces are manufactured and readily available for care in medical facilities or at home, including air-filled mattresses and cushions, low-air loss beds, and air-fluidized beds. These devices give adequate support while reducing pressure on vulnerable skin. They have been shown to exert less pressure on the skin of compromised patients than do regular mattresses. Patients using these devices and beds must still be repositioned every two hours.

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Betamethasone see **Corticosteroids**

Bicarbonate test see **Electrolyte tests**

Bile duct stone removal see **Endoscopic retrograde cholangiopancreatography**

## Biliary stenting

### Definition

A biliary stent is a plastic or metal tube that is inserted into a bile duct to relieve narrowing of the duct (also called bile duct stricture).

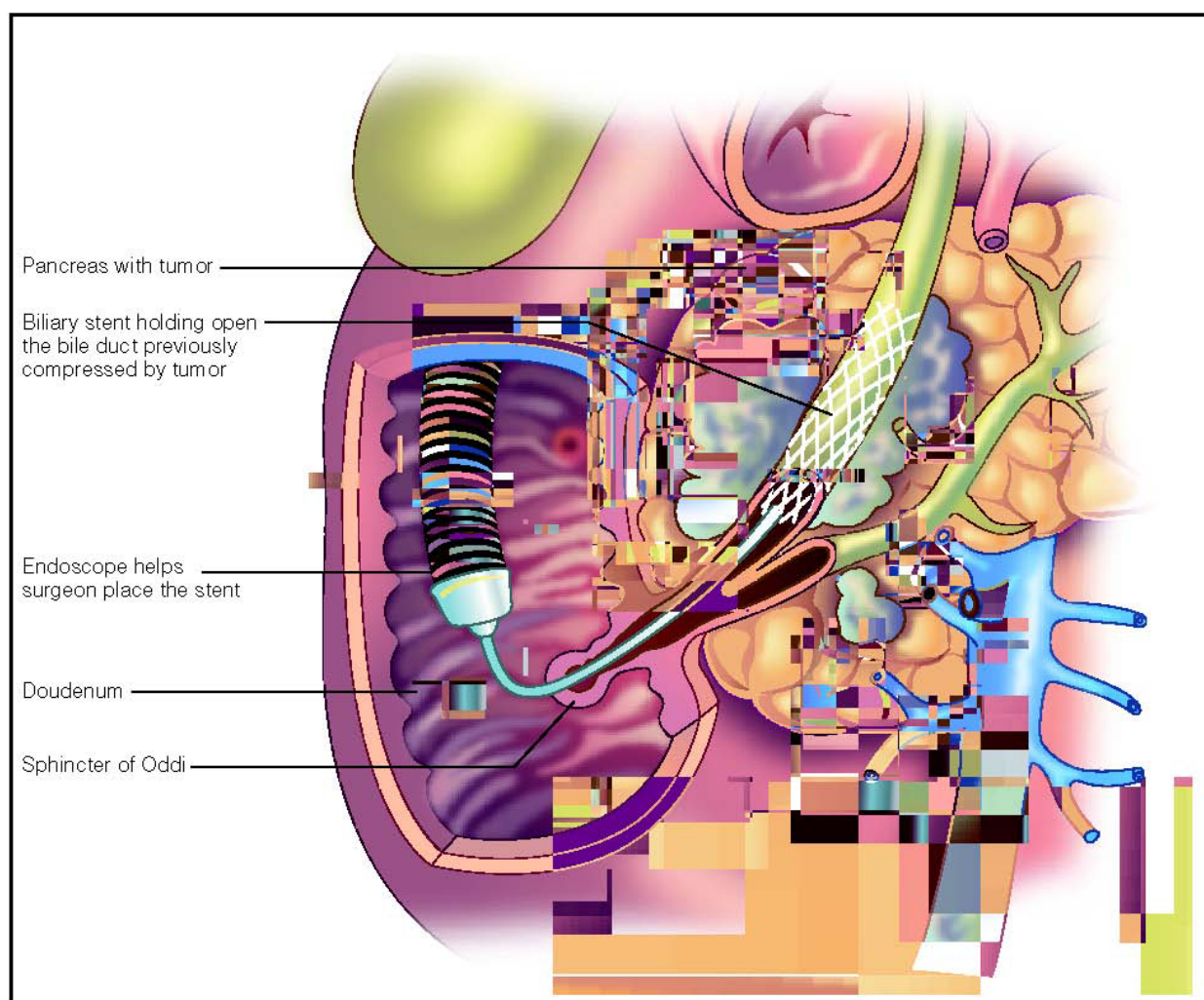
### Purpose

Biliary stenting is used to treat obstructions that occur in the bile ducts. Bile is a substance that helps to digest fats and is produced by the liver, secreted through the bile ducts, and stored in the gallbladder. It is released into the small intestine after a fat-containing meal has been eaten. The release of bile is controlled by a muscle called the sphincter of Oddi found at the junction of the bile ducts and the small intestine.

There are a number of conditions, malignant or benign, that can cause strictures of the bile duct. Pancreatic cancer is the most common malignant cause, followed by cancers of the gallbladder, bile duct, liver, and large intestine. Noncancerous causes of bile duct stricture include:

- injury to the bile ducts during surgery for gallbladder removal (accounting for 80% of nonmalignant strictures)
- pancreatitis (inflammation of the pancreas)
- primary sclerosing cholangitis (an inflammation of the bile ducts that may cause pain, jaundice, itching, or other symptoms)
- gallstones
- radiation therapy
- blunt trauma to the abdomen





(Illustration by Electronic Illustrators Group.)

## Demographics

The overall incidence of bile duct stricture is not known. Approximately 0.2–0.5% of patients undergoing gallbladder surgery or other operations affecting the bile duct develop biliary stricture.

## Description

A biliary stent is a thin, tube-like structure that is used to support a narrowed part of the bile duct and prevent the reformation of the stricture. Stents may be made of plastic or metal. The two most common methods that are used to place a biliary stent are **endoscopic retrograde cholangiopancreatography** (ERCP) and percutaneous transhepatic cholangiography (PTC).

## ERCP

ERCP is an imaging technique used to diagnose diseases of the pancreas, liver, gallbladder, and bile ducts that also has the advantage of being used as a therapeutic device. The endoscope (a thin, lighted, hollow tube attached to a viewing screen) is inserted into a patient's mouth, down the esophagus, through the stomach, and into the upper part of the small intestine, until it reaches the spot where the bile ducts empty. At this point a small tube called a cannula is inserted through the endoscope and used to inject a contrast dye into the ducts; the term retrograde refers to the backward direction of the dye. A series of x rays are then taken as the dye moves through the ducts.

If the x rays show that a biliary stricture exists, a stent may be placed into a duct to relieve the obstruction.

## KEY TERMS

**Hepatic duct**—A duct that carries bile from the liver.

**Intestinal perforation**—A hole in the intestinal wall.

**Pancreas**—An organ that secretes pancreatic juice into the upper part of the intestine; pancreatic juice is composed of specialized proteins that help to digest fats, proteins, and carbohydrates.

In order to do this, special instruments are inserted into the endoscope and a sphincterotomy (a cut into the sphincter of Oddi) is performed to provide access to the bile ducts. In some cases, the biliary stricture may first be dilated (expanded) using a thin, flexible tube called a catheter, followed by a balloon-type device that is inflated. The stent is then inserted into the bile duct.

### PTC

PTC is similar to ERCP in that the test is used to diagnose and treat obstructions affecting the flow of bile from the liver to the gastrointestinal tract. The procedure is generally reserved for patients who have undergone unsuccessful ERCP. A thin needle is used to inject a contrast dye through the skin and into the liver or gallbladder; x rays are taken while the dye moves through the bile ducts. If a biliary stricture becomes evident, a stent may then be placed. A hollow needle is introduced into the bile duct, and a thin guide wire inserted into the needle. The wire is guided to the area of obstruction; the stent is advanced over the wire and placed in the obstructed duct.

### Diagnosis/Preparation

Prior to ERCP or PTC, the patient will be instructed to refrain from eating or drinking for at least six hours to ensure that the stomach and upper part of the intestine are free of food. The physician should be notified as to what medications the patient takes and if the patient has an allergy to iodine, which is found in the contrast dye. **Antibiotics** will be started prior to surgery and continued for several days afterward.

### Aftercare

After the procedure, the patient is monitored for signs of complications. In the case of ERCP, the patient generally remains at the hospital or outpatient facility until the effects of the sedative wear off and to ensure no complications occur. After PTC, the patient is instructed to lie on his or her right side for at least six

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Biliary stenting is usually performed in the x-ray department of a hospital or outpatient facility in consultation with a general surgeon, a gastroenterologist (a medical doctor who specializes in the diagnosis and treatment of diseases of the digestive system), and/or an interventional radiologist (a medical doctor who specializes in the treatment of medical disorders using specialized imaging techniques).

hours to reduce the risk of bleeding from the injection site. To ensure that the stent is functioning properly, the patient will be frequently assessed for symptoms that indicate the recurrence of biliary stricture. These symptoms include changes in stool or urine color, jaundice (yellowing of the skin), itching, and abnormal **liver function tests**.

### Risks

Complications associated with ERCP include excessive bleeding, infection, pancreatitis, cholangitis (inflammation of the bile ducts), cholecystitis (inflammation of the gallbladder), and injury to the intestine. PTC may result in bleeding, infection of the injection site, sepsis (spread of infection to the blood), or leakage of the dye into the abdomen. Complications specific to the stent include migration (movement of the stent out of the area in which it was placed), occlusion (blockage), and intestinal perforation.

### Normal results

In more than 90% of patients, the placement of a biliary stent relieves the obstruction and allows the bile duct to drain properly.

### Morbidity and mortality rates

The rate of serious complications with ERCP is approximately 11%, and 5–10% with PTC. Stent occlusion occurs in up to 25% of patients, and stent migration in up to 6%. Recurrence of biliary stricture occurs in 15–45% of patients after an average time of four to nine years.

### Alternatives

The major alternative to biliary stenting is surgical repair of the stricture. The most common method is resection (removal) of the narrowed area followed by

## QUESTIONS TO ASK THE DOCTOR

- Why is biliary stenting recommended in my case?
- What diagnostic tests will be performed prior to the stenting procedure?
- What technique will be used to place the stent?
- What type of stent will be used and how long should it last?
- Is surgical repair of the stricture a better alternative?

the creation of a connection between the bile duct and the middle portion of the small intestine (called a choledochojejunostomy) or the hepatic duct and the small intestine (called a hepaticojejunostomy). Surgical stricture repair results in a cure for 85–98% of patients and is associated with a low risk of complications.

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- American Society for Gastrointestinal Endoscopy. 1520 Kensington Rd., Suite 202, Oak Brook, IL 60523. (630) 573 0600. <http://www.asge.org>.
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Biliopancreatic diversion see **Gastric bypass**

Bilirubin test see **Liver function tests**

## Biofeedback

### Definition

Biofeedback, or applied psychophysiological feedback, is a patient-guided treatment that teaches an individual to control muscle tension, pain, **body temperature**, brain waves, and other bodily functions and processes through relaxation, visualization, and other cognitive control techniques. The name biofeedback refers to the biological signals that are fed back, or returned, to the patient in order for the patient to develop techniques of manipulating them.

### Purpose

Biofeedback has been used to successfully treat a number of disorders and their symptoms, including temporomandibular joint disorder (TMJ), chronic pain, irritable bowel syndrome (IBS), Raynaud's syndrome, epilepsy, attention-deficit hyperactivity disorder (ADHD), migraine headaches, anxiety, depression, traumatic brain injury, and sleep disorders.

Illnesses that may be triggered at least in part by stress are also targeted by biofeedback therapy. Certain types of headaches, high blood pressure, bruxism (teeth grinding), post-traumatic stress disorder, eating disorders, substance abuse, and some anxiety disorders may be treated successfully by teaching patients the ability to relax and release both muscle and mental tension. Biofeedback is often just one part of a comprehensive treatment program for some of these disorders.

The U.S. National Aeronautics and Space Administration (NASA) has used biofeedback techniques to treat astronauts who suffer from severe space sickness, during which the autonomic nervous system is disrupted. Scientists at the University of Tennessee have adapted these techniques to treat individuals suffering from severe nausea and vomiting that is also rooted in autonomic nervous system dysfunction.

Recent research also indicates that biofeedback may be a useful tool in helping patients with urinary incontinence regain bladder control. Individuals learning pelvic-floor muscle strengthening exercises can gain better control over these muscles by using biofeedback. Sensors are placed on the muscles to help the patient learn where they are and when proper contractions are taking place.

## Description

### Origins

In 1961, Neal Miller, an experimental psychologist, suggested that autonomic nervous system responses (for instance, heart rate, blood pressure, gastrointestinal activity, regional blood flow) could be under voluntary control. As a result of his experiments, he showed that such autonomic processes were controllable. This work led to the creation of biofeedback therapy. Miller's work was expanded by other researchers. Research performed in the 1970s by UCLA researcher Dr. Barry Sterman established that both cats and monkeys could be trained to control their brain wave patterns. Sterman then used his research techniques on human patients with epilepsy; he was able to reduce seizures by 60% with the use of biofeedback techniques. Throughout the 1970s, other researchers published reports of their use of biofeedback in the treatment of cardiac arrhythmias, headaches, Raynaud's syndrome, excess stomach acid, and as a tool for teaching deep relaxation. Since the early work of Miller and Sterman, biofeedback has developed into a front-line behavioral treatment for an even wider range of disorders and symptoms.

During biofeedback, special sensors are placed on the body. These sensors measure the bodily function that is causing the patient problem symptoms, such as heart rate, blood pressure, muscle tension (EMG or electromyographic feedback), brain waves (EEG or electroencephalographic feedback), respiration, and body temperature (thermal feedback), and translates the information into a visual and/or audible readout, such as a paper tracing, a light display, or a series of beeps.

While the patient views the instantaneous feedback from the biofeedback monitors, he or she begins to recognize what thoughts, fears, and mental images influence his or her physical reactions. By monitoring this relationship between mind and body, the patient can then use these same thoughts and mental images as subtle cues, as these act as reminders to become deeply relaxed, instead of anxious. These reminders also work to manipulate heart beat, brain wave patterns, body temperature, and other bodily functions. This is achieved through relaxation exercises, mental imagery, and other cognitive therapy techniques.

As the biofeedback response takes place, patients can actually see or hear the results of their efforts instantly through the sensor readout on the biofeedback equipment. Once these techniques are learned and the patient is able to recognize the state of

relaxation or visualization necessary to alleviate symptoms, the biofeedback equipment itself is no longer needed. The patient then has a powerful, portable, and self-administered treatment tool to deal with problem symptoms.

Biofeedback that specializes in reading and altering brain waves is sometimes called neurofeedback. The brain produces four distinct types of brain waves—beta, alpha, theta, and delta—that all operate at a different frequency. Delta, the slowest frequency wave, is the brain wave pattern associated with deep sleep. Beta waves, the fastest frequency wave, occur in a normal, waking state and can range from 12–35 Hertz (Hz). Problems begin to develop when beta wave averages fall in the low end (underarousal) or the high end (overarousal) of that spectrum. Underarousal might be present in conditions such as depression or attention deficit disorder, and overarousal may be indicative of an anxiety disorder, obsessive compulsive disorder, or excessive stress. Beta wave neurofeedback focuses on normalizing that beta wave pattern to an optimum value of around 14 Hz. A second type of neurofeedback, alpha-theta, focuses on developing the more relaxing alpha (8–13 Hz) and theta waves (4–9 Hz) that are usually associated with deep, meditative states, and has been used with some success in substance abuse treatment.

Through brain-wave manipulation, neurofeedback can be useful in treating a variety of disorders that are suspected or proven to impact brain-wave patterns, such as epilepsy, attention deficit disorder, migraine headaches, anxiety, depression, traumatic brain injury, and sleep disorders. The equipment used for neurofeedback usually uses a monitor as an output device. The monitor displays specific patterns that the patient attempts to change by producing the appropriate type of brain wave. Or, the monitor may reward the patient for producing the appropriate brain wave by producing a positive reinforcer, or reward. For example, children may be rewarded with a series of successful moves in a displayed video game.

Depending on the type of biofeedback, individuals may need up to 30 sessions with a trained professional to learn the techniques required to control their symptoms on a long-term basis. Therapists usually recommend that their patients practice both biofeedback and relaxation techniques on their own at home.

### Preparations

Before initiating biofeedback treatment, the therapist and patient will have an initial consultation to



record the patient's medical history and treatment background and discuss goals for therapy.

Before a neurofeedback session, an EEG is taken to determine the patient's baseline brainwave pattern.

Biofeedback typically is performed in a quiet and relaxed atmosphere with comfortable seating for the patient. Depending on the type and goals of biofeedback being performed, one or more sensors will be attached to the patient's body with conductive gel and/or adhesives. These may include:

- **Electromyographic (EMG) sensors**—EMG sensors measure electrical activity in the muscles, specifically muscle tension. In treating TMJ or bruxism, these sensors would be placed along the muscles of the jaw. Chronic pain might be treated by monitoring electrical energy in other muscle groups.
- **Galvanic skin response (GSR) sensors**—These are electrodes placed on the fingers that monitor perspiration, or sweat gland, activity. These may also be called skin conductance level (SCL).
- **Temperature sensors**—Temperature, or thermal, sensors measure body temperature and changes in blood flow.
- **Electroencephalography (EEG) sensors**—These electrodes are applied to the scalp to measure the electrical activity of the brain, or brain waves.
- **Heart rate sensors**—A pulse monitor placed on the finger tip can monitor pulse rate.
- **Respiratory sensors**—Respiratory sensors monitor oxygen intake and carbon dioxide output.

### Precautions

Individuals who use a pacemaker or other implantable electrical devices should inform their biofeedback therapist before starting treatments, as certain types of biofeedback sensors have the potential to interfere with these devices.

Biofeedback may not be suitable for some patients. Patients must be willing to take a very active role in the treatment process. And because biofeedback focuses strictly on behavioral change, those patients who wish to gain insight into their symptoms by examining their past might be better served by psychodynamic therapy.

Biofeedback may also be inappropriate for cognitively impaired individuals, such as those patients with organic brain disease or a traumatic brain injury, depending on their function level.

Patients with specific pain symptoms of unknown origin should undergo a thorough medical examination before starting biofeedback treatments to rule out any

serious underlying disease. Once a diagnosis has been made, biofeedback can be used concurrently with conventional treatment.

Biofeedback may only be one component of a comprehensive treatment plan. For illnesses and symptoms that are manifested from an organic disease process, such as cancer or diabetes, biofeedback should be an adjunct to (complementary to), and not a replacement for, conventional medical treatment.

### Side effects

There are no known side effects to properly administered biofeedback or neurofeedback sessions.

### Research and general acceptance

Preliminary research published in late 1999 indicated that neurofeedback may be a promising new tool in the treatment of schizophrenia. Researchers reported that schizophrenic patients had used neurofeedback to simulate brain wave patterns that antipsychotic medications produce in the brain. Further research is needed to determine what impact this may have on treatment for schizophrenia.

The use of biofeedback techniques to treat an array of disorders has been extensively described in the medical literature. Controlled studies for some applications are limited, such as for the treatment of menopausal symptoms and premenstrual disorder (PMS). There is also some debate over the effectiveness of biofeedback in ADHD treatment, and the lack of controlled studies on that application. While many therapists, counselors, and mental health professionals have reported great success with treating their ADHD patients with neurofeedback techniques, some critics attribute this positive therapeutic impact to a placebo effect.

There is also some debate among mental health professionals as to whether biofeedback should be considered a first line treatment for some mental illnesses, and to what degree other treatments, such as medication, should be employed as an adjunct therapy.

### Interactions

There are no known interactions with biofeedback.

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#### ORGANIZATIONS

Association for Applied Psychotherapy and Biofeedback, 10200 W. 44th Avenue, Suite 304, Wheat Ridge, CO, 80033, (303) 422 8436, <http://www.aapb.org>.

Biofeedback Certification Institute of America, 10200 W. 44th Avenue, Suite 310, Wheat Ridge, CO, 80033, (303) 420 2902, <http://www.bcia.org>.

L. Fleming Fallon, Jr., M.D., Dr.P.H.

Birthmark excision see **Hemangioma excision**

## Bispectral index

### Definition

The bispectral index (BIS) is one of several systems used in anesthesiology as of 2003 to measure the effects of specific anesthetic drugs on the brain and to track changes in the patient's level of sedation or hypnosis. In technical terms, the bispectral index itself is a complex mathematical algorithm that allows a computer inside an anesthesia monitor to analyze data from a patient's electroencephalogram (EEG) during surgery. BIS, which has been in use since 1997, is a type of automated direct measurement of the patient's condition, in comparison to the Glasgow Coma Scale and similar scoring systems, which are indirect assessments of sedation.

### Purpose

#### Anesthetic depth

A brief discussion of anesthetic depth may be helpful in understanding people's interest in monitoring the brain's responses to anesthesia. Ever since the first modern anesthetics (ether, chloroform, and nitrous oxide) were used in the 1840s, doctors have been searching for a reliable method of measuring the depth of the patient's unconsciousness in order to guarantee the safety as well as the painlessness of surgery. Anesthetic drugs, whether inhaled or given intravenously, are toxic in high doses; too high a dose can stop the patient's breathing. On the other hand, too small a dose can result in the patient's coming to various degrees of awareness during surgery. Events of this type occur frequently enough to be publicized in general medical news sources as well as the professional literature. One Australian medical journal reports that postoperative recall of operations, including the patient's overhearing conversations among members of the **surgical team** as well as feeling helpless and experiencing physical pain, occurs in one of every 1,000 patients undergoing non-cardiac surgery and three of every 1,000 cardiac patients. An Israeli researcher gives the rate of accidental awareness during surgery as between 0.2% and 1.2% of patients. According to an American news account, "An estimated 40,000 to 200,000 mid-operative awakenings may occur each year in the United States alone." Research has indicated that patients' attitudes toward undergoing surgery are affected by the possibility of awakening during the procedure. A group of Australian researchers found that 56% of a group of 200 patients awaiting surgery had heard about awareness

during operations, mostly from the mass media; 42.5% of the group expressed anxiety about it. Post-traumatic stress disorder (PTSD) is a common result of awareness episodes; a 2001 study done at Boston University reported that 56.3% of a group of patients who had awakened during surgery met the diagnostic criteria for PTSD—as late as 17 years after their operation.

There are several reasons for anesthesiologists' difficulty in evaluating dosages of anesthetic agents:

- The lack of a universally accepted definition of “consciousness.” There are a number of scientific periodicals devoted solely to the study of human consciousness, as it concerns philosophers, psychologists, psychiatrists, and lawyers, as well as doctors involved in anesthesiology and critical care medicine. Some researchers emphasize the emotional or psychological dimensions of consciousness while others focus on physiological definitions—for example, the response of skin or muscle tissue to painful stimuli.
- The complex effects of anesthesia on the human organism. Scholarly debates about the nature of human consciousness are reflected in the variety of different goals that surgical anesthesia is expected to achieve. These goals are usually listed as blocking the nervous system's responses to pain (analgesia), inducing muscular relaxation and blocking reflexes (areflexia), keeping the patient asleep during the procedure (hypnosis), and preventing conscious recall of the procedure afterwards (amnesia). It is not always possible, however, to meet all four goals with the same degree of accuracy, since some patients suffer from health conditions that require the anesthesiologist to keep them under lighter sedation in order to lower the risk of heart or circulation problems.
- The increased use of combinations of anesthetic agents rather than single drugs. At present, anesthesiologists rarely use inhaled anesthetics by themselves; most prefer what is known as balanced anesthesia, which combines inhaled and intravenous anesthetics. When different agents are used together, however, they are often synergistic, which means that they intensify each other's effects. This characteristic makes it more difficult for the anesthesiologist to predict how much of each drug will be needed during the operation.
- Changes in the patient's response to anesthesia over the course of the operation.
- Age- and sex-related differences in responsiveness to specific anesthetics. Anesthesiologists have become increasingly aware of the special needs of elderly patients, for example; they are more likely than

younger patients to develop cardiovascular complications under anesthesia. With regard to sex, several studies have reported that women appear to emerge from anesthesia more rapidly than men after standardized anesthetic administration with the same agents.

- Large differences among individuals apart from age or sex groupings in regard to sensitivity to anesthesia.

### *Indirect measurements of consciousness*

Indirect methods that allow an observer to assess a person's level of awareness have been used since the early 1970s. The earliest and most widely used instrument for evaluating impaired consciousness is the Glasgow Coma Scale (GCS), first published in the *Lancet* in 1974. The GCS evaluates the patient's responsiveness under three headings: eye response (four levels of responsiveness), verbal response (five levels), and motor (movement) response (six levels). A normally conscious individual would score 15, the maximum score. In practice, however, the total score on the GCS is usually broken down into three subscores for the three types of response measured; thus E2V2M3 would represent a total GCS score of 7. Total scores on the Glasgow Coma Scale are interpreted as follows: 13–14 indicates mild impairment of consciousness; 9–12 indicates moderate impairment; 8 or lower indicates coma.

There are about a dozen other scales that have been devised to measure consciousness in addition to the GCS; the two that are the most important in this context are the Ramsay Sedation Score, first published in 1974 as a measurement of sedation in patients receiving intravenous sedatives prior to surgery; and the Observer's Assessment of Alertness/Sedation Scale (OAA/SS), first used in 1990 for the same purpose as the Ramsay. These two instruments are significant because they are commonly used in research evaluations of the bispectral index and similar monitoring systems. The Ramsay Score is a six-point scale ranging from one (“patient agitated or restless”) through six (“patient asleep; has no response to firm nailbed pressure or other noxious stimuli”). A score of 1 indicates inadequate sedation; 2–4, an acceptable level of sedation; and 5–6, oversedation.

The OAA/SS resembles the Glasgow Coma Scale in that it evaluates different categories of responsiveness, although the categories are different. The OAA/SS measures the patient's responsiveness to his or her name, quality of speech, degree of facial relaxation, and ability to focus the eyes.

## KEY TERMS

**Algorithm**—A procedure or formula for solving a problem. It is often used to refer to a sequence of steps used to program a computer to solve a specific problem.

**Analgesia**—Absence of the ability to feel pain. The term is also sometimes used to refer to pain relief without loss of consciousness. An analgesic is a drug that is given to relieve pain.

**Anesthesia**—Loss of the ability to feel pain, brought about by administration of a drug or such other medical interventions as hypnosis or acupuncture.

**Anesthesiology**—The branch of medicine that specializes in the study of anesthetic agents, their effects on patients, and their proper use and administration.

**Areflexia**—A condition in which the body's normal reflexes are absent. It is one of the objectives of general anesthesia.

**Balanced anesthesia**—The use of a combination of inhaled and intravenous drugs in anesthetizing patients.

**Coma**—A state of unconsciousness from which a person cannot be aroused, even by strong or painful stimuli.

**Electroencephalogram (EEG)**—A recording of the electrical activity of the nerve cells in the brain. The first such recording was made in 1929 by Hans Berger, an Austrian psychiatrist.

**Hemodynamics**—Measurement of the movements involved in the circulation of the blood; it usually includes blood pressure and heart rate.

**Hypnosis**—The term is used to refer to a specific verbal technique for refocusing a person's attention in order to change their perceptions, judgment, control of movements, and memory. A hypnotic medication is one that induces sleep.

**Proprietary**—Referring to a drug, device, or formula that is secret or sold only by the holder of the patent, trademark, or copyright. The algorithm used in BIS systems is proprietary information.

**Sedation**—A condition of calm or relaxation, brought about by the use of a drug or medication.

**Sequela (plural, sequelae)**—An abnormal condition or event resulting from a previous disease or disorder.

**Synergistic**—Enhancing the effects of another drug. Anesthetics given in combination are often synergistic.

### *Direct measurements of consciousness*

A variety of different physiological responses have been used in attempts to measure the depth of a patient's unconsciousness under anesthesia. Most anesthesiologists use hemodynamic responses—the patient's blood pressure and heart rate—as basic guidelines for adjusting the amount of anesthetic delivered to the patient during surgery. Other direct measurements have been based on movements of the patient's body during surgery, hormonal responses, sweating, eye movement, and the reactivity of the eyes to light. One difficulty that has emerged from these attempts at direct measurement is that they are not good predictors of the likelihood of awareness during surgery or recall of the procedure after surgery.

Another measurement that researchers have explored in their attempts to measure depth of anesthesia directly is the electroencephalogram, or EEG. The EEG is a complex recording of the electrical activity of the nerve cells in the brain. The first published paper on the EEG was written in 1929 by Dr. Hans Berger, an Austrian psychiatrist, on 73 recordings of

brain waves using his son Klaus as the subject. Berger was the first to distinguish between alpha and beta brain waves, and to use the term EEG to describe the technique of **electroencephalography**. In 1931 Berger discovered that brain waves change in amplitude and frequency when a person is asleep or anesthetized; they slow down, shift to lower frequencies, and become more closely synchronized with one another. He also noted that such diseases as multiple sclerosis and Alzheimer disease affect a person's EEG.

Several attempts were made in the late 1980s and early 1990s to make use of what is known about changes in the EEG in order to monitor anesthetic depth. One attempt is known as spectral edge frequency, or SEF. SEF is the frequency just above 95% of the total power spectrum of electrical energy recorded on an EEG. It was thought that the spectral edge frequency would be useful in guiding adjustments of anesthetics administered during surgery. Unfortunately, SEF is difficult to use with balanced anesthesia; it is also difficult to correlate with such other measures of anesthetic depth as movement or memory of the

procedure. Another method that has been tried is median frequency, which is based on the median frequency of the complex EEG electrical signal at any given moment. This method proved to have the same drawbacks as spectral edge frequency. The bispectral index can be understood historically as a slightly later and more sophisticated attempt to use EEG signals to monitor patients' responses to anesthesia.

### *Development of the bispectral index*

The bispectral index was first developed in the early 1990s by applying bispectral analysis to EEG recordings. Bispectral analysis is a method of analyzing the mathematical relationships among the various components of an EEG signal (phase couplings) as well as measuring amplitudes and frequencies. To compile a database for the index, researchers recorded EEGs from several thousand patients and volunteers anesthetized with a range of commonly used anesthetics and anesthetic combinations. Each subject's depth of unconsciousness was evaluated on the basis of a modified version of the OAA/SS described earlier (in the volunteers) or the amount of drug concentration in blood serum (in the patients). Segments of the recorded EEGs were used to draw up a set of EEG features that were then tested for their ability to distinguish between different levels of sedation or unconsciousness. The index that resulted from this process was then tested on different EEG recordings from the researchers' larger database. It is scaled from 100 to 0 so that the BIS value decreases linearly with increasing doses of anesthesia.

It should be noted that the bispectral index is a work in progress. As new anesthetic agents are developed and used, the BIS algorithm is continually retested and refined. In addition, the algorithm is proprietary information, which means that it is kept secret by the company that developed it.

### **Description**

When a patient is brought into the **operating room**, special BIS sensors are applied to his or her forehead. No additional gels or electrodes are required. The anesthesiologist can attach the sensors to the patient in less than 30 seconds, since preparing the patient's skin requires no more than an alcohol wipe to provide good electrical contact. The BIS system itself is integrated into patient monitoring devices produced by a number of different manufacturers that use enhanced EEG monitors. The BIS system displays both raw data from the EEG and a single number between 100 (indicating an awake patient) and 0

(indicating the absence of brain activity) that represents the patient's degree of sedation. The target number for most anesthetized patients is between 50 and 60.

## **Results**

### *Current applications of BIS*

BIS is presently used in intensive care units (ICUs) and some emergency departments as well as in operating rooms. According to company information, the bispectral index is used in about 26% of all hospital operating rooms in the United States as of late 2002. It is claimed that BIS reduces the risk of patient awareness during surgery as well as lowering hospital costs by speeding patient recovery and reducing the overuse of anesthetic agents.

### *Limitations of BIS*

As of 2003, published studies of the bispectral index and other anesthetic monitoring systems presently available indicate that none of them can be considered a "gold standard" for preventing instances of patient awareness under anesthesia or for predicting the depth of anesthesia in a specific patient. Researchers have noted several specific limitations of the BIS system:

- BIS values are affected by the choice of anesthetic agent. This finding means that a patient with a BIS score of 60 anesthetized with one combination of agents may be more deeply sedated than another patient with the same score but anesthetized with a different combination of drugs. In addition, the BIS monitor appears unable to accurately track changes in consciousness produced by certain anesthetics, specifically ketamine and nitrous oxide.
- The changes in the BIS algorithm resulting from updating and refinement of the producer's database make it difficult to compare results obtained by different investigators using different versions of the BIS monitor. This fact also leaves hospital-based anesthesiologists uncertain as to whether findings based on earlier versions of the BIS system are still valid.
- BIS values are difficult to correlate with other measurements of anesthetic depth or altered consciousness. One group of Norwegian researchers found that BIS values had little relationship to serum blood concentrations of anesthetic agents. Other researchers in the United States have found that BIS scores showed wide variability when compared with Glasgow Coma Scores for emergency room patients.



- Standard BIS scores are not useful in monitoring special patient populations, particularly critically ill patients with unstable body temperatures and patients with dementia.

## Alternatives

Other anesthesia monitoring systems that are in use as of 2003 include the Patient State Analyzer, or PSA 4000, which is also based on EEG data; and the A-Line (R) monitor, which processes signals derived from auditory stimuli. Current opinion among anesthesiologists appears to be that none of the present monitoring systems are sufficiently sensitive to guarantee that patients will not awaken during surgery while simultaneously preventing undesirable cardiovascular reactions, other stress responses, or overuse of anesthetic agents.

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- American Academy of Emergency Medicine (AAEM). 611 East Wells Street, Milwaukee, WI 53202. (800) 884 2236. <http://www.aaem.org>.
- American Association of Nurse Anesthetists (AANA). 222 South Prospect Avenue, Park Ridge, IL 60068 4001. (847) 692 7050. <http://www.aana.com>.
- American Society of Anesthesiologists (ASA). 520 N. Northwest Highway, Park Ridge, IL 60068 2573. (847) 825 5586. <http://www.asahq.org>.
- American Society of Perianesthesia Nurses (ASPAN). 10 Melrose Avenue, Suite 110, Cherry Hill, NJ 08003. (877) 737 9696 or (856) 616 9600. <http://www.aspan.org>.
- Center for Emergency Medicine. 230 McKee Place, Suite 500, Pittsburgh, PA 15213. (412) 647 5300. <http://www.centerem.com>.
- Society for Technology in Anesthesia (STA). PMB 300, 223 North Guadalupe, Santa Fe, NM 87501. (505) 983 4923. <http://www.anestech.org>.



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Rebecca Frey, PhD

## Bladder augmentation

### Definition

Bladder augmentation, also known as augmentation cystoplasty, is **reconstructive surgery** to increase the reservoir capacity of the bladder. The procedure is very common and involves tissue grafts (anastomosis) from a section of the small intestine (bowel), stomach, or other substitutes that are attached to the urinary bladder by sewing or stapling. Whether due to chronic obstructive bladder damage, birth defects that resulted in small reservoir capacity, or dysfunction due to nerve innervation of the bladder muscle (sphincter), surgery is chosen only after a thorough medical work-up that involves assessment of the lower urinary tract, functional physiological evaluation, and anatomic assessment. Some laparoscopic methods (surgery with a fiber-optic instrument inserted through the abdomen) of bladder augmentation have been tried, but reports indicate that these are technically arduous and may not have the long-lasting effects of open surgery.

### Purpose

Bladder dysfunction and incontinence may be due to problems with the reservoir capacity of the bladder or with the “gatekeeping” muscle (the sphincter), which, instructed by the brain, allows urine to build up or to be released. Bladder augmentation is used to treat serious and irreversible forms of incontinence and to protect the upper urinary tract (kidney function) from reflexia (urine back up to the kidneys).

Many candidates for the surgery are highly compromised individuals with other serious conditions like spinal cord injuries and multiple sclerosis, as well as patients likely to undergo **kidney transplantation**. Patients who undergo bladder augmentation must be free of bowel and urethral disease and be able to perform self-catheterization (place a urinary tube into their urethra).

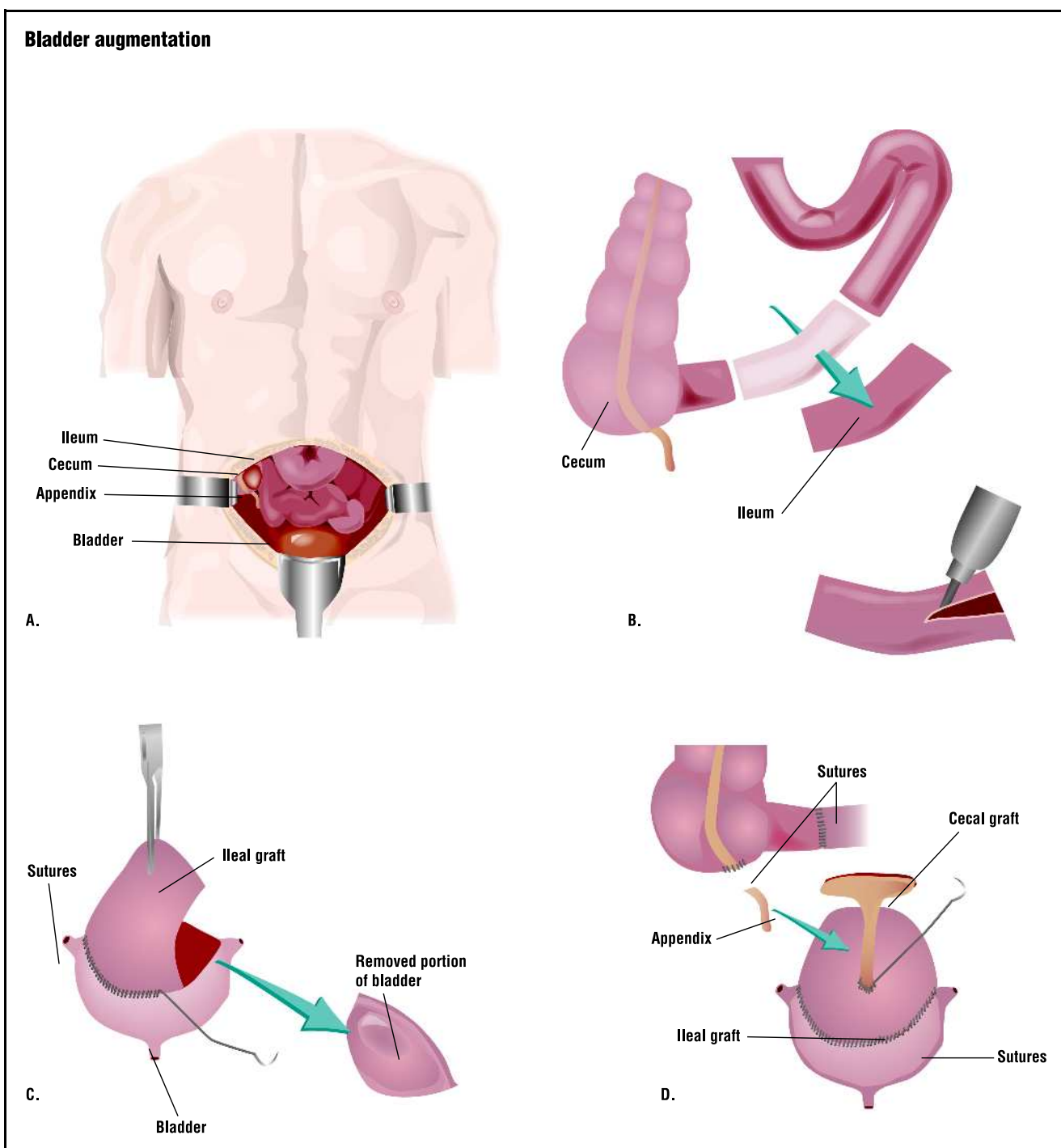
### Description

Standard augmentation involves segments of the bowel used to create a pouch or wider wall for the bladder in order to enhance its reservoir capacity. Often this reconstruction surgery is accompanied by procedures that tighten the neck of the bladder as well. Until the 1970s it was thought that those with bladder dysfunction could be treated with bladder diversion, and that this procedure offered a simple and safe means of emptying the bladder. However, it was soon discovered that pressure from the bladder caused irreparable damage to the kidneys, with 50% of patients exhibiting such deterioration. The new diagnostic assessment of the bladder as well as the need for a new medical intervention for patients with severe bladder dysfunction opened the way for urinary tract reconstruction. Today, many techniques are available, along with new types of grafting substitutions.

The basic procedure involves open abdominal surgery with removal of a 10–12-in (25–30-cm) segment of ileum (part of the small intestine), cecum (first part of the large intestine), or the ileocecum (the junction of small and large intestines) cut down the middle (detubularized), and shaped into a U-configuration with a pouch at the bottom. This opening or pouch will be the “patch” for the bladder. During surgery, the bladder itself is also opened at the dome and cut at right angles to create a clam-like shape. The open bowel “patch” is then attached to the bladder with sutures or stapling.

### Diagnosis/Preparation

Patients selected for bladder augmentation are chosen after they undergo a thorough physical exam, x-ray tests, and bladder physiology tests, as well as a renal and bladder **ultrasound** for any dilation of the kidneys or ureters or kidney obstruction. A VCUG (holding and voiding urine) test is performed to assess the contour of the bladder and to assess for ureteral reflux (back up of urine to the kidneys). Finally, a cystometrogram (CMG) is performed in the physician’s office to judge the pressure and volume levels



During a bladder augmentation procedure, an incision is made in the abdomen to expose the intestines and bladder (A). A section of ileum (small intestine) is removed and opened (B). After being sterilized, it is grafted onto the bladder to increase its capacity (C). The appendix and cecum (large intestine) may also be used (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

at which the urine leakage occurs. Once the tests, patient history, and physical exam are completed, a treatment plans commence.

The patient should plan for up to two weeks in the hospital. The patient will have been on a low-residue diet for a few days before admission. Surgery will take

## KEY TERMS

**Anastomosis**—The surgical union of parts and especially hollow tubular parts.

**Catherization**—the use of or insertion of a catheter (as in or into the bladder, trachea, or heart).

**Cystoplasty**—Reconstructive surgery of the urinary bladder.

**Neurogenic bladder**—A urinary problem of neurological origin in which there is abnormal emptying of the bladder with subsequent retention or incontinence of urine.

**Ureter**—Either of the paired channels that carry urine from a kidney to the bladder.

place two to three days after hospital admittance. In the hospital, a general examination will be performed and blood taken. The bowel will need to be cleaned in preparation. Clear fluids will be given, as well as a strong laxative prior to surgery.

## Aftercare

Early complications of surgery include cardiovascular, thrombo-embolic (blood clot), gastrointestinal, and respiratory complications associated with major abdominal surgery. Many patients require three months after surgery to allow their augmented bladder to establish itself. This involves a special diet for a few months. The patient also should be aware that the augmented bladder empties after their own (native) bladder. Two weeks after surgery, tests are performed to ensure that the patch is leak proof. Once a watertight reservoir is demonstrated, the catheters and drains that were introduced for surgery are removed.

## Risks

Long term risks of the procedure include peptic ulceration of the bladder and perforation of the gastric segment. Spontaneous perforation is rare but it is life threatening and has a 25% mortality rate. Other risks include bacterial infections, metabolic changes, urinary tract infections, and urinary tract stones. Nocturnal incontinence is sometimes a problem after the surgery.

## Normal results

Although some patients recover spontaneous voiding function, this does not occur with reliable predictability. Preoperatively, patients should be prepared for

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Bladder augmentation is performed by a urological surgeon, who is an MD with advanced training in urology. He or she should have had special surgical training for this type of surgery. The surgery takes place in a general hospital.

the likelihood that they will have to perform lifelong intermittent catherization and irrigation of the augmented bladder. Other effects are a special diet for up to three months and pain after surgery.

## Morbidity and mortality rates

Reported surgical risks include 3–5.7% rate of adhesive small bowel obstruction requiring operative intervention; 5–6% incidence of wound infection; and up to 3% **reoperation** rate for bleeding. Long term complications include a 50% unchanged bladder compliance and renal deterioration. No reduction in growth in children has been reported, but the procedure is not recommended for children who have not reached puberty unless there is the threat of kidney damage without surgery.

## Alternatives

Bladder augmentation is a medical treatment of last resort for those patients unable to avoid incontinence through medical alternatives. Other surgeries may be indicated if the individual is not a candidate for self-catherization or has other medical or psychological conditions that would rule out bladder augmentation.

## Resources

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## QUESTIONS TO ASK THE DOCTOR

- How many bladder augmentation surgeries do you perform a year?
- What complications of this surgery do you think are the most likely and/or worrisome?
- Are there other patients with my underlying medical conditions who have had this surgery that I could contact?
- Is there a pre-operative patient group with this hospital that could help me understand my rehabilitation and help with the compliance with the diet and self-catherization?

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- National Association for Continence. P.O. Box 8310 Spartanburg, SC 29305. (800) BLADDER, (252) 3337. <http://www.nafc.org>.
- National Kidney and Urologic Diseases Information Clearinghouse. 3 Information Way, Bethesda, MD 20892-3580. (301) 654-4415. <http://www.niddk.nih.gov>.
- The Simon Foundation for Continence. P.O. Box 835 Wilmette, IL 60091. (800) 23SIMON (237-4666). <http://www.simonfoundation.org>.

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Nancy McKenzie, Ph.D.

Bladder removal see **Cystectomy**

Bladder resection see **Transurethral bladder resection**

Bladder tumor antigen test see **Tumor marker tests**

## Blepharoplasty

### Definition

Blepharoplasty is a cosmetic surgical procedure that removes fat deposits, excess tissue, or muscle from the eyelids to improve the appearance of the eyes.

### Purpose

The primary use of blepharoplasty is for improving the cosmetic appearance of the eyes. In some older persons, however, sagging and excess skin surrounding the eyes can be so extensive that it limits the range of vision. In those cases, blepharoplasty serves a more functional purpose.

### Demographics

Approximately 100,000 blepharoplasty procedures are performed each year in the United States. The procedure is more common among women than men.

### Description

Blepharoplasty can be performed on the upper or lower eyelid. It can involve the removal of excess skin and fat deposits and the tightening of selected muscles surrounding the eyelids. The goal is to provide a more youthful appearance and/or to improve eyesight.

The surgeon begins by deciding whether excess skin, fat deposits, or muscle looseness are at fault. While a person is sitting upright, the surgeon marks where incisions will be made on the skin. Care is taken to hide the incision lines in the natural skin folds above and below the eye. The surgeon then injects a local anesthetic to numb the pain. Many surgeons also administer a sedative intravenously during the procedure.

After a small, crescent-shaped section of eyelid skin is removed, the surgeon works to tease out small pockets of fat that have collected in the lids. If muscle looseness is also a problem, the surgeon may trim tissue or add a stitch to pull muscle tissue tighter. Then the incision is closed with **stitches**.

In some persons, fat deposits in the lower eyelid may be the only or primary problem. Such people may be good candidates for transconjunctival blepharoplasty. In this procedure the surgeon makes no incision on the surface of the eyelid, but instead enters from behind, through the inner surface of the lid, to tease out the fat deposits from a small incision. The advantage of this procedure is that there is no visible scar.

## KEY TERMS

**Ectropion**—A complication of blepharoplasty, in which the lower lid is pulled downward, exposing the inner surface.

**Intravenous sedation**—A method of injecting a fluid sedative into the blood through the vein.

**Retrobulbar hematoma**—A rare complication of blepharoplasty, in which a pocket of blood forms behind the eyeball.

**Transconjunctival blepharoplasty**—A type of blepharoplasty in which the surgeon makes no incision on the surface of the eyelid, but, instead, enters from behind to tease out the fat deposits.

## Diagnosis/Preparation

Before performing blepharoplasty, the surgeon assesses whether a person is a good candidate for the treatment. A thorough medical history is important. The surgeon requires knowledge of any history of thyroid disease, hypertension, or eye problems, which may increase the risk of complications.

Prior to surgery, surgeons and their candidates meet to discuss the procedure, clarify the results that can be achieved, and discuss potential problems that might occur. Having realistic expectations is important in any cosmetic procedure. Candidates learn, for example, that although blepharoplasty can improve the appearance of the eyelid, other procedures, such as a chemical peel, may be necessary to reduce the appearance of wrinkles around the eye. Some surgeons prescribe vitamin C and vitamin K for 10 days prior to surgery in the belief that this helps the healing process. Candidates are also told to stop smoking in the weeks before and after the procedure, and to refrain from using alcohol or **aspirin**.

## Aftercare

An antibiotic ointment is applied to the line of stitches each day for several days after surgery. Patients also take an antibiotic several times a day to prevent infection. Ice-cold compresses are applied to the eyes continuously for the first day following surgery, and several times a day for the next week or so, to reduce swelling. Some swelling and discoloration around the eyes is expected with the procedure. Persons should avoid aspirin or alcoholic beverages for one week and should limit their activities, including bending, straining, and lifting. The stitches are removed a

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Blepharoplasty procedures are performed by surgeons with specialized training in plastic and reconstructive surgery. They are most commonly performed in outpatient facilities or in private professional offices. The procedure may also be performed in a hospital.

In 2003, the average price of blepharoplasty for both upper lids was approximately \$4,000. For both lower lids, the cost may be slightly higher. The cost for both upper and lower blepharoplasty was approximately \$6,000. These prices usually include anesthesia and surgeon fees. Medications and lab work, as well as any revisionary work, are not included.

few days after surgery. People can generally return to their usual activities within a week to 10 days.

## Risks

As with any surgical procedure, blepharoplasty can lead to infection and scarring. Good care of the wound following surgery can minimize these risks. In cases where too much skin is removed from the eyelids, people may experience difficulty closing their eyes. Dry eye syndrome may develop, requiring the use of artificial tears to lubricate the eye. In a rare complication, called retrobulbar hematoma, a pocket of blood forms behind the eyeball.

## Normal results

Most people can expect good results from blepharoplasty, with the removal of excess eyelid skin and fat producing a more youthful appearance. Some swelling and discoloration is expected immediately following the procedure, but this clears in time. Small scars will be left where the surgeon has made incisions; but these generally lighten in appearance over several months, and, if placed correctly, will not be readily noticeable.

## Morbidity and mortality rates

If too much excess skin is removed from the upper eyelid, persons may be unable to close their eyes completely. Another surgery to correct the defect may be required. Similarly, too much skin can be removed



## QUESTIONS TO ASK THE DOCTOR

- What will be my resulting appearance?
- Is the surgeon board certified in plastic and reconstructive surgery?
- How many blepharoplasty procedures has the surgeon performed?
- What is the surgeon's complication rate?

from the lower eyelid, allowing too much of the white of the eye (the sclera) to show. In extreme cases, the lower lid may be pulled down too far, revealing the underlying tissue. This is called an ectropion and also may require a second, corrective surgery. The eye's ability to make tears may also be compromised, leading to dry eye syndrome. Dry eye syndrome can be dangerous; in rare cases it leads to damage to the cornea of the eye and vision loss.

### Alternatives

Some of the alternatives to blepharoplasty include losing some excess body fat through diet and **exercise**, accepting one's body and appearance as it is, or using makeup to de-emphasize the area.

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- American Board of Plastic Surgery. Seven Penn Center, Suite 400, 1635 Market Street, Philadelphia, PA 19103-2204. (215) 587-9322. <http://www.abplsurg.org>.
- American College of Plastic and Reconstructive Surgery. <http://www.breastimplant.org>.
- American College of Surgeons. 633 North Saint Claire Street, Chicago, IL, 60611. (312) 202-5000. <http://www.facs.org>.
- American Society for Aesthetic Plastic Surgery. 11081 Winners Circle, Los Alamitos, CA 90720. (800) 364-2147 or (562) 799-2356. <http://www.surgery.org>.
- American Society for Dermatologic Surgery. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168-4014. (847) 330-9830. <http://www.asdsnet.org>.
- American Society of Plastic and Reconstructive Surgeons. 44 E. Algonquin Rd., Arlington Heights, IL 60005. (847) 228-9900. <http://www.plasticsurgery.org>.
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L. Fleming Fallon, Jr., MD, DrPH

## Blood Ca (calcium) level

### Definition

Calcium is the most prevalent mineral in the body. It is a major component of bones and teeth, and is also important in the functioning of the muscles, nervous system, heart, and the blood clotting system.

Verföhrung Pflanzen-Arten	Elemente	Normales Bewertung	Ergebnis
	Na	9600 2000	1848
	K	1750 1050	1859
	Ca	595 97.0	56.24
	Mg	14.0 36.0	31.21
	Cu	1.10 1.20	0.98
	Fe	440 480	500.6
	Zn	5.10 7.70	7.42
	P	350 390	348.8
	Pb	76 0.10	
	Li	0.010 0.050	

Alle Werte beziehen sich auf mg/l. — All values refer to mg/l.

**Blood calcium level results.** (blickwinkel / Alamy)

The bones are the body's major storage compartment for calcium. About 99% of the body's total calcium is located in bone. In the blood, calcium is either free or bound to the protein albumin. The bound calcium is essentially inactive; the free calcium is considered biologically active. Calcium is obtained through the diet, and requires the presence of a normal quantity of vitamin D for efficient absorption from the intestine into the bloodstream.

Hormones involved in calcium metabolism include parathyroid hormone and calcitonin. Parathyroid hormone is released by the parathyroid glands, which are located behind the thyroid gland in the mid-neck. When blood calcium levels are low, the parathyroid glands are stimulated to produce and release parathyroid hormone. Parathyroid hormone acts to induce the release of calcium from bone. Parathyroid hormone is also active in the kidney, and is involved in keeping calcium from being excreted out of the body. Parathyroid hormone also stimulates the kidney to convert vitamin D into its active form, calcitriol, which is paramount to the intestinal absorption of calcium. Calcitonin is produced by special cells (parafollicular cells) in the thyroid gland. Calcitonin is involved in prompting bone to resorb calcium from the bloodstream.

### Purpose

A blood calcium level may be drawn as part of a general metabolic panel, during a routine **physical examination**. A blood calcium level may also be ordered if there are concerns regarding arrhythmias of the heart; problems with the muscles or nervous system; kidney stone; pancreatitis; infection; evidence of kidney disease; concerns about intestinal absorption; or problems with blood clotting. The test may also be useful if the patient has signs of too much

blood calcium (hypercalcemia) or low blood calcium (hypocalcemia). Signs of hypercalcemia can include abnormal tiredness, weakness, decreased appetite, nausea and vomiting, constipation, excessive thirstiness, increased urination. Signs of hypocalcemia can include numbness or a tingling sensation in the hands and feet and around the mouth, muscle spasms, or abdominal cramps. Blood calcium levels may also be monitored regularly in patients who have conditions that may cause abnormal calcium levels, such as cancers of the breast, lung, head and neck, kidney, and multiple myeloma; malnutrition (including due to anorexia or other eating disorders); thyroid disease; intestinal disorders; kidney disease; history of kidney transplant; treatment with calcium or vitamin D supplements.

### Precautions

Patients who use calcium supplements or vitamin D should stop taking them for the twenty-four hours prior to their blood test.

### Description

This test requires blood to be drawn from a vein (usually one in the forearm), generally by a nurse or phlebotomist (an individual who has been trained to draw blood). A tourniquet is applied to the arm above the area where the needle stick will be performed. The site of the needle stick is cleaned with antiseptic, and the needle is inserted. The blood is collected in vacuum tubes. After collection, the needle is withdrawn, and pressure is kept on the blood draw site to stop any bleeding and decrease bruising. A bandage is then applied.

### Preparation

There are no restrictions on diet or physical activity, either before or after the blood test.

### Aftercare

As with any blood tests, discomfort, bruising, and/or a very small amount of bleeding is common at the puncture site. Immediately after the needle is withdrawn, it is helpful to put pressure on the puncture site until the bleeding has stopped. This decreases the chance of significant bruising. Warm packs may relieve minor discomfort. Some individuals may feel briefly woozy after a blood test, and they should be encouraged to lie down and rest until they feel better.

## KEY TERMS

**Calcitonin**—A hormone made by the thyroid gland. Calcitonin is involved in regulating levels of calcium and phosphorus in the blood.

**Hypercalcemia**—High levels of blood calcium.

**Hypocalcemia**—Low levels of blood calcium.

**Pancreatitis**—Inflammation of the pancreas.

**Parathyroid hormone**—A hormone that is secreted by the parathyroid glands. Parathyroid hormone is involved in the regulation of calcium levels in the blood.

## Risks

Basic blood tests, such as blood calcium levels, do not carry any significant risks, other than slight bruising and the chance of brief dizziness.

## Results

The blood calcium level can be determined by measuring the total blood calcium (the calcium that is bound to the protein albumin and the calcium that is free in the blood serum), or by measuring the free (ionized) calcium. Although measuring the total blood calcium is generally easier and usually sufficient in most patients, some patients have conditions that will affect these results; in these patients, it is important to measure the free calcium. Such patients include those who are extremely, critically ill, patients who are getting blood transfusions or large quantities of intravenous fluids or nutrition; patients who will undergo or have recently undergone major surgery, and patients who do not have normal levels of blood protein (albumin).

Normal results for a total blood calcium level in adults ranges from 0.0–103.5 milligrams per deciliter (mg/dL) or 2.25–2.75 millimoles per liter (mmol/L). Children have higher calcium levels, because their bones are in such a high-growth phase. Normal total blood calcium levels in children range from 7.6–10.8 mg/dL or 1.9–2.7 mmol/L. A normal free or ionized calcium level in adults is 4.65–5.28 mg/dL.

## High levels

High blood calcium levels may be due to:

- prolonged bedrest;
- hyperparathyroidism (overactive parathyroid glands);
- kidney disease;

- tuberculosis;
- cancer in the bones;
- too much calcium, vitamin D, or vitamin A in the diet; excessive intake of dairy products; excessive intake of antacids or supplements;
- dehydration;
- sarcoidosis;
- Paget's disease;
- Addison's disease; or
- chronic kidney or liver diseases.

## Low levels

Low blood calcium levels may be due to:

- hypoparathyroidism (underactive parathyroid glands);
- intestinal problems that interfere with appropriate absorption of nutrients;
- bone disorders;
- kidney disease;
- pancreatitis;
- low serum albumin (hypoalbuminemia);
- low magnesium;
- pregnancy; or
- advanced age in men.

## Resources

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### ORGANIZATIONS

- American Association for Clinical Chemistry, 1850 K Street, NW, Suite 625, Washington, DC, 20006, (800) 892 1400, <http://www.aacc.org>.

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## Blood carbon dioxide level

### Definition

Carbon dioxide is the waste product of the respiratory system. It is a gas that is exchanged for oxygen in the body's tissues, transported to the lungs, and then breathed off during exhalation.

Carbon dioxide travels throughout the body in the form of bicarbonate, or  $\text{HCO}_3^-$ . Bicarbonate levels are involved in keeping the body in appropriate acid-base balance (pH level). When the kidneys sense that the body's acid-base balance is tending towards the acidic, the kidneys secrete more bicarbonate, in order to neutralize the acid. When the kidneys sense that the body's acid-base balance is tending towards the more alkaline, the kidneys reabsorb bicarbonate from the bloodstream, in order to decrease the body's alkalinity.

On a cellular level, bicarbonate works in concert with sodium, chloride, and potassium to attain and maintain appropriate pH balance within cells.

A blood carbon dioxide level reflects the presence of all three forms of carbon dioxide in the blood, including bicarbonate ( $\text{HCO}_3^-$ ), carbonic acid ( $\text{H}_2\text{CO}_3$ ) and dissolved  $\text{CO}_2$ . The level of bicarbonate present, therefore, is extrapolated from the overall blood carbon dioxide level; it is not an exact measurement, but an estimate based on the total blood carbon dioxide level measured.

### Purpose

A blood carbon dioxide level is usually drawn as part of a larger panel of electrolytes. Other measurements in the electrolyte panel include chloride, potassium, and sodium. Sometimes the blood carbon dioxide level is drawn along with an **arterial blood gas**, and the results are correlated with each other to help determine whether the acid-base imbalance is due to respiratory causes or metabolic causes. Respiratory acid-base imbalances are due to an imbalance in the intake of oxygen relative to the output of carbon dioxide. Metabolic acid-base imbalances are due to inappropriate amounts of bicarbonate in the blood. Excess bicarbonate results in metabolic alkalosis; a shortage of bicarbonate results in metabolic acidosis.

### Precautions

There are no precautions necessary prior to having a blood carbon dioxide level drawn. Patients can continue their usual diet, activities, and medications.

## KEY TERMS

**Acid**—Any chemical or compound that lowers the pH of a solution below 7.0, meaning that there is a surplus of hydrogen ions dissociated within that solution.

**Alkaline**—Any chemical or compound that raises the pH of a solution above 7.0, meaning that there is a relative shortage of hydrogen ions dissociated within that solution.

**Metabolic**—Pertaining to metabolism, the physical and chemical processes of living things that produce energy.

**Neutralize**—The way the body addresses acidity or alkalinity: adding acid to an alkaline environment to arrive at a neutral pH value, or adding bicarbonate to an acidic environment to arrive at a neutral pH value.

**pH**—A measure of the acidity or alkalinity of a solution, relative to a standard solution. A neutral pH value is 7.0. An acidic pH value is below 7.0. An alkaline pH value is above 7.0.

Patients who are taking anticoagulant medications should inform their healthcare practitioner, since this may increase their chance of bleeding or bruising after a blood test.

### Description

This test requires blood to be drawn from a vein (usually one in the forearm), generally by a nurse or phlebotomist (an individual who has been trained to draw blood). A tourniquet is applied to the arm above the area where the needle stick will be performed. The site of the needle stick is cleaned with antiseptic, and the needle is inserted. The blood is collected in vacuum tubes. After collection, the needle is withdrawn, and pressure is kept on the blood draw site to stop any bleeding and decrease bruising. A bandage is then applied.

### Preparation

There are no restrictions on diet or physical activity, either before or after the blood test.

### Aftercare

As with any blood tests, discomfort, bruising, and/or a very small amount of bleeding is common



at the puncture site. Immediately after the needle is withdrawn, it is helpful to put pressure on the puncture site until the bleeding has stopped. This decreases the chance of significant bruising. Warm packs may relieve minor discomfort. Some individuals may feel briefly woozy after a blood test, and they should be encouraged to lie down and rest until they feel better.

### Risks

Basic blood tests, such as blood carbon dioxide levels, do not carry any significant risks, other than slight bruising and the chance of brief dizziness.

### Results

In adults, a normal blood carbon dioxide level is 23–29 millimoles per liter (mmol/L). In children a normal blood carbon dioxide level is 20–28 mmol/L. In infants, a normal blood carbon dioxide level is 13–22 mmol/L.

A number of drugs may affect the results of the test. Blood carbon dioxide levels may be elevated in patients who are using steroid medications, **barbiturates**, bicarbonates, and loop **diuretics**. Blood carbon dioxide levels may be decreased in patients who are using methicillin, nitrofurantoin, tetracycline, thiazide diuretics, and triamterene. It is important that the healthcare provider take into consideration the effects that these drugs may have on the blood carbon dioxide level.

### High levels

High blood carbon dioxide levels may be due to:

- chronic obstructive pulmonary disease;
- emphysema;
- pneumonia;
- Cushing's disease;
- Conn's syndrome;
- alcoholism; or
- vomiting.

### Low levels

Low blood carbon dioxide levels may be due to:

- pneumonia;
- cirrhosis of the liver;
- liver failure;
- hyperventilation (fast, shallow breathing);
- diabetes;
- kidney failure;
- liver failure;

- salicylate (aspirin) overdose;
- shock states;
- chronic diarrhea;
- dehydration;
- chronic severe malnutrition; or
- ingestion of toxins such as antifreeze (ethylene glycol) or wood alcohol (methanol).

### Resources

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Blood clot prevention see **Venous thrombosis prevention**

Blood count see **Complete blood count**

Blood crossmatching see **Type and screen**

## Blood culture

### Definition

A blood culture is done when a person has symptoms of a blood infection, also called bacteremia. Blood is drawn from the person one or more times and is tested in a laboratory to find and identify any microorganism present and growing in the blood. If a microorganism is found, more testing is done to determine the **antibiotics** that will be effective in treating the infection.





**Blood in agar growth medium.** (Andrew Paterson / Alamy)

## Purpose

Bacteremia is a serious clinical condition and can lead to **death**. To give the best chance for effective treatment and survival, a blood culture is done as soon as an infection is suspected.

Symptoms of bacteremia are fever, chills, mental confusion, anxiety, rapid heart beat, hyperventilation, blood clotting problems, and shock. These symptoms are especially significant in a person who already has another illness or infection, is hospitalized, or has trouble fighting infections because of a weak immune system. Often, the blood infection results from an infection somewhere else in the body that has spread.

Additionally, blood cultures are done to find the causes of other infections. These include bacterial pneumonia (an infection of the lung), and infectious endocarditis (an infection of the inner layer of the heart). Both of these infections leak bacteria into the blood.

After a blood infection has been diagnosed, confirmed by culture, and treated, an additional blood culture may be done to make sure the infection is gone.

## Description

### *Culture strategies*

There are many variables involved in performing a blood culture. Before the person's blood is drawn, the physician must make several decisions based on a knowledge of infections and the person's clinical condition and medical history.

Several groups of microorganisms, including bacteria, viruses, mold, and yeast, can cause blood infections. The bacteria group can be further broken down into aerobes and anaerobes. Most microbes do not need oxygen to live. They can grow with oxygen (aerobic microbes) or without oxygen (anaerobic microbes).

Based on the clinical condition of the patient, the physician determines what group of microorganisms is likely to be causing the infection and then orders one or more specific types of blood culture, including aerobic, anaerobic, viral, or fungal (for yeasts and molds). Each specific type of culture is handled differently by the laboratory. Most blood cultures test for both aerobic and anaerobic microbes. Fungal, viral, and mycobacterial blood cultures can also be done, but are less common.

The physician must also decide how many blood cultures should be done. One culture is rarely enough; two to three are usually adequate. Four cultures are occasionally required. Some factors influencing this decision are the specific microorganisms the physician expects to find based on the person's symptoms or previous culture results, and whether or not the person has had recent antibiotic therapy.

The time at which the cultures are to be drawn is another decision made by the physician. During most blood infections (called intermittent bacteremia) microorganisms enter the blood at various time intervals. Blood drawn randomly may miss the microorganisms. Since microorganisms enter the blood 30–90 minutes before the person's fever spikes, collecting the culture just after the fever spike offers the best likelihood of finding the microorganism. The second and third cultures may be collected at the same time, but from different places on the person, or spaced at 30-minute or one-hour intervals, as the physician chooses. During continuous bacteremia, such as infective endocarditis, microorganisms are always in the blood and the timing of culture collection is less important. Blood cultures should always be collected before antibiotic treatment has begun.

### *Laboratory analysis*

Bacteria are the most common microorganisms found in blood infections. Laboratory analysis of a bacterial blood culture differs slightly from that of a fungal culture and significantly from that of a viral culture.

Blood is drawn from a person and put directly into a blood culture bottle containing a nutritional broth. After the laboratory receives the blood culture bottle, several processes must be completed:

- provide an environment for the bacteria to grow;
- detect the growth when it occurs;
- identify the bacteria that grow; and
- test the bacteria against certain antibiotics to determine which antibiotic will be effective.

There are several types of systems, both manual and automated, available to laboratories to carry out these processes.

The broth in the blood culture bottle is the first step in creating an environment in which bacteria will grow. It contains all the nutrients that bacteria need to grow. If the physician expects anaerobic bacteria to grow, oxygen will be kept out of the blood culture bottle; if aerobes are expected, oxygen will be allowed in the bottle.

The bottles are placed in an incubator and kept at **body temperature**. They are watched daily for signs of growth, including cloudiness or a color change in the broth, gas bubbles, or clumps of bacteria. When there is evidence of growth, the laboratory does a gram stain and a subculture. To do the gram stain, a drop of blood is removed from the bottle and placed on a microscope slide. The blood is allowed to dry and then is stained with purple and red stains and examined under the microscope. If bacteria are seen, the color of stain they picked up (purple or red), their shape (such as round or rectangular), and their size provide valuable clues as to what type of microorganism they are and what antibiotics might work best. To do the subculture, a drop of blood is placed on a culture plate, spread over the surface, and placed in an incubator.

If there is no immediate visible evidence of growth in the bottles, the laboratory looks for bacteria by doing gram stains and subcultures. These steps are repeated daily for the first several days and periodically after that.

When bacteria grows, the laboratory identifies it using biochemical tests and the gram stain. Sensitivity testing, also called antibiotic susceptibility testing, is

also done. The bacteria are tested against many different antibiotics to see which antibiotics can effectively kill it.

All information is passed on to the physician as soon as it is known. An early report, known as a preliminary report, is usually available after one day. This report will tell if any bacteria have been found yet and, if so, the results of the gram stain. The next preliminary report may include a description of the bacteria growing on the subculture. The laboratory notifies the physician immediately when an organism is found and as soon as sensitivity tests are complete. Sensitivity tests may be complete before the bacteria is completely identified. The final report may not be available for five to seven days. If bacteria was found, the report will include its complete identification and a list of the antibiotics to which the bacteria is sensitive.

One automated system is considered one of the most important technical advances in blood cultures. It is called continuous-monitoring blood culture systems (CMBCS). The instruments automatically monitor the bottles containing the patient blood for evidence of microorganisms, usually every 10 minutes. Many data points are collected daily for each bottle, and fed into a computer for analysis. Sophisticated mathematical calculations can determine when microorganisms have grown. This, combined with more frequent blood tests, make it possible to detect microbial growth earlier. In addition, all CMBCS instruments have the detection system, incubator, and agitation device in one unit.

### **Preparation**

Ten ml (milliliter) of blood is usually needed for each blood culture bottle. First a healthcare worker locates a vein in the inner elbow region. The area of skin where the blood will be drawn must be disinfected to prevent any microorganisms on a person's skin from entering the blood culture bottle and contaminating it. The area is disinfected by wiping the area with alcohol in a circular fashion, starting with tiny circles at the spot where the needle will puncture the skin and enlarging the size of the circles while wiping away from the puncture site. The same pattern of wiping is repeated using an iodine or iodophor solution. The top of the bottle is disinfected using alcohol. After the person's skin has been disinfected, the healthcare worker draws the blood and about 10 ml of blood is injected into each blood culture bottle. The type of bottles used will vary based on whether the physician is looking for bacteria (aerobes or anaerobes), yeast, mold, or viruses.

## Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs relieve discomfort.

## Normal results

Normal results will be negative. A single negative culture does not rule out a blood infection. False negatives can occur if the person was started on antibiotics before the blood was drawn, if the environment for growth was not right, the timing was off, or for some unknown reason the microorganism just didn't grow. Three negative cultures may be enough to rule out bacteremia in the case of endocarditis.

## Abnormal results

The physician's skill in interpreting the culture results and assessing the person's clinical condition is essential in distinguishing a blood culture that is truly positive from a culture that is positive because it became contaminated. In true bacteremia, the patient's clinical condition should be consistent with a blood infection caused by the microorganism that was found. The microorganism is usually found in more than one culture, it usually grows soon after the bottles are incubated, and it is often the cause of an infection somewhere else in the person's body.

When the culture is positive because of contamination, the patient's clinical condition usually is not consistent with an infection from the identified microorganism. In addition, the microorganism is often one commonly found on skin, it rarely causes infection, it is found in only one bottle, and it may appear after several days of incubation. More than one microorganism often grow in contaminated cultures.

## Morbidity and mortality rates

Morbidity rates are miniscule. The most common problems are minor bleeding and bruising. Since neither are reportable events, morbidity can only be estimated. Mortality is essentially zero.

## Precautions

The only precaution needed is to clean the venipuncture site with alcohol.

## Side effects

The most common side effects of a blood culture are minor bleeding and bruising.

## Resources

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- American Association for Clinical Chemistry, 1850 K Street, NW, Suite 625, Washington, DC, 20006, (800) 892-1400, <http://www.aacc.org/AACC/>.
- American Society for Clinical Laboratory Science, 6701 Democracy Blvd., Suite 300, Bethesda, MD, 20817, (301) 657-2768, <http://www.ascls.org/>.
- American Society for Clinical Pathology, 1225 New York Ave., NW, Suite 250, Washington, DC, 20005, (202) 347-4450, <http://www.ascp.org/>.

College of American Pathologists, 325 Waukegan Rd.,  
Northfield, IL, 60093 2750, (800) 323 4040, <http://www.cap.org/apps/cap.portal>.

L. Fleming Fallon, Jr., M.D., Dr.P.H.

## Blood donation and registry

### Definition

Blood donation, also called blood banking, refers to the process of collecting, testing, preparing, and storing whole blood and blood components intended primarily for **transfusion**. Blood donors are typically unpaid volunteers, but they may also be paid by commercial blood donation and processing enterprises, such as independent blood banks and donor centers. Blood registry refers to the collection and sharing of data about donated blood and donors. Donors who have been determined to be temporarily or permanently ineligible to donate blood are listed in a confidential national data base known as the Donor Deferral Register. The quality and safety of the U.S. blood supply is governed by physician-established guidelines for the practice of blood banking as found in the Standards of the American Association of Blood Banks (AABB) and through the organization's inspection and accreditation program. The Food and Drug Administration (FDA) controls federal licensure of blood banks. Hospital blood banks are also inspected by The College of American Pathologists (CAP) and the Joint Commission on Accreditation of Healthcare Organizations (JCAHC).

### Purpose

Blood is collected, processed, stored, and distributed to maintain an adequate supply of whole blood and blood components for transfusion as needed. Blood replacement may be needed by people who have lost blood through accidents, burns, hemorrhage, or surgery. Blood or blood components are also used in the treatment of certain types of anemia, various disease conditions, and for medical research.

Healthy donors may be called upon to donate periodically to help maintain the overall blood supply or when their specific blood type is needed. People may sometimes donate blood to benefit a specific person. Directed donor blood is reserved for an intended recipient, such as a family member or friend; it is tested and processed as all other donated blood to ensure that it is appropriate for the recipient. People

## KEY TERMS

**Apheresis**—Extraction of a specific component from donated blood, with the remainder returned to the donor.

**Autologous donation**—Blood donated for the donor's own use.

**Granulocytes**—White blood cells.

**Plasma**—The liquid part of anticoagulated blood. (Serum is the term for the liquid in a clotted blood sample.)

**Platelets**—Tiny, disk-like elements of plasma that promote clotting.

preparing for **elective surgery** may have their blood collected and held, and then returned to them if needed during their surgery. This process is known as **autologous blood donation**. Donors are advised to give blood only once in an eight-week period to maintain the iron stores in their blood. Autologous donors may donate more often if it is determined by their physician to be to their benefit.

The National Blood Data Resource Center reports that about 13.9 million units of whole blood (one unit of whole blood equals 450 ml, or about 1 pt) are donated annually in the United States, of which about 695,000 are autologous donations for elective surgery. The country's blood supply is donated by about eight million people, representing a broad cross section of the population, although fewer than 5% of those eligible donate. About half of the total amount needed is processed, stored, and delivered by the 36 regional blood centers of the American Red Cross; hospital blood banks, community blood centers, mobile blood drives, and independent blood banks collect, process, and distribute the other half.

Blood is donated as whole blood, collected in a plastic bag containing an anticoagulant that will keep the blood from clotting and allow it to be separated into multiple components. By dividing blood into components that each offer different clinical benefits, one unit of donated blood can meet the transfusion needs for more than one person. This practice is essential to meet the constant demand for blood; every year in the United States, more than four million people require blood transfusions. About 26 million transfusions are administered either as whole blood or components that have been prepared from whole blood. About 34,000 units per day, for example, are transfused as red cells.



Whole blood and blood components are used in various ways to meet the clinical needs of recipients. Whole blood is sometimes used to replace blood volume when a significant amount of blood has been lost through accidents or surgery. Red blood cells, which carry oxygen, are used to treat certain anemias and are often the preferred component when multiple transfusions are being administered to one person, as in open heart surgery or organ transplants. Platelets, part of the complex coagulation (clotting) system that helps control bleeding, are commonly used in the treatment of acute leukemia and some types of cancer. Fresh frozen plasma, which contains critical coagulation factors, is used to control bleeding in people who lack these factors. Cryoprecipitated (prepared from frozen plasma) antihemophilic factor (AHF) is transfused to provide a specific coagulation factor that is deficient in hemophilia and other diseases. Blood for transfusion is requested by physicians. Pre-transfusion testing and issuance of blood and components to the recipients is performed by a transfusion service, which is commonly provided or supervised by a hospital blood bank.

### Description

The actual process of donating whole blood takes about 20 minutes. The donor will either lie down or will sit in a special donor chair that elevates the lower body and legs. After selecting an appropriate vein, the phlebotomist (an individual trained in blood collection technique) will clean the arm well at the site of the needle puncture (venipuncture). With a tourniquet tightly in place on the donor's arm, a sterile needle is inserted into a vein. As the tourniquet is released, blood flows through plastic tubing into a plastic blood bag. The donor may be asked to open and close a fist to encourage blood to flow. Usually only one unit of blood is collected. Pressure is applied to the site of the venipuncture until the blood flow has been stopped. Donors are then escorted to an observation area, given light refreshments that include liquid, and allowed to rest. Positive identification of the donor and the blood bag from that donor are essential. The same unique identification number is assigned to the bag, all samples from the bag used for testing, and on all donor and testing records.

Plasma, the liquid portion of whole, anticoagulated blood in which blood cells, coagulation factors, and other blood constituents are suspended, is also collected. This is often done by commercial enterprises that sell it to companies manufacturing clotting factors and specific plasma protein products, or to companies and institutions engaged in medical research.

Plasma is collected using a process known as apheresis, in which whole blood is collected, the desired blood component is removed, and the remainder is returned to the donor. Collecting plasma generally takes one to two hours. Apheresis may also be used to collect other blood components, such as platelets and granulocytes.

Different blood components vary in how long they can be stored. Red blood cells can be refrigerated for up to 42 days or coated with a protective agent and frozen at extremely low temperatures in liquid nitrogen, a process that preserves them for up to 10 years. Platelets must be used soon after they are prepared; they are stored at room temperature for no more than five days. Fresh frozen plasma and cryoprecipitated AHF can be kept for as long as one year.

To ensure the safety of the blood supply, a multi-tiered process of donor screening and deferral is employed. This involves donor education, taking a detailed **health history** of each prospective donor, and giving potential donors a simple **physical examination**, which includes measuring blood pressure and pulse rate, taking a few drops of blood to test for hemoglobin, the iron-bearing protein in blood, and also measuring blood cell volume. These tests will indicate general health and help ensure that donation will not contribute to anemia in the donor. At any point in the process, a potential donor may be "deferred," or determined to be ineligible to donate blood. This deferral may be temporary or permanent, depending on the reason. Potential donors are also encouraged to "self-defer," or voluntarily decline to donate, rather than put future blood recipients at risk.

In general, blood donors must be at least 17 years old (some states allow younger people to donate blood with their parents' consent), must weigh at least 110 lb (50 kg), and must be in good health. Donors with a history of heart, lung, or liver disease or who are pregnant are usually deferred. Donors can be disqualified if they are known to have engaged in behavior that put them at risk of infection (such as having had a tattoo, having had sex with people in high-risk groups, having used illegal intravenous drugs, having had certain diseases, or having been raped) or have spent time in specific parts of the world, such as areas where malaria may be prevalent.

### Preparation

All donated blood is extensively tested before being distributed for use by transfusion services. The first step is determining the blood type, which is the primary indication of who can receive the blood. Blood is also screened for any irregular antibodies that could cause complications for the recipients. In



addition, donor blood is screened for infectious diseases, such as hepatitis, AIDS, and syphilis, by testing for specific markers of these diseases that will appear in the blood of those infected. These include: Hepatitis B surface antigen (donors with this antigen are immune and can be accepted), hepatitis B core antigen, hepatitis C virus antibody, HIV-1 and HIV-2 antibodies, HIV p24 antigen, and HTLV-I and HTLV-II antibodies. Other tests may be performed if a recipient's doctor requests them.

In order to detect the greatest possible number of infections, when present at even the lowest levels in donor blood, these screening tests are extremely sensitive. For this reason, however, donors sometimes receive false positive test results. In these cases, more specific confirmatory tests are performed to help rule out false positive results. Blood found to be not suitable for transfusion is discarded, and all items coming into direct contact with donors are used only once and then discarded. Donors of infected blood are entered into the Donor Deferral Register to prevent subsequent donation of their blood at other blood donation facilities.

There are eight major blood types comprising four ABO groups (A, B, AB, and O), and the presence or absence of the Rh factor, designated as either type Rh positive (+) or type Rh negative (-). These types and their approximate distribution in the U.S. population are as follows: O+ (38%), O- (7%), A+ (34%), A- (6%), B+ (9%), B- (2%), AB+ (3%), AB- (1%). In an emergency, when there may be no time for compatibility testing, anyone can safely receive type O red blood cells, and people with this blood type are known as "universal donors." People with type AB blood, known as "universal recipients," can receive any type of red blood cells and can give plasma to all blood types. Receiving the wrong blood type can result in the destruction of red cells in the recipients body and even **death**. For this reason, the transfusion service must conduct more pre-transfusion testing to determine the compatibility of the donor blood with the blood of the recipient. This compatibility testing, known as type and cross match, begins with matching the major blood types. Additional testing will include antibody screening of the recipient and, if specific antibodies are found, testing of other blood groups (the MN group or Kell and Lewis groups, for example) will be done to find compatible donor blood.

### Risks

Thanks to the use of a multi-tiered donor screening system and advances in the effectiveness of screening tests, the risk of transmitting infectious diseases to

recipients via transfusion has been significantly diminished. Nonetheless, there is still a minuscule risk that blood recipients could contract human immunodeficiency virus (HIV), hepatitis, or other diseases via transfusion. Other diseases that are of particular concern to blood-collection agencies include: babesiosis, Chagas disease, human T-lymphotropic virus (HTLV-I and -II), cytomegalovirus (CMV), Lyme disease, malaria, Creutzfeldt-Jakob disease, and new variant Creutzfeldt-Jakob disease.

There are few risks to healthy donors when AABB standards for donation are followed. People who donate blood replace the fluid they lose within 24 hours and the red cells within two months. A person can safely donate blood once in eight weeks. Donors' blood will be tested prior to donation to determine their eligibility; those ineligible will be advised of the temporary or permanent reasons for being disqualified. Their names will be placed on the national deferral registry to prevent donation at other sites and to help protect the blood supply.

Medical professionals who draw the blood of eligible donors will advise donors of any necessary precautions following donation. Most blood donors suffer no significant after effects. Occasionally donors may feel faint or dizzy, nauseous, or have tenderness, redness, or a bruise where the needle was inserted to draw their blood. More serious complications, which rarely occur, may include fainting, muscle spasms, or nerve damage.

AABB standards are designed to protect donors and recipients and especially to help ensure that compatible blood is transfused to each recipient. The accurate labeling of blood, blood components, and donor records, and the recording of all data is essential from the time blood is collected, through testing and preparation, and through pre-transfusion testing and issuance of the blood or blood component. Autologous blood donors run a tiny risk of having the wrong blood returned to them due to clerical error. There is also a faint possibility of bacterial contamination of the autologous blood. These rare occurrences apply to all other transfusions as well.

### Resources

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American Red Cross. 430 17th Street NW, Washington, D.C. 20006. <http://www.redcross.org>.

National Blood Data Resource Center. (301) 215 6506. <http://www.nbdrc.org>.

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## Blood phosphate level

### Definition

Phosphate is a mineral that is found in abundance in the body. About 85% of the body's phosphate is in bone. Phosphate is also a major component of teeth. Phosphate is involved in producing and repairing bone, as well as in the functioning of both nerves and muscles. Phosphate is used to help produce energy for the cell, as well as in the production of DNA.

Calcium and phosphate are both present in the blood, but in inverse proportions. In other words, higher blood calcium levels result in lower blood phosphate levels; lower blood calcium levels result in higher blood phosphate levels. Excess phosphate in the blood, beyond what is needed for proper functioning, is processed by the kidneys and excreted in the urine.

Phosphate acquired through the diet, in yeast, beans, lentils, grains, peanuts, and almonds. As with calcium, vitamin D is required for the proper absorption of phosphate. Excess phosphate in the body is excreted through the urine and the stool.

### Purpose

A blood phosphate level is usually drawn as part of a larger panel of electrolytes. Other measurements in the electrolyte panel include calcium, chloride, potassium, and sodium. A blood phosphate level is usually checked when there are concerns about the functioning of the patient's kidneys, to monitor patients who are on renal dialysis, in the presence of bone disease, to diagnose disorders of the parathyroid glands, to monitor intestinal disorders that affect nutrient absorption, and as part of the monitoring performed when a diabetic patient goes into ketoacidosis.

## KEY TERMS

**Acromegaly**—A condition in which an overactive pituitary gland pumps out an excess amount of growth hormone.

**Dialysis**—A procedure that takes over the blood filtering capacity normally provided by the kidneys. Includes both hemodialysis (in which blood passes out of the body through a tube running from a blood vessel in the arm to a special dialysis machine) and peritoneal dialysis (in which a special catheter is implanted in the abdominal cavity, a special dialysis solution is infused into the abdomen, waste products from the body enter the solution, and the solution is then drained back out of the abdominal cavity).

**Hyperphosphatemia**—Elevated blood phosphate levels.

**Hypophosphatemia**—Low blood phosphate levels.

**Ketoacidosis**—A condition brought on by extremely elevated blood glucose, resulting in a life-threatening metabolic acidosis.

**Parathyroid**—Several small glands located behind the thyroid glands in the mid-neck. The parathyroid glands secrete parathyroid hormone, which is highly involved in the chemical equilibrium of calcium and phosphate throughout the body.

### Precautions

The test results can be affected by alcohol, as well as some medications, such as steroids, androgen hormones, vitamin D supplements, and enemas containing phosphate, antacids containing aluminum, insulin, acetazolamide, epinephrine, or large quantities of glucose. Patients who are taking anticoagulant medications should inform their healthcare practitioner since this may increase their chance of bleeding or bruising after a blood test.

### Description

This test requires blood to be drawn from a vein (usually one in the forearm), generally by a nurse or phlebotomist (an individual who has been trained to draw blood). A tourniquet is applied to the arm above the area where the needle stick will be performed. The site of the needle stick is cleaned with antiseptic, and the needle is inserted. The blood is collected in vacuum tubes. After collection, the needle is withdrawn, and pressure is kept on the blood draw site to stop any bleeding and decrease bruising. A bandage is then applied.

## Preparation

There are no restrictions on diet or physical activity, either before or after the blood test.

## Aftercare

As with any blood tests, discomfort, bruising, and/or a very small amount of bleeding is common at the puncture site. Immediately after the needle is withdrawn, it is helpful to put pressure on the puncture site until the bleeding has stopped. This decreases the chance of significant bruising. Warm packs may relieve minor discomfort. Some individuals may feel briefly woozy after a blood test, and they should be encouraged to lie down and rest until they feel better.

## Risks

Basic blood tests, such as blood phosphate levels, do not carry any significant risks, other than slight bruising and the chance of brief dizziness.

## Results

In adults, a normal blood phosphate level is 3.0–4.5 milligrams per deciliter (mg/dL) or 0.97–1.45 millimoles per liter (mmol/L). Children and infants normally have higher blood phosphate levels because their bodies are in a phase involving rapid bone growth. In children a normal blood phosphate level is 4.5–6.5 mg/dL or 1.45–2.10 mmol/L. In infants, a normal blood phosphate level is 4.3–9.3 mg/dL or 1.4–3.0 mmol/L.

## High levels

High blood phosphate levels may be due to:

- kidney disease;
- poorly functioning parathyroid glands (hypoparathyroidism);
- acromegaly (a condition in which the pituitary is overactive, and secretes too much growth hormone);
- rhabdomyolysis (a condition in which muscle is broken down, releasing phosphate, among other substances);
- bone diseases, including recent fractured bones;
- diabetic ketoacidosis (a condition in which the blood glucose becomes extremely elevated);
- excess vitamin D;
- shortage of magnesium; or
- pregnancy.

## Low levels

Low blood phosphate levels may be due to:

- overactive parathyroid glands (hyperparathyroidism);
- kidney disease;
- liver disease;
- malnutrition or outright starvation;
- burns;
- severe alcoholism;
- excess blood calcium (hypercalcemia);
- vitamin D deficiency;
- bone disorders, such as osteomalacia (an adult type of rickets in which the bones becomes softer due to a vitamin D deficiency); or
- intestinal disorders that result in poor absorption of nutrients.

## Resources

### BOOKS

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### ORGANIZATIONS

- American Association for Clinical Chemistry, 1850 K Street, NW, Suite 625, Washington, DC, 20006, (800) 892 1400, <http://www.aacc.org>.

Rosalyn Carson-DeWitt, M.D.

## Blood potassium level

### Definition

Potassium is a mineral that is found in abundance in the body, primarily within its cells. Only about 2% of the body's total potassium is not within its cells. Potassium levels are crucial to the appropriate functioning of all cells, especially nerve and muscle cells. For the body to function normally, blood potassium levels have to be maintained at a very narrow range; when potassium levels are too high or too low, there

can be serious health consequences. The body keeps its potassium levels in equilibrium by prompting the kidneys to resorb more (when the body needs potassium) or excrete more (when there is excess potassium). The hormone responsible for stimulating the processing of potassium in the kidneys is called aldosterone. Aldosterone is secreted by the adrenal glands. When blood potassium levels get too high, the condition is called hyperkalemia. When blood potassium levels get too low, the condition is called hypokalemia.

### Purpose

A blood potassium level is usually drawn as part of a larger panel of electrolytes. Other measurements in the electrolyte panel include sodium, chloride, and carbon dioxide. A blood potassium level is usually checked during a regular **physical examination**, when there are concerns about the functioning of the patient's kidneys, when the patient has high blood pressure (hypertension), to monitor potassium levels during the use of medications that affect its equilibrium (such as certain **diuretics**, which cause potassium to be lost in the urine), in patients on dialysis, in patients who are on intravenous fluids or receiving parenteral nutrition, and in patients who have symptoms such as unexplained weakness or abnormal heart rhythms (cardiac arrhythmias).

### Precautions

Blood potassium levels can be affected by a number of medications. Patients who are on these medications should inform their doctor, so that test results can be interpreted appropriately. Medications that increase blood potassium levels include some chemotherapy agents, aminocaproic acid, high blood pressure medications (specifically angiotensin-converting enzyme or ACE inhibitors), certain diuretics (referred to as potassium-sparing or potassium-conserving diuretics), epinephrine, heparine, histamine, isoniazid, mannitol, and succinylcholine. Medications that decrease blood potassium levels include acetazolamide, aminosalicic acid, amphotericin B, carbenicillin, cisplatin, potassium-wasting diuretics (such as thiazide diuretics and furosemide), insulin, **laxatives**, penicillin G, phenothiazines, salicylates, and sodium polystyrene sulfonate. Other factors that may skew the results of blood potassium level include intravenous infusion of fluids containing potassium, as well as intravenous infusion of either glucose-containing solutions or insulin.

Patients who are taking anticoagulant medications should inform their healthcare practitioner since this may increase their chance of bleeding or bruising after a blood test.

## KEY TERMS

**Addison's disease**—A condition in which the adrenal glands are not functioning properly. Addison's disease can be caused by a problem in the adrenal glands themselves, or in the pituitary gland (which secretes a hormone that affects the adrenal glands).

**Bartter's syndrome**—An inherited disorder which affects a number of body processes, including the functioning of the part of the kidney that regulates potassium excretion and absorption. People with Bartter's syndrome have abnormally low blood potassium levels (hypokalemia).

**Diuretic**—A medication that increases the flow of urine through the kidneys and out of the body.

**Hyperkalemia**—Elevated blood potassium levels.

**Hypokalemia**—Low blood potassium levels.

Proper technique in drawing the potassium blood level and in handling the sample is crucial to an accurate result. If the patient is clenching and relaxing arm muscles in the arm from which the blood is being drawn, the potassium blood level may be falsely elevated. If the flow of blood into the vacuum tubes is not carefully regulated, and the blood flows too quickly or too slowly into the tubes, then the blood cells may be damaged due to turbulence. This will cause the blood cells to leak potassium into the sample, falsely elevating the result. Delay in testing the blood at the laboratory will also result in an artificially elevated blood potassium level being reported.

### Description

This test requires blood to be drawn from a vein (usually one in the forearm), generally by a nurse or phlebotomist (an individual who has been trained to draw blood). A tourniquet is applied to the arm above the area where the needle stick will be performed. The site of the needle stick is cleaned with antiseptic, and the needle is inserted. The blood is collected in vacuum tubes. After collection, the needle is withdrawn, and pressure is kept on the blood draw site to stop any bleeding and decrease bruising. A bandage is then applied.

### Preparation

There are no restrictions on diet or physical activity, either before or after the blood test.



## Aftercare

As with any blood tests, discomfort, bruising, and/or a very small amount of bleeding is common at the puncture site. Immediately after the needle is withdrawn, it is helpful to put pressure on the puncture site until the bleeding has stopped. This decreases the chance of significant bruising. Warm packs may relieve minor discomfort. Some individuals may feel briefly woozy after a blood test, and they should be encouraged to lie down and rest until they feel better.

## Risks

Basic blood tests, such as blood potassium levels, do not carry any significant risks other than slight bruising and the chance of brief dizziness.

## Results

In adults, a normal blood potassium level is 3.5–5.0 milliequivalents per liter (mEq/L) or 3.5–5.0 millimoles per liter (mmol/L). In children a normal blood potassium level is 3.4–4.7 mEq/L or 3.4–4.7 mmol/L. In infants, a normal blood potassium level is 4.13–5.3 mEq/L or 4.1–5.3 mmol/L. In newborns, a normal blood potassium level is 3.9–5.9 mEq/L or 3.9–5.9 mmol/L.

## High levels

High blood potassium levels may be due to:

- kidney disease, either acute or chronic kidney failure;
- Addison's disease (a disease in which the adrenal gland is under-functioning);
- low blood levels of the hormone aldosterone, termed hypoaldosteronism;
- tissue injury, resulting in the release of potassium into the bloodstream, including trauma, heart attack, severe burns;
- infection;
- dehydration;
- diabetes;
- excess intake of foods containing potassium (in particular, fruits and fruit juices are often high in potassium);
- excess intake of potassium supplements; or
- medications that elevate potassium, including NSAIDs (ibuprofen); beta blockers (propranolol and atenolol); ACE inhibitors (captopril, enalapril, lisinopril); and diuretics such as triamterene, amiloride, and spironolactone.

## Low levels

Low blood potassium levels may be due to:

- dehydration;
- severe vomiting;
- severe diarrhea;
- insulin use;
- Cushing's syndrome;
- cystic fibrosis;
- poor nutritional status due to alcoholism, eating disorder, and other causes of malnutrition;
- Bartter's syndrome;
- too much aldosterone in the blood (hyperaldosteronism);
- diuretic use (thiazide diuretics and furosemide, in particular); or
- poor dietary intake of potassium.

## Resources

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### ORGANIZATIONS

- American Association for Clinical Chemistry, 1850 K Street, NW, Suite 625, Washington, DC, 20006, (800) 892 1400, <http://www.aacc.org>.

Rosalyn Carson-DeWitt, M.D.

## Blood pressure measurement

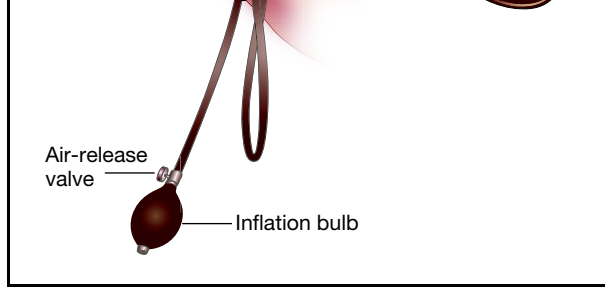
### Definition

Blood pressure measurement is the noninvasive measurement of the pressure exerted by the circulating blood on the walls of the body's arteries.

### Purpose

The purpose of non-invasive blood pressure measurement is to detect any changes from normal values, which may indicate disease. Measurement is also performed to monitor the effectiveness of medication





(Illustration by Electronic Illustrators Group.)

and other methods used to control elevated blood pressure.

Blood pressure should be routinely checked every one to two years and may be monitored more closely during illnesses that affect blood pressure or during medical treatments which may change blood pressure. Measurement can be taken as often as every few minutes.

### Precautions

As there may be no prior knowledge of the patient's previous blood pressure for comparison, a wide range of normal values apply to patients of different ages. The inflated cuff can cause discomfort, and this should be taken into account when dealing with very ill patients. Patients with a history of sickle cell anemia should not have non-invasive blood pressure measurements made with a typical blood pressure cuff, because the sickling process can be initiated by the pressure on the arm. Blood pressure measurements should occur on a limb free of intravascular catheters and **arterial venous fistulas** (joined artery and vein) used for chronic dialysis.

### Description

Blood pressure is usually recorded by measuring the force of the blood during the contraction of the ventricles (lower chambers of the heart) as blood is

**Systolic**—Maximum arterial blood pressure during ventricular contraction.

pumped from the heart to the rest of the body (systolic pressure), and during the period when the heart relaxed between beats and pressure is lowest (diastolic pressure).

The cardiac output, resistance, quality, and quantity of blood circulating through the heart, and the condition of the arterial walls are all factors that influence the blood pressure. Hypertension is an elevation in the blood pressure above normal values, with the diastolic pressure being the indicator most commonly used.

Hypotension is a reduction in the blood pressure below normal values. If a very high or very low pressure is taken, the blood pressure reading may be inaccurate and should be repeated immediately, prior to the initiation of medical treatment.

The non-invasive blood pressure is taken using a **sphygmomanometer**, a hand bulb pump, and a cuff.

The sphygmomanometer may be electronic or mercury-based. The mercury-based unit has a manually inflatable cuff attached by tubing to the unit that contains mercury and is calibrated in millimeters of mercury. The electronic unit is similar, but is mercury-free and inflates and deflates automatically with the reading displayed digitally. The electronic units are also calibrated to display the measurement in millimeters of mercury. Blood pressure can be measured with either unit, although electronic units are becoming more commonplace in both **home care** and clinical use.

Children and adults with smaller or larger than average-sized limbs require special sized cuffs appropriate for their needs. The blood pressure cuff is usually placed on the arm, but can also be used on the leg.

To record blood pressure, the patient may be seated or lying down. The cuff will be positioned so

that it is level with the heart. With an electronic unit the cuff is placed in accordance with manufacturer instructions on the bare upper arm, on the bare wrist, or on the bare index finger.

If the blood pressure is monitored with a manual system, a cuff is placed level with the heart and wrapped firmly but not too tightly around the bare arm 1 in (2.5 cm) above the elbow, with any creases in the cuff smoothed out. Blood pressure measurements taken on the leg require the cuff to be positioned below the groin on the bare leg.

Following the manufacturer's guidelines (electronic models), the cuff is inflated and then deflated automatically. The reading is displayed and recorded by the user. The results are charted with the systolic pressure first, then by the diastolic pressure in the following manner, xxx/xx (e.g., 120/70). A manual system requires a **stethoscope** be placed over the artery, the cuff is then inflated until the artery is occluded and no sound is heard through the stethoscope.

The cuff is then inflated a further 10 mm Hg above the last sound heard. The valve in the pump is slowly opened no faster than 5 mm Hg per second to deflate the pressure in the cuff to the point where a tapping sound is heard over the artery. This point is noted as the systolic pressure. The sounds continue as the pressure in the cuff is released and the artery is no longer occluded. At this point, the noises are no longer heard and this is noted as the diastolic pressure.

With children, the tapping noise changes to a soft muffled sound. That point is noted as the diastolic pressure, as commonly in children, sounds continue to be heard as the cuff deflates to zero.

## Preparation

Medical staff should explain the procedure fully to the patient and reassure him or her that recording blood pressure is part of normal health checks and that it is necessary to ensure the patient's health is being correctly monitored. The appropriate-sized cuff should be used for the patient to give an accurate reading.

The test can be performed at any time, but is best performed when the patient has been resting for at least five minutes so that any exertion, such as climbing stairs prior to the test, will not unduly influence the outcome of the reading.

Devices should be checked and calibrated annually by a qualified technician to ensure accurate readings.

## Aftercare

The health-care practitioner should make the patient comfortable. The medical staff should be notified if the blood pressure measurement is above or below normal values so that treatment can be initiated, continued, or adjusted. Repeated measurements are required for screening purposes and continuity of care.

## Results

The normal values for blood pressure measurement is a systolic pressure of 120 mm Hg and a diastolic pressure of 70–80 mm Hg. Mild hypertension is a diastolic pressure above 90 mm Hg. The American Heart Association states that a systolic pressure above 130–139 mm Hg needs to be watched carefully. Significant hypertension is a systolic pressure above 200 mm Hg. The blood pressure measurement is recorded and compared with normal ranges for the patient's age and medical condition. Based on the results, a decision is made as to whether any further action is required. Hypertension increases the risk of serious diseases such as heart attack and stroke.

Hypotension is demonstrated by with a systolic blood pressure under 80 mm Hg. Treatment options depend on the patient's current health and may include blood or saline administration. Drugs to improve heart rate and function may also be administered.

## Resources

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### ORGANIZATIONS

American College of Nurse Practitioners. 503 Capitol Ct. NE #300, Washington, DC 20002. (202) 546 4825. [acnp@nurse.org](mailto:acnp@nurse.org).

American Heart Association. AHA National Center, 7272 Greenville Avenue, Dallas, TX 75231. (800) AHA USA1. <http://www.americanheart.org>.

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Blood pressure measurement device see

**Sphygmomanometer**

Blood removal see **Phlebotomy**

## Blood salvage

### Definition

Blood salvage is the recovery of a patient's own blood (autologous donation) from a surgical site. This blood is then readministered to the patient.

### Purpose

Preoperative blood salvage can be performed prior to the surgical incision during the induction of anesthesia. This blood is collected to be administered postoperatively, because the clotting factors and platelets are protected from activation and destruction caused by the surgery. This procedure is most often used if cardiopulmonary bypass (use of a heart-lung machine) will be instituted. If the blood is not given to the patient, it will be discarded. Preoperative **blood donation** or **autologous blood donation** is a coordinated donation process planned prior to a scheduled surgical procedure, but it is not considered blood salvage.

Blood salvage is performed during surgical procedures when the risk of significant blood loss is expected. The recovered blood is collected, processed, and readministered to the patient, decreasing or preventing the need for allogeneic (from a donor) blood product administration. If the blood is not given to the patient, it will be discarded.

Postoperative blood salvage is used to collect blood from the surgical cavity as the wound heals. The blood is collected, may or may not be processed, and returned to the patient. If the blood is not given to the patient, it will be discarded.

Administration of the patient's own blood eliminates the risk of transfusion-transmitted viral disease and **transfusion** reactions. Patients with multiple red blood cell antibodies or rare blood types benefit by blood salvage during the perioperative (during surgery) and postoperative period. Shortages of rare blood types can put the patient at risk for cardiovascular

## KEY TERMS

**Allogeneic**—Blood and blood products collected from a blood donor for administration to a recipient.

**Autologous**—Blood and blood products collected from an individual for readministration to self.

**Catheter**—A tube for transferring fluids out of the body. Patients experiencing open heart surgery will have at least one chest tube placed in the chest cavity to provide removal of blood from the chest cavity for collection and readministration.

**Transfusion container**—An administration bag made of polyvinyl chloride or other latex-free polymer for collection of blood products for administration to the patient.

collapse caused if hemorrhage occurs during the surgical procedure.

Some Jehovah's Witnesses patients refuse allogeneic blood donation. Blood salvage provides an opportunity for autologous blood donation for these patients. Certain modifications in collection technique make autologous blood donation an acceptable treatment for members of this faith.

Neurological, vascular, cardiac, liver transplant, and orthopedic procedures make extensive use of blood salvage techniques. Patients having surgical procedures involving amniotic fluid, malignancies, bowel contamination, or microfibrillar collagen materials are not eligible for blood salvage. In the presence of amniotic fluid or bowel contamination, thorough rinsing of the surgical site may allow for blood salvage.

### Description

#### *Preoperative blood salvage*

The patient will be provided with cardiac monitoring prior to the initiation of autologous blood collection. A venous access site will be gained with a catheter. The 500–1,000 ml of whole blood is collected into a transfusion container treated with anticoagulant. The container is properly labeled for the patient and clearly marked "AUTOLOGOUS DONOR." The blood can be stored for six hours if refrigerated, and will be destroyed if not used within that time.

Blood collected in this manner is not processed further, but stored for later administration. The whole blood product provides not only red blood cells, but more importantly, plasma proteins including clotting

factors and platelets. This technique is most often associated with cardiopulmonary bypass, since the heart-lung machine can damage clotting factors and platelets. The preoperative collection protects the blood components.

### *Perioperative blood salvage*

During surgery, the surgeon suctions blood in the surgical cavity for collection. Anticoagulant is mixed with the blood at the tip of the suction apparatus. The blood is filtered as it is collected into a container. From this collection container the blood may be placed into a transfusion container for direct administration to the patient. This blood will be anticoagulated and will contain all plasma proteins, including activated clotting factors and platelets. More commonly, the blood is processed by centrifugation. The blood is centrifuged to separate the red blood cells from the plasma. The plasma is removed as saline enters the centrifuge to wash the blood. Washing the blood removes anticoagulation, plasma-free hemoglobin, and plasma proteins, including activated clotting factors and platelets. This product is called washed packed red cells. After washing is complete, the blood is collected into a transfusion container free of anticoagulant, since all clotting factors have been removed during washing. The container is properly labeled for the patient and clearly marked "AUTOLOGOUS DONOR." The blood can be stored for six hours if refrigerated, and will be destroyed if not used within that time.

### *Postoperative blood salvage*

Postoperative blood salvage is used to remove shed blood from the surgical cavity that has been closed at the completion of the surgical procedure. At wound closure, a catheter is left in the cavity and penetrates the skin for connection to the collection reservoir. If the blood is collected from the chest cavity, no anticoagulation is required. If the blood is collected from a joint, it must receive anticoagulation during collection. The blood from the chest cavity is usually reinfused without additional processing, but may be washed. Blood collected from a joint must be washed prior to infusion. Washing involves centrifugation of the blood to separate the red blood cells from the plasma. The plasma contains anticoagulant-free hemoglobin and plasma proteins, including activated clotting factors and platelets. Once the red blood cells and plasma are separated, saline is introduced to the centrifuge to displace the plasma. The end product, called washed packed red blood cells, is collected into a transfusion container. The container is properly

labeled for the patient and clearly marked "AUTOLOGOUS DONOR." The blood can be stored for six hours if refrigerated, and will be destroyed if not used within that time.

### Normal results

The patient will receive autologous blood donation when the red blood cell volume, as measured by hemoglobin or **hematocrit** values, falls below the desired level, commonly 18–21% or 6–7 g/dl, respectively. These values will be dictated by the physician in the orders for patient care.

If the patient's condition is acceptable, autologous blood donation with preoperative blood collection occurs immediately following the termination of cardiopulmonary bypass. Blood collected postoperatively will be administered as need for maintenance of blood pressure or red cell volume.

The patient benefits from blood salvage by the elimination of risk of blood-transmitted virus or blood transfusion reactions. Blood transfusion reactions are experienced by about 10% of recipients for each unit transfused.

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#### ORGANIZATIONS

American Association of Blood Banks. 8101 Glenbrook Rd., Bethesda, MD 20814. (301) 907 6977. <http://www.aabb.org/content>.

American Red Cross. 431 18th St., NW, Washington, DC 20006. (202) 639 3520. <http://www.redcross.org>.

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## Blood sodium level

### Definition

Sodium is a mineral that is found throughout the body and is crucial (along with other electrolytes) to the appropriate balance of fluid in the body. Sodium is primarily found in bodily fluids and blood. For the body to function normally, blood sodium levels have to be maintained at a very narrow range; when sodium levels are too high or too low, serious health consequences can result. The body keeps its sodium levels in equilibrium by prompting the kidneys to resorb more (when the body needs sodium) or excrete more (when there is excess sodium). The hormones responsible for stimulating the processing of sodium in the kidneys are called natriuretic peptides, which prompt the kidneys to excrete sodium into the urine and out of the body; aldosterone, which prompts the kidneys to hold onto or resorb sodium; and antidiuretic hormone or ADH, which prompts the retention of fluids in the bloodstream, thus increasing the amount of water in the bloodstream and diluting the blood sodium level. The mechanism of thirst is another important way that blood sodium levels are controlled; as small as a 1% increase in blood sodium level will prompt thirst, which initiates drinking behavior and serves to drop the elevated blood sodium level. When blood sodium levels get too high, the condition is called hypernatremia. When blood sodium levels get too low, the condition is called hyperkalemia.

### Purpose

A blood sodium level is usually drawn as part of a larger panel of electrolytes. Other measurements in the electrolyte panel include chloride, potassium, and carbon dioxide. A blood sodium level is usually checked during a routine **physical examination**, as well as when there are concerns about the functioning of the patient's kidneys; when the patient has high blood pressure (hypertension); to monitor sodium levels during the use of intravenous fluid therapy; in patients on dialysis; in patients who have symptoms of heart failure or who are known to have heart failure; in patients with liver disease; in patients with lower leg swelling or other fluid accumulation; and in patients with symptoms that could possibly be due to electrolyte imbalance, specifically low blood sodium levels or hyponatremia. These symptoms can include confusion, severe fatigue and weakness, extreme thirst, low urine output, muscle twitching, irritability, or agitation.

### Precautions

Blood sodium levels can be affected by a number of medications. Patients who are on these medications should inform their doctor, so that test results can be interpreted appropriately. Medications that increase blood sodium levels include birth control pills, some **antibiotics**, clonidine, steroid medications, anabolic steroid use, cough preparations, **laxatives**, methyldopa, and nonsteroidal anti-inflammatory agents (including ibuprofen). Medications that decrease blood sodium levels include carbamazepine, **diuretics**, sulfonylureas, triamterene, and vasopressin. Other factors that may skew the results of blood sodium level include intravenous infusion of fluids containing sodium; excess ingestion of food or beverages containing salt; excess consumption of fluids; use of the hormone aldosterone; and recent severe injury, surgery, or shock.

Patients who are taking anticoagulant medications should inform their healthcare practitioner since this may increase their chance of bleeding or bruising after a blood test.

### Description

This test requires blood to be drawn from a vein (usually one in the forearm), generally by a nurse or phlebotomist (an individual who has been trained to draw blood). A tourniquet is applied to the arm above the area where the needle stick will be performed. The site of the needle stick is cleaned with antiseptic and the needle is inserted. The blood is collected in vacuum tubes. After collection, the needle is withdrawn and pressure is kept on the blood draw site to stop any bleeding and decrease bruising. A bandage is then applied.

### Preparation

There are no restrictions on diet or physical activity, either before or after the blood test.

### Aftercare

As with any blood tests, discomfort, bruising, and/or a very small amount of bleeding is common at the puncture site. Immediately after the needle is withdrawn, it is helpful to put pressure on the puncture site until the bleeding has stopped. This decreases the chance of significant bruising. Warm packs may relieve minor discomfort. Some individuals may feel briefly woozy after a blood test, and they should be encouraged to lie down and rest until they feel better.



## KEY TERMS

**Addison's disease**—A condition in which the adrenal glands are not functioning properly. Addison's disease can be caused by a problem in the adrenal glands themselves, or in the pituitary gland, which secretes a hormone that affects the adrenal glands.

**Aldosterone**—A hormone secreted by the adrenal glands that prompts the kidneys to hold onto sodium.

**Antidiuretic hormone (ADH)**—Also called vasopressin. A hormone produced by the hypothalamus and stored in and excreted by the pituitary gland. ADH acts on the kidneys to reduce the flow of urine, increasing total body fluid.

**Cushing's syndrome**—A disorder affecting the adrenal glands and their secretion of cortisol.

**Diuretic**—A medication that increases the flow of urine through the kidneys and out of the body.

**Hypernatremia**—Elevated blood sodium levels.

**Hyponatremia**—Low blood sodium levels.

**Natriuretic peptides**—Peptides that prompt the kidneys to excrete sodium into the urine and out of the body.

## Risks

Basic blood tests, such as blood sodium levels, do not carry any significant risks other than slight bruising and the chance of brief dizziness.

## Results

A normal blood sodium level is 136–145 milliequivalents per liter (mEq/L), or 136–145 millimoles per liter (mmol/L).

### High levels

High blood sodium levels may be due to:

- dehydration (increased loss of body water without sufficient replacement by drinking, which often occurs in febrile illnesses, with severe diarrhea and/or vomiting, or in situations involving heavy exercise in hot weather, resulting in fluid loss through sweating);
- high blood levels of the hormone aldosterone, termed hyperaldosteronism;
- Cushing's syndrome;
- diabetes insipidus (caused by a shortage of antidiuretic hormone);

- diabetic ketoacidosis;
- diuretic use;
- head injury or brain surgery, particularly if the pituitary gland is affected;
- sickle cell anemia;
- kidney disease;
- medications including lithium, demeclocycline, or diuretics; or
- ingestion of an extremely high-sodium diet.

### Low levels

Low blood sodium levels may be due to:

- Addison's disease;
- thyroid insufficiency;
- severe diarrhea;
- diuretic use;
- excess sweating;
- serious burns;
- kidney disease, including those resulting in the loss of protein from the body (nephrotic syndrome);
- cirrhosis of the liver;
- cystic fibrosis;
- increased retention of water in the body, due to excess consumption of water, heart failure, or cirrhosis of the liver
- poor nutritional status due to alcoholism, eating disorder, other causes of malnutrition;
- disorders involving the pituitary gland;
- medications such as chlorpropamide, carbamazepine, vincristine, clofibrate, antipsychotic medications, aspirin, ibuprofen, synthetic vasopressin, and oxytocin;
- too much antidiuretic hormone (also called vasopressin) in the blood (referred to as syndrome of inappropriate antidiuretic hormone or SIADH). This syndrome can occur due to a wide variety of conditions involving the lung and brain, including brain injury, infections such as meningitis and encephalitis, pneumonia, acute respiratory failure, brain tumors, lung cancer, and psychosis;
- a number of conditions can also stimulate release of ADH from the pituitary, such as pain, stress, exercise, dehydration, increased levels of other blood electrolytes, and low blood sugar levels; or
- poor dietary intake of sodium (this is extremely rare).

## Resources

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#### ORGANIZATIONS

American Association for Clinical Chemistry, 1850 K Street, NW, Suite 625, Washington, DC, 20006, (800) 892 1400, <http://www.aacc.org>.

Rosalyn Carson-DeWitt, MD

Blood sugar test see **Glucose tests**

Blood thinners see **Anticoagulant and anti-platelet drugs**

Blood transfusion see **Transfusion**

## Blood type test

### Definition

A blood type test determines to which of the major blood groups an individual's blood belongs. Blood typing categorizes blood by identifying the presence or absence of particular substances on the surface of the red blood cell. The substances are called "antigens," and may be molecules of protein, carbohydrate, glycolipid, or glycoprotein.

Although there are a large number (perhaps as many as 690) of blood group systems that can identify unique attributes of antigens on red blood cells, two are commonly used and seem to be the most clinically relevant. These are the ABO blood group system and the Rhesus or Rh blood group system. These two blood group systems are the most well known, well-defined, and also the most important as regards known reactions to situations involving blood transfusions.

Blood typing is particularly important when an individual needs to receive a blood **transfusion**. If the wrong blood type is given, there is a high risk of an adverse transfusion reaction. The recipient's immune system will recognize the antigen on the donor blood as foreign, and will begin to produce antibodies directed against that antigen. The antibodies will attack the donor blood, damaging and bursting the donor red blood cells. This results in high serum levels of hemoglobin spilling from the burst red blood cells

(called hemoglobinemia), disseminated intravascular coagulation or DIC (a condition in which clotting factors are used up very rapidly, resulting in the potential for severe, uncontrollable bleeding), kidney failure, and eventually complete cardiovascular collapse (a combination of heart attack, shock, and lack of blood flow to all major organs and tissues).

The Rh system identifies the presence (denoted as positive) or absence (denoted as negative) of another type of antigen termed the Rhesus antigen, because it was first identified on the red blood cell surfaces of Rhesus monkeys. The major blood type, then, is reported as a combination of the ABO and Rh blood group system; for example, A-positive, or A-negative, etc.

Knowing a pregnant woman's Rh-factor is crucial because there is always a chance during pregnancy, labor, and delivery that some of the baby's blood will get into the mother's bloodstream. If this happens in an Rh-negative mother with an Rh-positive baby, the mother's body will identify the baby's Rh-negative blood as foreign and begin producing antibodies against the Rh-factor. This is called Rh-sensitization. The first time this sensitization occurs between a mother and her baby, the baby usually doesn't suffer any ill-effects. But in subsequent pregnancies, if the mother is again carrying an Rh-positive baby, having already been exposed to the Rh-antigen previously, her body will begin to produce Rh-antibodies more quickly and in greater numbers. If these cross over into the baby's bloodstream, they can begin destroying the baby's red blood cells, resulting in severe illness. This problem is referred to as Rh disease, hemolytic disease of the newborn, or erythroblastosis fetalis. In order to avoid this problem, Rh testing is done prior to pregnancy or early in pregnancy. Rh-negative women can be given a special shot called Rh-immune globulin which can prevent Rh-sensitization.

### Purpose

Blood typing is ordered prior to a blood transfusion, to make sure that the donor blood type is appropriately compatible with the recipient's blood type. It is also done on donor blood, on a donor who is giving an organ to be used for transplantation, as well as prior to surgery (so that the patient's blood type is known, should the individual needs an unexpected, emergency blood transfusion). Rh-typing is also important in pregnant women. When the mother and the baby have different Rh-types, there is a risk to the baby of illness caused by the mother's antibodies; if the mother is identified as having Rh-negative

## KEY TERMS

**Disseminated intravascular dissemination**—A condition in which the clotting factors in the blood are rapidly used up, resulting in a severe deficit in clotting factors and a very high risk of severe, uncontrollable bleeding.

**Erythroblastosis fetalis**—A condition in which the incompatibility between a mother's Rh-negative blood type and a baby's Rh-positive blood type results in destruction of the baby's red blood cells by maternal antibodies.

blood, a shot called Rh-immune globulin can prevent the problem from developing.

### Precautions

Some situations may confuse the results of blood typing, including a recent x-ray test using contrast, use of medications such as methyldopa, levodopa, and certain **antibiotics** (including cephalexin). Other factors that may confuse test results include having received a blood transfusion in the previous three months, having had a bone marrow transplant in the past, or having a history of cancer or leukemia.

### Description

This test requires blood to be drawn from a vein (usually one in the forearm), generally by a nurse or phlebotomist (an individual who has been trained to draw blood). A tourniquet is applied to the arm above the area where the needle stick will be performed. The site of the needle stick is cleaned with antiseptic, and the needle is inserted. The blood is collected in vacuum tubes. After collection, the needle is withdrawn, and pressure is kept on the blood draw site to stop any bleeding and decrease bruising. A bandage is then applied.

### Preparation

There are no restrictions on diet or physical activity, either before or after the blood test.

### Aftercare

As with any blood tests, discomfort, bruising, and/or a very small amount of bleeding is common at the puncture site. Immediately after the needle is withdrawn, it is helpful to put pressure on the puncture site until the bleeding has stopped. This decreases

the chance of significant bruising. Warm packs may relieve minor discomfort. Some individuals may feel briefly woozy after a blood test, and they should be encouraged to lie down and rest until they feel better.

### Risks

Basic blood tests, such as blood typing, do not carry any significant risks, other than slight bruising and the chance of brief dizziness.

### Results

The ABO blood group system identifies a type of protein antigen on the red blood cell surface. The types of blood types within this system include type A, type B, type AB, and type O:

- People with type A blood have the A antigen on their red blood cell surface; they produce antibodies that can destroy B-type antigens. They can only safely receive either types A or O blood in transfusion.
- People with type B blood have the B antigen on their red blood cell surface; they produce antibodies that can destroy A-type antigens. They can only safely receive either types B or O blood in transfusion.
- People with type AB blood have both A and B antigens on their red blood cell surface; they do not produce any antibodies against A or B antigens. Type AB individuals have both types of major antigens present on their red blood cells, therefore they can safely receive any of the blood types (A, B, or O) in a transfusion without the risk of producing antibodies against the donor blood types. People with type AB blood are sometimes called “universal recipients.”
- People with type O blood have neither A nor B antigens on their red blood cell surface, and they produce antibodies against both A and B antigens. Type O blood is sometimes called the “universal donor” type because it displays no antigens on its red blood cell surface and can be transfused into people with types A, B, or AB blood without causing adverse effects; however, people with type O blood can only safely receive type O blood in a transfusion.

The most common ABO blood type in the United States is type O; the most common Rh factor in the United States is positive. Distribution of blood types in the United States is as follows:

- 45% type O, of which 38% are O-positive and 7% are O-negative
- 40% type A, of which 34% are A-positive and 6% are A-negative

- 11% type B, of which 3% are B-positive and 1% are B-negative
- 4% type AB, of which 3% are AB-positive and 1% are AB-negative

## Resources

### BOOKS

Goldman L., D. Ausiello, eds. *Cecil Textbook of Internal Medicine*, 23rd ed. Philadelphia: Saunders, 2007.

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### ORGANIZATIONS

American Association for Clinical Chemistry, 1850 K Street, NW, Suite 625, Washington, DC, 20006, (800) 892 1400, <http://www.aacc.org>.

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Blood typing see **Type and screen**

## Blood urea nitrogen test

### Definition

Blood urea nitrogen (BUN) is a chemical waste product of protein metabolism. Proteins are broken down into amino acids within the liver; these amino acids are metabolized, giving rise to nitrogen. Nitrogen is coupled with other molecules within the liver, producing the waste product urea that circulates in the bloodstream and goes to the kidneys. Healthy kidneys filter out this waste material from the blood. It passes into the urine and out of the body. Unhealthy kidneys, however, are unable to filter urea out of the blood. The urea remains circulating in the bloodstream, and blood urea nitrogen (BUN) levels rise as the liver continues to metabolize proteins.

The blood urea nitrogen level is used to predict how the kidneys are functioning. In many cases, the blood urea nitrogen level will begin to rise before a patient is even aware of any symptoms of kidney malfunction. High BUN levels indicate the need for further investigation into the possibility that kidney

failure is ensuing. If a BUN level is elevated, then other tests such as a **serum creatinine level** or a 24-hour urine creatinine will be performed. Calculations involving serum and urine creatinine levels will give the creatinine clearance, a figure which reflects the capacity of the kidneys to filter small molecules out of the bloodstream.

### Purpose

A blood urea nitrogen level is usually drawn as part of a larger metabolic panel or screen. Other tests performed in this panel include electrolytes (sodium, potassium, chloride, and carbon dioxide), as well as calcium, glucose, and serum creatinine level. A blood urea nitrogen level is usually checked during a routine **physical examination**, as well as to evaluate acutely or chronically ill patients for the presence of kidney or liver disease, to monitor patients who have illnesses or who are taking medications that might affect the functioning of their kidneys, or to make sure that treatment for kidney disease (including hemodialysis or peritoneal dialysis) is effective.

### Precautions

Blood urea nitrogen levels can be affected by a number of medications. Patients who are on these medications should inform their doctor, so that test results can be interpreted appropriately. Medications that may affect blood urea nitrogen levels include **diuretics**, amphotericin B, nafcillin, aminoglycosides, kanamycin, tobramycin, steroid medications, tetracycline **antibiotics**, and chloramphenicol. Additionally, if the blood urea nitrogen level is going to be used in calculations with serum or urine creatinine levels to evaluate kidney functioning, results may be skewed by the following medications: methyldopa, trimethoprim, vitamin C, cimetidine, certain diuretics, cephalosporin antibiotics, phenytoin, captopril, quinine, quinidine, and procainamide.

Patients who are taking anticoagulant medications should inform their healthcare practitioner since this may increase their chance of bleeding or bruising after a blood test.

### Description

This test requires serum to be drawn from a vein (usually one in the forearm), generally by a nurse or phlebotomist (an individual who has been trained to draw serum). A tourniquet is applied to the arm above the area where the needle stick will be performed. The site of the needle stick is cleaned with antiseptic, and the needle is inserted. The serum is collected in vacuum



## KEY TERMS

**Creatine**—Creatine is a substance produced from protein and stored in the muscles. Creatine is a source for energy, allowing muscle contraction to take place. Some creatine is converted to creatinine, and enters the bloodstream, where it is filtered out by healthy kidneys and leaves the body in the urine. When the kidneys are not functioning properly, creatinine levels in the blood become abnormally elevated.

**Creatinine**—Creatinine is a chemical waste product that is produced by the muscles. Creatinine enters the bloodstream and goes to the kidneys. Healthy kidneys filter out this waste material from the blood. It passes into the urine and out of the body. Unhealthy kidneys, however, are unable to filter out the creatinine from the blood. The creatinine remains circulating in the bloodstream, and levels rise as the muscles continue to produce more and more.

**Urine creatinine level**—A value obtained by testing a 24-hour collection of urine for the amount of creatinine present.

tubes. After collection, the needle is withdrawn, and pressure is kept on the serum draw site to stop any bleeding and decrease bruising. A bandage is then applied.

## Preparation

In the 24–48 hours prior to a blood urea nitrogen level, patients should be advised to limit the amount of protein they ingest. Because urea is a waste product of protein metabolism, ingesting more than eight ounces of meat (particularly beef) or other protein sources in the 24 hours prior to the blood urea nitrogen level is performed may affect the results.

## Aftercare

As with any blood tests, discomfort, bruising, and/or a very small amount of bleeding is common at the puncture site. Immediately after the needle is withdrawn, it is helpful to put pressure on the puncture site until the bleeding has stopped. This decreases the chance of significant bruising. Warm packs may relieve minor discomfort. Some individuals may feel briefly woozy after a serum test, and they should be encouraged to lie down and rest until they feel better.

## Risks

Basic serum tests, such as blood urea nitrogen levels, do not carry any significant risks, other than slight bruising and the chance of brief dizziness.

## Results

A normal blood urea nitrogen level is 10–20 milligrams per deciliter (mg/dL) or 3.6–7.1 millimoles per liter (mmol/L). Women and children metabolize protein slightly differently than do men, so their BUN levels may normally be lower than those of men. BUN levels also regularly rise with age, and

### High levels

High blood urea nitrogen levels suggest that the kidneys are suffering from damage or disease. Kidneys can be damaged by severe infections, shock, cancer, dehydration, high blood pressure, diabetes, or conditions that limit the blood flow reaching the kidneys (such as heart attack, stress, shock, congestive heart failure, or severe burns). High blood urea nitrogen levels can also occur when the urinary tract is blocked (by a kidney stone or tumor). Other causes of increased BUN include excess Addison's disease, dietary intake of protein, bleeding in the gastrointestinal tract (resulting in the metabolism of these blood proteins generating increased urea), tissue damage that increases protein levels that reach the liver (such as may occur with very severe burns), or increases in the rate of protein metabolism in the body. BUN levels may also be elevated during a completely normal pregnancy.

### Low levels

Low blood urea nitrogen levels are not diagnostic; however, they may reflect the presence of conditions such as overhydration, poor nutrition, liver disease, or pregnancy.

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American Association for Clinical Chemistry, 1850 K Street, NW, Suite 625, Washington, DC, 20006, (800) 892 1400, <http://www.aacc.org>.

Rosalyn Carson-DeWitt, M.D.

## Bloodless surgery

### Definition

Bloodless surgery is an approach to health care that began in the 1960s to avoid the use of transfused blood or blood-related products. The technique has grown over the last four decades, however, to include changed attitudes toward blood conservation, as well as new technologies that minimize the need for transfusions during surgery.

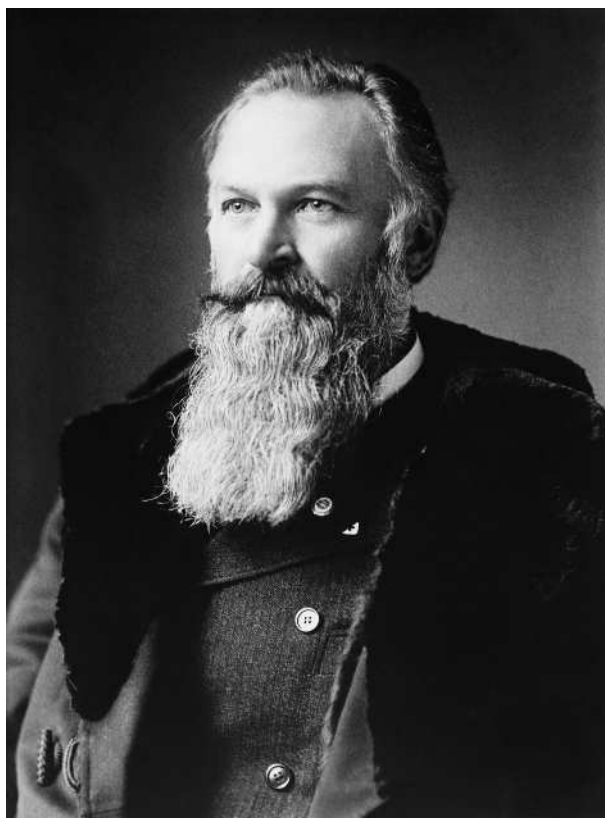
### Purpose

The new interest in bloodless surgery has emerged from a variety of religious and social concerns, as well as medical, legal, and economic issues.

### *Religious and ethical considerations*

One of the earliest motivations for bloodless surgery was finding ways to treat Jehovah's Witnesses who needed **emergency surgery** without offending their beliefs about blood **transfusion**. Many of the larger bloodless surgery centers in the United States serve areas with a large population of Jehovah's Witnesses. The specific Biblical passages that Witnesses cite as the basis for their objections are Genesis 9: 4–5, in which God forbids eating animal “flesh with its blood”; and Acts 15:29, in which the Apostles ask their first converts to “abstain from blood.”

Respect for the religious beliefs of a specific group, however, is related to a more general ethical concern for patients' rights. While a majority of bloodless surgical procedures are still requested by Jehovah's Witnesses, the proportion of other patients requesting bloodless surgery has risen and is expected to continue to increase. The number of medical centers in the United States that offer bloodless surgery continues to expand. The increased demand for bloodless procedures reflects changing attitudes on the part of patients, who are aware that they have choices about health care and expect medical professionals to respect their decisions. Hospitals with bloodless surgery centers emphasize the importance of patients' ethical rights to privacy and self-determination, as well as their legal rights to refuse treatments that they find objectionable.



**Adolf Lorenz (1854–1946), orthopedic surgeon and pioneer of bloodless surgery.** (Library of Congress / Photo Researchers, Inc.)

### *Patient safety*

The most important non-religious reason that patients give for requesting bloodless surgery is concern about the safety of blood transfusions. These fears are related to the quality of the American blood supply, as well as the process of blood transfusion itself, and include:

- Blood-borne diseases. Many patients are afraid of contracting such diseases as AIDS and hepatitis from allogeneic (donated) blood. The risk of contracting these specific diseases has been vastly reduced over the past several decades. The risk of contracting hepatitis from transfused blood has continued to decrease since the 1960s. The risk of contracting HIV infection has been reduced by a factor of 10,000 since the virus was first identified in 1983. However, many patients are concerned about the possibility of being infected by disease agents that have not yet been identified as blood borne.
- Transfusion reactions related to medical errors. In contrast to the reduction of risk from infection, there has been little reduction of risk since 1960 of non-infectious serious hazards of transfusion (NISHOT).

## KEY TERMS

**Allogeneic blood**—Blood that comes from a human donor other than the patient receiving the blood.

**Autologous blood**—The patient's own blood is drawn and set aside before surgery for use in case a transfusion is needed.

**Autotransfusion**—A technique for recovering blood during surgery, separating and concentrating the red blood cells, and reinfusing them in the patient. Also known as blood salvage.

**Electrocautery**—A technique for sealing a blood vessel with a holder that contains a wire heated by electricity.

**Erythropoietin**—A hormone secreted chiefly by the kidney (in adults) that stimulates the production of red blood cells.

**Harmonic scalpel**—A scalpel that uses ultrasound technology to seal tissues while it is cutting.

**Hemodilution**—A technique in which the fluid content of the blood is increased without increasing the number of red blood cells.

**Hemoglobin**—The red pigment in red blood cells that carries oxygen.

**Hypotension**—In the context of bloodless surgery, the deliberate lowering of the patient's arterial blood pressure in order to decrease blood loss.

**Plasma**—The liquid portion of blood, as distinguished from blood cells. Plasma constitutes about 55% of blood volume.

**Platelets**—Disk-shaped structures found in blood that play an active role in blood clotting. Also known as thrombocytes.

NISHOT statistics include mistransfusion and ABO/Rh-incompatibility. Although transfusion errors are only a small percentage of all medical errors reported in North American hospitals, they are the most common cause of serious mortality and morbidity associated with blood transfusions. About 25 patients die each year in the United States from transfusion errors involving ABO-Rh incompatibility. These errors are due to misidentification of type-and-cross-match samples, laboratory errors, or misidentification of the transfusion recipient. Even patients who donate their own blood (autologous donation) in preparation for elective surgery cannot be completely certain that their blood will be correctly labeled and used during their operation.

- Immune system reactions. Allogeneic blood has been shown to disrupt the immune system and reduce longevity in cancer patients. Other studies have shown that transfused donor blood suppresses the production of B-cells and T-cells in recipients.
- Availability of blood. Many healthcare professionals are concerned about the growing shortage of blood for surgical procedures in the United States. Some blood types are less common than others; in addition, there are often seasonal shortages of blood. Additionally, there is an increasing demand for blood; three million pints of blood are used in the United States every year just for elective surgery. Also, many surgical procedures require large amounts of blood or blood products.

### *Economic issues*

The cost of allogeneic blood transfusions is higher than most people realize. Even though the donated blood itself is free, the costs of preparing, storing, transporting, and unpackaging the blood can be very high.

### *Demographics*

A significant problem confronting blood banks in the United States is the growing proportion of older Americans in the general population. Their numbers are not matched by any corresponding increase in the donor population; it is estimated that only 5% of American adults give blood regularly. Although a wide cross-section of the public can be found at blood drives, the statistically average donor is a college-educated married Caucasian male between the ages of 30 and 50 with an above-average income. The aging of the so-called baby boomer generation, which represents a large segment of the population, is expected to lead to a critical shortage of blood by 2030. The rise in the number of complex orthopedic procedures associated with high-volume blood loss that are performed largely in elderly patients contributes to the likelihood of a severe blood shortage over the next two decades.

Another demographic change that affects the size of the population eligible to donate blood is the increased popularity of tourism and the rising number of people stationed in other countries by their employers or the military. People who have been exposed to or have a history of certain diseases from living abroad are either indefinitely or permanently deferred from giving blood.

## Description

Bloodless surgery covers a wide variety of changes in medical practice as well as new equipment and technological innovations.

### *Preoperative assessment of patients*

A patient seeking bloodless **elective surgery** is carefully evaluated for a history of unexpected bleeding or clotting problems after medical or dental procedures. The patient will also be asked about a family history of bleeding disorders.

The patient's blood will be tested to determine hemoglobin levels. In most cases, the patient will be given medications to build up hemoglobin levels prior to surgery.

Care is taken to minimize the number and size of blood samples drawn for **presurgical testing**. The invention of microanalyzers allows hospital laboratories to run blood tests on samples of blood that are 30–60% smaller than those previously collected and to use the same blood sample for multiple tests.

### *New instruments and surgical techniques to reduce blood loss during surgery*

The invention of several types of new **surgical instruments** has allowed surgeons to perform a variety of procedures with minimal blood loss. Miniaturized endoscopes make it possible to perform surgery on the abdomen and spine through very small incisions, often shorter than 1 in (2.5 cm) in length. The invention of argon beam coagulators, electrocautery devices, and harmonic scalpels, which use a combination of **ultrasound** vibration and friction to clot blood at the same time as cutting, also help to make transfusions unnecessary. In addition, surgeons are being trained to use extra caution during surgery and to clamp or cauterize open blood vessels as quickly as possible.

Blood transfusions can sometimes be avoided by scheduling lengthy surgical procedures in two stages. Although this approach requires additional exposure to **general anesthesia**, it can shorten the overall length of the patient's hospital stay. The patient can be discharged after the first operation relatively quickly and build up his or her hemoglobin levels before the second procedure. In addition, the second surgery can be completed without the need for allogeneic blood.

Hypotension in surgery refers to the intentional lowering of the patient's arterial blood pressure during the procedure. Lowering blood pressure has been shown to reduce blood loss and the consequent need for transfusions. It also shortens the length of time

spent in the **operating room**. The limitation of hypotension is that it cannot be used in surgical procedures requiring tissue grafting or in patients with coronary artery disease.

Hemodilution is a technique in which whole blood from the patient is withdrawn before surgery for temporary storage and replaced with crystalloid or colloid solutions that restore the normal fluid volume of the blood without adding new blood cells. The patient thus loses fewer red blood cells during surgery. At the close of the operation, the patient's own blood is reinfused, thus minimizing the possibility of transfusion error or a transfusion reaction.

**Blood salvage**, which is also called autotransfusion, involves an automated recovery system that collects the patient's blood during surgery in a cell separation device. This device separates the red blood cells from other blood components, washes them, and concentrates them for reinfusion.

### *Reevaluation of postoperative anemia*

Another change that has affected the frequency and number of blood transfusions is the reevaluation of anemia and its effects on the body. At one time, patients were automatically given blood transfusions if their hemoglobin level fell below 10 g/dL. More recent studies have shown that patients can tolerate hemoglobin levels of 5 g/dL or even lower. At present, the so-called transfusion trigger is a hemoglobin level of 7 g/dL, evaluated in the context of the patient's overall clinical condition.

### *Red cell substitutes*

Researchers are presently investigating the possibility of manufacturing substitutes for red blood cells that would reduce the cost of transfusions while improving patient safety. Two approaches that have been explored are cell-free hemoglobin solutions and perfluorocarbon solutions. Neither approach has yielded satisfactory results so far: the hemoglobin solutions have a short half-life, and the perfluorocarbon solutions would be difficult to administer intravenously. Further research is underway.

## Diagnosis/Preparation

### *Administrative*

Preparation for nonemergency bloodless surgery includes a registration process as well as medical preparation. The patient is given an advance directive and enrollment form to sign. The documents are kept on file with the patient's preadmission chart. After the

patient is admitted, he or she is given a red (or other distinctive color) wristband with the words “Do Not Administer Blood Products.” Signs and stickers with the same warning are attached to the patient’s bed and chart.

### Medical

One of the basic components of bloodless surgery programs is presurgical treatment intended to boost the oxygen-carrying capacity of the patient’s blood. Patients are given erythropoietin (EPO) several weeks before surgery. EPO is a hormone that stimulates the bone marrow to produce more red blood cells, as many as seven times the normal amount. The greater number of red cells increases the blood’s ability to carry oxygen. In addition to the EPO, patients are given iron supplements, most commonly ferrous sulfate, iron dextran, or vitamin B.

### Normal results

Patients who have been treated in bloodless surgery centers are generally satisfied with the care they receive. Hospitals have found that patients recover faster with fewer complications; it has been reported that patients requiring inpatient procedures leave the hospital on average a full day earlier than patients who have had conventional transfusions.

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## Body temperature

### Definition

Temperature is a measure of an organism’s ability to generate and get rid of heat. The human body has mechanisms to maintain its internal temperature within a relatively narrow, safe range despite relatively large variations in temperatures in which the body exists.

### Purpose

The purpose of maintaining body temperature within a relatively narrow range is to promote and sustain life.



## Demographics

Thermometers are used to measure body temperature. They are calibrated in either degrees Fahrenheit (°F) or degrees Celsius (°C). Temperatures in the United States are typically measured in degrees Fahrenheit. The standard in most countries of the world is degrees Celsius.

## Description

When humans become too warm, blood vessels in the skin increase in diameter (dilate). The purpose is to carry the excess heat to the surface of the skin. In turn, this causes the body to begin to perspire. As the perspiration evaporates, it helps to cool the body. When the body becomes too cold, the blood vessels decrease in diameter (contract) so that blood flow to the skin is reduced in an attempt to conserve body heat. This often causes people to start shivering. This involves rapid, involuntary contractions of muscles. Shivering helps to generate additional heat through muscle activity. Under normal conditions, these activities maintain human body temperature within a narrow range that is healthy for the organism.

Body temperature can be measured in many locations. The mouth, ear, armpit, and rectum are the most commonly used places. Temperature can also be measured on the forehead.

Body temperature is checked for several reasons.

- To detect fever.
- To document an abnormally low body temperature (hypothermia) in people who have been exposed to cold.
- To document an abnormally high body temperature (hyperthermia) in people who have been exposed to heat.
- To monitor the effectiveness of a fever-reducing medicine (antipyretic).
- To determine when a female is ovulating, thereby increasing the probability of becoming pregnant.

## Preparation

Preparation for taking a body temperature consists of ensuring that the **thermometer** is clean and disinfected.

## Aftercare

Aftercare consists of ensuring that a thermometer is clean and disinfected. Electronic thermometers must be turned off to conserve their batteries.

## Risks

Taking a body temperature involves little risk. Inserting a thermometer into the rectum can occasionally be painful. Breaking a thermometer that contains mercury causes exposure to a toxic substance (mercury).

## Normal results

Most people consider a normal body temperature to be an oral temperature of 98.6 degrees Fahrenheit. This is more correctly an average of body temperatures. A person's body temperature varies during each 24 hour period. A normal range encompasses temperatures that are 1°F (0.6°C) above or below 98.6 degrees F. Some variation is due to fluctuations in physiology and cellular metabolism. Bodily activities (or lack) can temporarily increase (or decrease) body temperature. Body temperature is very sensitive to hormone levels and may be higher or lower when a female is ovulating during her menstrual cycle.

A rectal or ear (tympanic membrane) temperature reading is 0.5 to 1 degree F (0.3 to 0.6 degrees C) higher than an oral temperature reading. A temperature taken in the armpit is 0.5 to 1 degree F (0.3 to 0.6 degrees C) lower than an oral temperature reading.

In adults, an oral temperature above 100 degrees F or a rectal or ear temperature above 101 degrees F is considered to be a fever. Children are considered to have a fever when their rectal temperature is 100.4 degrees F or higher.

Abnormally low body temperature is called hypothermia. It is always serious and can be life-threatening. Hypothermia can occur after exposure to cold, when a person is in shock, or after alcohol or drug usage. Metabolic disorders, such as hypothyroidism or diabetes can trigger hypothermia. An infection involving the entire body (sepsis) can cause hypothermia. Infections in older adults, newborn infants or other frail persons may be accompanied by hypothermia.

## Morbidity and mortality rates

Perforations of the colon due to inserting a rectal thermometer too far have been reported. These are uncommon. The number of deaths associated with taking a temperature is essentially zero.

## Alternatives

There are no alternatives to obtaining a body temperature.



## KEY TERMS

**Fever**—An abnormally elevated body temperature, usually defined as being 101 degrees Fahrenheit or more

**Hypothermia**—An abnormally low body temperature, usually defined as being 90 degrees Fahrenheit or less

**Sepsis**—An infection involving the entire body

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- American Academy of Pediatrics. 141 Northwest Point Boulevard, Elk Grove Village, IL 60007 1098. (847) 434 4000, Fax: (847) 434 8000. E mail: kidsdoc@aap.org. <http://www.aap.org/default.htm>.
- American College of Physicians. 190 N. Independence Mall West, Philadelphia, PA 19106 1572. (800) 523 1546, x2600, or (215) 351 2600. <http://www.acponline.org>.
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## Bone grafting

### Definition

Bone grafting is a surgical procedure that places new bone or a replacement material into spaces between or around broken bone (fractures) or in holes in bone (defects) to aid in healing.

### Purpose

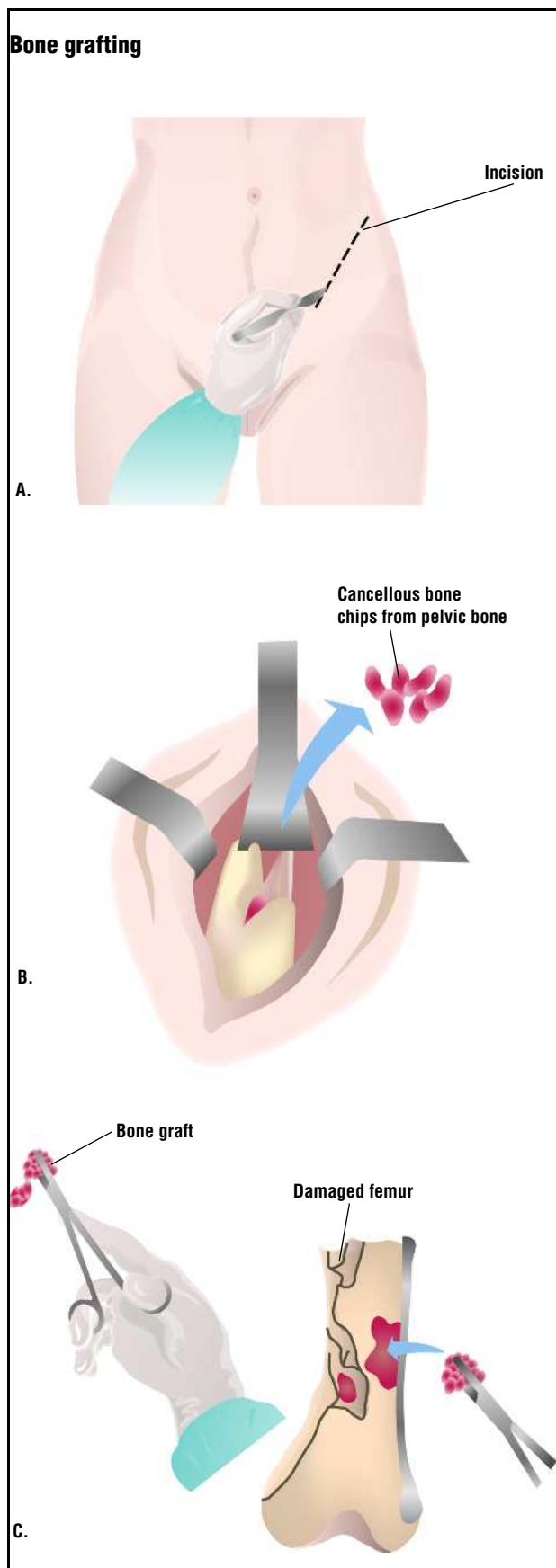
Bone grafting is used to repair bone fractures that are extremely complex, pose a significant risk to the patient, or fail to heal properly. Bone grafting is also used to help fusion between vertebrae, correct deformities, or provide structural support for fractures of the spine. In addition to **fracture repair**, bone grafting is used to repair defects in bone caused by congenital disorders, traumatic injury, or surgery for bone cancer. Bone grafts are also used for facial or cranial reconstruction.

### Demographics

Degenerative diseases of the spine increase with age. People over age 50 are more likely to need a bone graft if their condition requires surgery. Traumatic injuries occur most often in people 18–44 years.

### Description

Bone tissue is a matrix-like structure primarily composed of a protein called collagen. It is strengthened by hydroxyapatite, deposits of calcium and phosphate salts. Four types of bone cells are located within and around this matrix. Together, these four types of cells are responsible for building the bone matrix, maintaining it, and remodeling the bone as needed. The four types of bone cells are:



- osteoblasts, which produce the bone matrix;
- osteocytes, mature osteoblasts that maintain the bone;
- osteoclasts, which break down and remove bone tissue; and
- bone lining cells, which cover bone surfaces.

There are three ways that a bone graft can help repair a defect:

- osteogenesis, the formation of new bone by the cells contained within the graft;
- osteoinduction, a chemical process in which molecules contained within the graft (bone morphogenetic proteins, abbreviated as BMP) convert the patient's cells into cells capable of forming bone; and
- osteoconduction, a physical effect whereby the graft matrix configures a scaffold on which cells in the recipient form new bone.

The term "graft" commonly refers to an autograft or allograft. A graft made of bone from the patient's own body (e.g., hip bones or ribs) is an autograft. To obtain a piece of bone for an autograft, the patient undergoes surgery under **general anesthesia**. An incision is made over the crest of the hip bone, a piece of bone is removed, and the incision is stitched closed.

An allograft uses bone from a cadaver, which has been frozen and stored in a tissue bank. Allografts are used because of the inadequate amount of available autograft material, and the limited size and shape of a person's own bone. Bones for allografts are usually available from organs and tissues donated by healthy people who die unexpectedly. Occasionally, allograft bone may be provided by a living donor. Allograft bone is commonly used in **reconstructive surgery** of the hip, knee, and long bones, as well as cases of bone loss due to trauma or tumors. Using allograft tissue eliminates the need for a second operation to remove autograft bone or tendon. It also reduces the risk of infection, and safeguards against temporary pain and loss of function at or near the secondary site.

To place an autograft or allograft, the surgeon makes an incision in the skin over the bone defect, and shapes the bone graft or replacement material to fit into it. After the graft is placed into the defect, it is held in place with pins, plates, or screws. The incision is stitched closed, and a splint or cast is often used to prevent movement of the bones while healing.

**For bone grafting, an incision is made in the donor's hip (A). Pieces of bone are chipped off and removed (B). The bone materials are then transferred to the recipient area, in this case a femur that has been badly broken, to strengthen the bone (C).** (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Allograft**—Tissue for transplantation that is taken from another person.

**Arthrodesis**—Surgery that joins (or fuses) two bones so that the joint can no longer move; it may be done on joints such as the fingers, knees, ankles, or spine.

**Autograft**—Tissue for transplantation that is taken from the patient.

**Bone morphogenetic proteins**—A family of substances in human bones and blood that encourage the process of osteoinduction.

**Computed tomography scan (CT)**—A special type of X-ray that can produce detailed pictures of structures inside the body.

**Fusion**—A union, joining together; e.g., bone fusion.

**Hydroxyapatite**—A calcium phosphate complex that is the primary mineral component of bone.

**Magnetic resonance imaging (MRI)**—A test that provides images of organs and structures inside the body using a magnetic field and pulses of radio-wave energy. This form of imaging detects tumors, infection, and other types of tissue disease or damage, and helps diagnose conditions that affect blood flow. The

area of the body being studied is positioned inside a strong magnetic field.

**Morbidity**—A statistic that provides the rate at which an illness or abnormality occurs.

**Mortality**—The death rate, which reflects the number of deaths per unit of population in any specific region, age group, disease, or other classification, usually expressed as deaths per 1,000, 10,000, or 1,000,000.

**Osteoblasts**—Bone cells that build new bone tissue.

**Osteoclasts**—Bone cells that break down and remove bone tissue.

**Osteoconduction**—Provision of a scaffold for the growth of new bone.

**Osteocytes**—Bone cells that maintain bone tissue.

**Osteogenesis**—Growth of new bone.

**Osteoinduction**—Acceleration of new bone formation by chemical means. Also refers to the process of building, healing, and remodeling bone in humans.

**Vertebra**—The bones that make up the back bone (spine).

After the bone graft has been accepted by the body, the transplanted bone is slowly converted into new living bone or soft tissue, and incorporated into the body as a functional unit.

### *Bone grafts for spinal fusion*

In surgery of the spine, especially **spinal fusion**, (also called arthrodesis), surgeons may decide to use bone grafts to assist in the healing and remodeling of the spine after surgery. Normally, small pieces of bone are placed into the space between the vertebrae to be fused, and sometimes larger solid pieces of bone provide immediate structural support. Spinal fusion involves the surgical treatment of abnormalities in the vertebrae, such as curvatures, scoliosis or kyphosis, or injuries (fractures). Bone grafts may be used in spinal fusion surgery involving the lower (lumbar) or upper (cervical) spine. Cervical spinal fusion joins selected bones in the neck. This surgery may also be performed by other means, such as metal rods, which would not require bone grafts.

### Diagnosis/Preparation

The surgeon does a clinical examination and conducts tests to determine the necessity of a bone graft.

Diagnostic tests determine the precise location of damage. These tests include x rays, **magnetic resonance imaging (MRI)**, and computed tomography (CT) scan. They provide an image of the affected area and indicate the exact amount of damage that has occurred due to the fracture or defect.

Orthopedic surgeries pose varying degrees of difficulty. The patient is instructed on what will take place during the procedure, as well as risks involved. A consent form is obtained before surgery.

The following activities will help the patient prepare for surgery:

- thorough physician consult before surgery;
- banking some of his or her own blood in case a transfusion is needed;
- eating well to achieve good nutritional status before and after surgery;
- following a recommended exercise program before and after surgery;
- maintaining a positive attitude; and
- smoking cessation.

## Aftercare

Pain is normal for a few days following surgery and medication is given regularly to alleviate this problem. The patient will likely have a urinary catheter.

The time required for convalescence after bone grafts due to fractures or spinal fusion varies from one to 10 days. Vigorous **exercise** may be limited for up to three months. Children heal faster than adults.

If a spinal fusion was performed, the patient may be discharged from the hospital with a back brace or cast. The family will be taught how to provide **home care** for the patient. A splint or cast prevents injury or movement while healing.

## Risks

The risks for any surgical procedure requiring anesthesia include reactions to the medications and breathing problems. Bleeding and infection are also risks of surgery.

There is little risk of graft rejection for autografts, but there are drawbacks:

- additional surgical and anesthesia time (typically 30 minutes per procedure) to obtain or harvest the bone for grafting;
- added costs for the additional surgery;
- pain and infection at the site from which the graft is taken;
- the relatively small amount of bone available for grafting; and
- surgical complications, such as infection and pain that sometimes last a longer period of time than the primary surgery (up to two years).

Allografts also have drawbacks:

- bone variability because it is harvested from a variety of donors;
- grafted bone may take longer to incorporate with the host bone (than in an autograft);
- graft may be less effective than an autograft;
- possibility of transferring diseases to the patient; and
- potential immune response complications (patient's immune system fighting against the grafted bone tissue). This problem is lessened through the use of anti-rejection drugs.

## Normal results

Most bone grafts are successful in helping the bone defect to heal. The extent of recovery depends on the size of the defect and the condition of the bone

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Bone grafts are performed by orthopedic surgeons, neurosurgeons, craniofacial surgeons, and periodontists. These physicians have specialized training in their field of expertise. They have completed additional education beyond a general medical residency. A physician becomes board certified after completing training in a specialty area, passing examinations, and meeting certification requirements. To become certified, the physician must:

- complete the education required for a medical doctor or doctor of neurosurgery;
- complete three to seven years of training in a residency program in the specialty field;
- pass a written, and sometimes an oral, test given by the specialty board; and
- prepare for periodic recertification (required in most fields).

Specialty boards certify that physicians have met certain standards. Not all specialists are certified; certification is voluntary.

The surgeon and his or her surgical team will perform the surgery in a hospital on an inpatient basis.

surrounding the graft at the time of surgery. Severe defects take some time to heal, and may require further attention after the initial graft. Less severe bone defects should heal completely without serious complications. Repeat surgery is sometimes required if the condition recurs or complications develop.

If the bone graft is done on the face or head, the surgeries usually result in a more normal appearance.

## Morbidity and mortality rates

Although bone harvested from the patient is ideal, postoperative morbidity is sometimes associated with hip bone or fibula (part of the knee) autografts. Morbidity of allografts is usually related to the graft incorporating more slowly and less completely into the body.

In one study of over 1,000 patients who received very large allografts after bone cancer surgery, researchers found that approximately 85% were able to return to work or normal physical activities



## QUESTIONS TO ASK THE DOCTOR

- What should be done in preparation for the graft?
- Who will provide education about the grafting process?
- How many attending surgeons are available to do this type of surgery?
- For how long is hospitalization necessary?
- How long will recovery take?
- When will it be safe to resume normal activities?

without crutches; however, approximately 25% required a second operation because the first graft did not heal properly.

Infections associated with bacterial contamination of allografts are rare, but can result in serious illness and **death**.

### Alternatives

Despite the increase in the number of procedures requiring bone grafts, there is no ideal bone graft substitute; however, there are a variety of natural and synthetic replacement materials used instead of bone, including collagen (the protein substance of the white fibers of the skin, bone, and connective tissue); polymers, such as silicone and some acrylics; hydroxyapatite; calcium sulfate; and ceramics. Several new products are available or in development. They function as bone graft substitutes or extenders. Demineralized bone matrix (bone that has had its calcium removed) possesses some of the properties that the body uses to induce bone formation. Calcium hydroxyapatite products or coral have structures similar to bone, and act as scaffolding for new bone.

New bone morphogenetic protein (BMP) products are expected to be strong inducers of bone growth (osteoinductive). These new products will be relatively expensive, but will grow bone better than the patient's own bone, eliminating the need for bone graft harvesting. BMPs have been extracted from natural tissues and produced in the laboratory to stimulate bone production in animals and humans. Because they do not have the same drawbacks as grafts, surgeons are hopeful that they will soon be able to use BMP and

laboratory-produced BMP to aid in the generation and repair of bone.

The INFUSE Bone Graft (rhBMP-2) has received U.S. Food and Drug Administration approval, and has demonstrated better patient outcomes than hip autografts with regard to length of surgery, blood loss, hospital stay, re-operation rate, median time to return to work, and fusion rates at 6, 12, and 24 months following surgery.

Advances in tissue engineering have provided polymer-based graft substitutes with degradable, porous, three-dimensional structure. New bone may be grown on these products; the grafts then slowly dissolve, leaving only the new bone behind.

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American Association of Tissue Banks, 1320 Old Chain Bridge Road, Suite 450, McLean, VA, 22101, (703) 827 9582, (703) 356 2198, [aatb@aatb.org](mailto:aatb@aatb.org), <http://www.aatb.org>.

National Institutes of Health, 9000 Rockville Pike, Bethesda, MD, 20892, (301) 496 4000, [NIHinfo@od.nih.gov](mailto:NIHinfo@od.nih.gov), <http://www.nih.gov/>.

North American Spine Society, 22 Calendar Court, 2nd Floor, LaGrange, IL, 60525, (877) 774 6337, [info@spine.org](mailto:info@spine.org), <http://www.spine.org>.

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Bone lengthening/shortening see **Leg lengthening/shortening**

## Bone marrow aspiration and biopsy

**Definition**

Bone marrow aspiration, also called bone marrow sampling, is the removal by suction of the soft, spongy semisolid tissue (marrow) that fills the inside of the body's long and flat bones. Bone marrow biopsy, or needle core biopsy, is the removal of a small piece (about 0.75 x 0.06 in, 2 x 0.16 cm) of intact bone marrow. The bone marrow is where blood cells are made.

**Purpose**

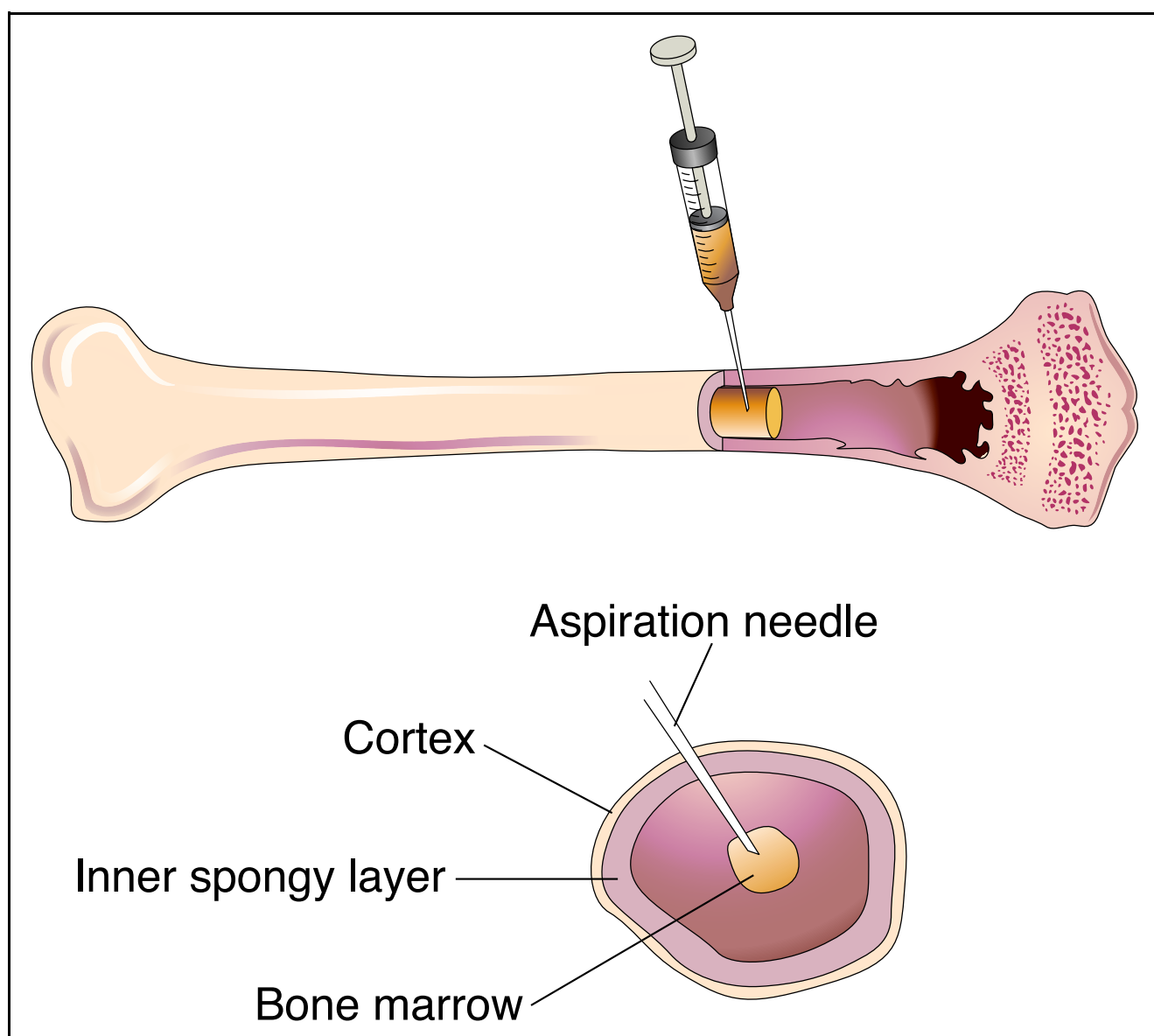
Examination of the bone marrow may be the next step that follows an irregular clinical finding, such as an abnormal **complete blood count** (CBC), and/or an abnormal peripheral blood smear. It may also be performed following an abnormal bone image, such as the finding of a lesion on x rays.

A biopsy of bone marrow shows the intact tissue, so that the structure of the fat cells, lymphocytes,

plasma cells, fibrous connective tissue cells, and other cells—and their relationships to each other—can be seen. A bone marrow biopsy is used for all the following:

- diagnose and manage any form of leukemia or other myeloproliferative condition such as multiple myeloma
- rule out or confirm bone marrow infiltration by malignancies such as Hodgkin's disease, non-Hodgkin's lymphoma, and metastatic carcinoma
- monitor the effects of chemotherapy and the response or lack of response to treatment of blood disease
- evaluate the success of bone marrow transplantation
- diagnose certain genetic diseases (e.g., lipid storage disease)
- investigate pancytopenia (a decrease of all blood cells in peripheral blood), neutropenia (decreased phagocytic white blood cells), or thrombocytopenia (decreased platelets)
- diagnose an infection of unknown origin
- investigate rare anemias for which a cause cannot be found or which does not respond to treatment as anticipated
- obtain intact bone marrow for laboratory analysis
- diagnose some types of cancer, or anemia and other blood disorders
- identify the source of an unexplained fever (e.g., granulomatous lesions)
- diagnose fibrosis of bone marrow and myeloma when bone marrow aspiration has failed to provide an appropriate specimen

The combination of aspiration and biopsy procedures are commonly used to ensure the availability of the best possible bone marrow specimen. The aspirate is collected at the same time as the bone core biopsy by attaching a syringe to the bone marrow needle and withdrawing the sample before the cutting blades are inserted and the bone core is removed. The aspirate is the sample of choice for studying and classifying the nucleated blood cells of the bone marrow (e.g., determining the ratio of immature white blood cells to red blood cells, which is the M:E ratio). The biopsy is the only sample that shows the blood-forming cells in relation to the structural and connective tissue elements (i.e., the microarchitecture) of the bone marrow. It provides the best sample for evaluating the cellularity of the bone marrow (the percentage of blood-forming tissue versus fat).



**In a bone marrow aspiration, a needle is inserted beneath the skin and rotated until it penetrates the cortex, or outer covering of the bone. A small amount of marrow is suctioned out of the bone by a syringe attached to the needle. (Illustration by Electronic Illustrators Group. Cengage Learning, Gale.)**

### Description

Bone marrow aspiration and biopsy are performed by a pathologist, hematologist, or oncologist with special training in this procedure. The procedure may be performed on an outpatient basis. In adults, the specimen is usually taken from the posterior superior iliac crest (top rear part of the hip). The sternum (breastbone) may be used for aspiration, but is less desirable because it carries the risk of cardiac puncture. Other sites that are rarely used are the anterior superior iliac crest or a spinal column bone. When the

patient is a child, the biopsy site is generally the anterior tibia, the larger of the two bones in the lower leg. A vertebra may also be used.

The skin covering the biopsy site is cleansed with an antiseptic, and the patient may be given a mild sedative. A local anesthetic such as lidocaine is administered first under the skin with a fine needle and then around the bone at the intended puncture site with a somewhat larger-gauge needle. When the area is numb, a small incision is made in the skin and the biopsy needle is inserted. Pressure is applied to force

## KEY TERMS

**Antibodies**—Proteins that are produced normally by specialized white blood cells after stimulation by a foreign substance (antigen) and that act specifically against the antigen in an immune response.

**Aspiration**—A procedure to withdraw fluid and cells from the body.

**Connective tissue**—Cells such as fibroblasts, and material such as collagen and reticulin, that unite one part of the body with another.

**Fibrosis**—A condition characterized by the presence of scar tissue, or reticulin and collagen proliferation in tissues to the extent that it replaces normal tissues.

**Hematologist**—A specialist who treats diseases and disorders of the blood and blood-forming organs.

**Hematoma**—Blood that collects under the skin, forms a blood clot, and causes swelling.

**Hemorrhage**—Heavy bleeding.

**Immune system**—Mechanism that protects the body from foreign substances, foreign cells, and pathogens. The thymus, spleen, lymph nodes, white

blood cells, including the B cells and T cells, and antibodies are involved in the immune response, which aims to destroy these foreign bodies.

**Lymphocytes**—Type of white blood cells that are part of the immune system. The lymphocytes are composed of three main cell lines: B lymphocytes, T lymphocytes, and natural killer (NK) cells.

**Myeloma (multiple myeloma)**—A tumor of plasma cells that originates in bone marrow and usually spreads to more than one bone.

**Needle biopsy**—The procedure of using a large hollow needle to obtain a sample of intact tissue.

**Pathologist**—A medical doctor that specializes in identifying diseases by studying cells and tissues under a microscope.

**Plasma cells**—Cells in the blood and bone marrow that are formed from B lymphocytes, and that produce antibodies.

**White blood cells (leukocytes)**—Cells of the blood that are responsible for fighting infection.

the needle through the outer bone, and a decrease in resistance signals entry into the marrow cavity. The needle most often used for bone marrow biopsy is a Jamshidi trephine needle or a Westerman-Jensen trephine needle. A syringe is placed on the top of the needle and 1–2 ml of the bone marrow is aspirated into the syringe. In some instances, the marrow cannot be aspirated because it is fibrosed, or packed with neoplastic cells. The syringe is removed and the medical technologist uses this sample to prepare several smears containing small pieces of bone (spicules). Another syringe is fitted onto the needle hub and another sample of 3 ml is removed and transferred to a tube containing EDTA for analysis by flow cytometry, cytogenetic testing, or other special laboratory procedures. Following aspiration, the cutting blades are inserted into the hollow of the needle until they protrude into the marrow. The needle is then forced over the tips of the cutting blades and the needle is rotated as it is withdrawn from the bone. This process captures the core sample inside the needle. A wire probe is inserted at the cutting end, and the bone marrow sample is pushed through the hub of the needle onto sterile gauze. The specimen is used to make several preparations on glass slides or cover glasses and is transferred to a fixative solution.

In the laboratory, the aspirate slides are stained with Wright stain or Wright-Giemsa stain. The biopsy material is sectioned onto glass slides and stained with hematoxylin-eosin, Giemsa, and Prussian blue stains. Prussian blue stain is used to evaluate the amount of bone marrow iron, and the other stains are used to contrast cell structures under the microscope. In addition, special stains may be used that aid in the classification of malignant white blood cells.

### Diagnosis/Preparation

The physician should be informed of any medication the patient is using and of any heart surgery that the patient may have undergone.

Adults require no special preparation for this test. As for infants and children, they need physical and psychological preparation, depending on their age, previous medical experiences, and level of trust.

#### Infant preparation

Before the test, parents should know that their child will most probably cry, and that restraints might be used. To provide comfort and to help their child through this procedure, parents are commonly asked to be present during the procedure. Crying is a

normal infant response to an unfamiliar environment, strangers, restraints, and separation from the parent. Infants cry more for these reasons than because they hurt. An infant will be restrained by hand or with devices because they have not yet developed the physical control, coordination, and ability to follow commands as adults have. The restraints used thus aim to ensure the infant's safety.

### *Toddler preparation*

Parents should prepare a toddler for bone marrow aspiration directly before the procedure, because toddlers have a very short attention span. Some general guidelines for parents include the following:

- Explain the procedure in a simple language, using concrete terms and avoiding abstract terminology.
- Make sure that the child understands where on the body the procedure will be performed and that it will be limited to that area.
- Allow the child to yell, cry, or express anything, especially pain, verbally.
- Describe how the test will feel.
- Stress the benefits of the procedure and anything that the child may find enjoyable afterwards, such as feeling better or going home.

### *Preschooler preparation*

Parents should prepare a preschooler for bone marrow aspiration directly before the procedure, so that the child does not worry about it for days in advance. Parents should ensure that the child understands that the procedure is not a punishment. Some general guidelines for parents include the following:

- Explain the procedure in a simple language, using concrete terms and avoiding abstract terminology.
- Make sure that the child understands where on the body the procedure will be performed and that it will be limited to that area.
- Allow the child to yell, cry, or express anything, especially pain, verbally.
- Describe how the test will feel and be honest about any pain that may be felt.
- Allow the child to practice different positions or movements that will be required for the procedure.
- Stress the benefits of the procedure and anything that the child may find enjoyable afterwards, such as feeling better or going for a treat on the way home.
- Practice deep breathing and other relaxation exercises. Practice also to have the child hold your hand and tell him or her to squeeze it when he or she feels pain during the procedure.

### *School-age child preparation*

Explanations should be limited to 20 minutes, and repeated if required. The older the child, the earlier a parent can start preparation. Guidelines for parents include the ones provided for preschoolers, as well as the following:

- Suggest ways for maintaining control during the procedure; for example, counting, deep breathing, and relaxation (thinking pleasant thoughts).
- Include the child in the decision-making process; for example, the time of day or the body site where the procedure will be performed. These of course depend on the scheduling constraints of the physician and the type of procedure being performed.
- Encourage the child to participate in the procedure; for example, by holding an instrument, if allowed by the attending hospital staff.
- Encourage the child to hold your hand or the hand of a nurse. Physical contact does help reduce pain and anxiety.

### *Adolescent preparation*

An adolescent is best prepared by being provided with detailed information and reasons for the procedure. Adolescents should be encouraged to make as many decisions as possible. An adolescent may or may not wish a parent to be present during the procedure, and such wishes should be respected, since privacy is important during adolescence. Other guidelines include the following:

- Explain the procedure in correct medical terminology, and provide the reason for it.
- As clearly as possible, describe the equipment that will be involved in concrete terms.
- Discuss potential risks honestly and openly.

### *Aftercare*

After the needle is removed, the biopsy site is covered with a clean, dry pressure bandage. The patient must remain lying down and is observed for bleeding for one hour. The patient's pulse, breathing, blood pressure, and temperature are monitored until they return to normal. The biopsy site should be kept covered and dry for several hours.

The patient should be able to leave the clinic and resume most normal activities immediately. Patients who have received a sedative often feel sleepy for the rest of the day; so driving, cooking, and other activities that require clear thinking and quick reactions should be avoided. Walking or prescribed pain medications

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A physician requests or orders the procedure. The aspirate and biopsy are most often performed in a hospital or clinic by a hematologist or pathologist that has been trained in the procedure. The analysis of the bone marrow is done by a pathologist, and a written report is added to the patient's medical record. A histologic technician performs special stains for bone marrow. Clinical laboratory scientists/medical technologists perform smear reviews and analysis of bone marrow cells by flow cytometry. Cytogenetic technologists may perform chromosomal analysis of bone marrow white blood cells.

usually ease any discomfort felt at the biopsy site, and ice can be used to reduce swelling.

A doctor should be notified if the patient:

- feels severe pain for more than 24 hours after the procedure.
- experiences persistent bleeding or notices more than a few drops of blood on the wound dressing.
- has a temperature above 101°F (38.3°C).
- has inflammation and pus at the biopsy site and other signs of infection.

### Risks

A small amount of bleeding and moderate discomfort often occur at the biopsy site. Rarely, reactions to anesthetic agents, infection, and hematoma (blood clot) or hemorrhage (excessive bleeding) may also develop. In rare instances, the heart or a major blood vessel is pierced when marrow is extracted from the sternum during bone marrow biopsy. This can lead to severe hemorrhage.

### Normal results

Healthy adult bone marrow contains yellow fat cells, connective tissue, and red marrow that produces blood. Bone marrow is evaluated for cellularity, megakaryocyte production, M:E ratio, differential (classification of blood-forming cells), iron content, lymphoid, bone, and connective tissue cells, and bone and blood vessel abnormalities. The bone marrow of a healthy infant is primarily red (75–100% cellularity), but the distribution of blood-forming cells is very different

## QUESTIONS TO ASK THE DOCTOR

- What are the possible risks involved in this procedure?
- How many times will the procedure be required?
- How do I prepare for the procedure?
- Must I do anything special after the procedure?
- How long does it take to know the results?
- How many bone marrow aspirations/biopsies do you perform each year?

than adult marrow. Consequently, age-related normal values must be used.

Microscopic examination of bone marrow can reveal leukemia, granulomas, myelofibrosis, myeloma, lymphoma, or metastatic cancers, bone marrow infection, and bone disease. Bone marrow evaluation is usually not needed to diagnose anemia, but may be useful in cases that cannot be classified by other means.

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- National Cancer Institute Cancer Information Service. 31 Center Drive, Bethesda, MD 20892 2580. (800) 422 6237. <http://www.nci.nih.gov> (accessed March 7, 2008).
- National Marrow Donor Program. Suite 500, 3001 Broadway Street NE, Minneapolis, MN 55413 1753. (800) 627 7692. <http://www.marrow.org> (accessed March 7, 2008).



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## Bone marrow transplantation

### Definition

The bone marrow—the sponge-like tissue found in the center of certain bones—contains stem cells that are the precursors of white blood cells, red blood cells, and platelets. These blood cells are vital for normal body functions, such as oxygen transport, defense against infection and disease, and clotting. Blood cells have a limited life span and are constantly being replaced; therefore, the production of healthy stem cells is vital.

In association with certain diseases, stem cells may produce too many, too few, or abnormal blood cells. Also, medical treatments may destroy stem cells or alter blood cell production. Blood cell abnormalities can be life threatening.

Bone marrow transplantation involves extracting bone marrow containing normal stem cells or peripheral stem cells from a healthy donor, and transferring it to a recipient whose body cannot manufacture proper quantities of normal blood cells. The goal of the transplant is to rebuild the recipient's blood cells and immune system and hopefully cure the underlying disease.

### Purpose

A person's red blood cells, white blood cells, and platelets may be destroyed or may be abnormal due to disease. Also, certain medical therapies, particularly chemotherapy or radiation therapy, may destroy a person's stem cells. The consequence to a person's health is severe. Under normal circumstances, red blood cells carry oxygen throughout the body and remove carbon dioxide from the body's tissues. White blood cells form the cornerstone of the body's immune system and defend it against infection. Platelets limit bleeding by enabling the blood to clot if a blood vessel is damaged.

A bone marrow transplant is used to rebuild the body's capacity to produce these blood cells and bring their numbers to normal levels. Illnesses that may be treated with a bone marrow transplant include both cancerous and non-cancerous diseases.

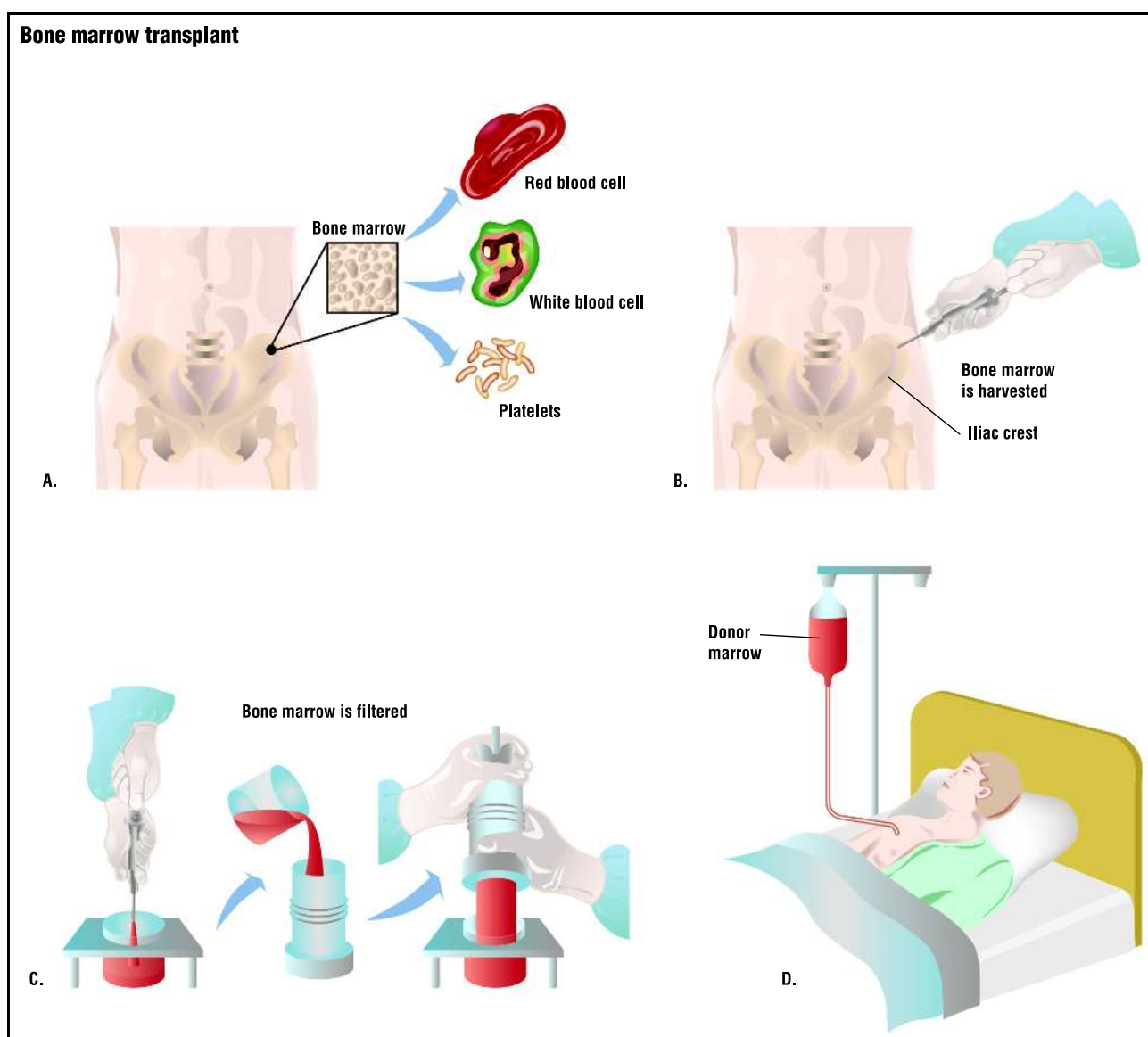
Cancerous diseases may or may not specifically involve blood cells; but, cancer treatment can destroy the body's ability to manufacture new blood cells. Bone marrow transplantation may be used in conjunction with additional treatments, such as chemotherapy, for various types of leukemia, Hodgkin's disease, lymphoma, breast and ovarian cancer, renal cell carcinoma, myelodysplasia, myelofibrosis, germ cell cancer, and other cancers. Non-cancerous diseases for which bone marrow transplantation can be a treatment option include aplastic anemia, sickle cell disease, thalassemia, and severe immunodeficiency.

### Demographics

The decision to prescribe a bone marrow transplant is based on the patient's age, general physical condition, diagnosis and stage of the disease. A person's age or state of health may prohibit use of a bone marrow transplant. The typical cut-off age for a transplant ranges from 40 to 55 years; however, a person's general health is usually the more important factor. Before undergoing a bone marrow transplant, the bone marrow transplant team will ensure that the patient understands the potential benefits and risks of the procedure.

The first successful bone marrow transplant took place in 1968 at the University of Minnesota. The recipient was a child with severe combined immunodeficiency disease and the donor was a sibling. In 1973, the first unrelated bone marrow transplant was performed at Memorial Sloan-Kettering Cancer Center in New York City on a five-year-old patient with severe combined immunodeficiency disease. In 1984, Congress passed the National Organ Transplant Act, which included language to evaluate unrelated marrow transplantation and determine if a national donor registry was feasible. The National Bone Marrow Donor Registry (NBMDR), now called the National Marrow Donor Program (NMDP), was established in 1986.

The NMDP Network has more than 10 million volunteer donors (6 million domestically, and another 4 million through its relationships worldwide) and has 43 donor centers and transplant centers in 16 countries.



In a bone marrow transplant, bone marrow is harvested from the donor's pelvic bone at the iliac crest (B). The marrow is filtered (C) before being introduced into a large vein in the recipient's chest via a catheter (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## Description

### *Types of bone marrow transplants*

#### **AUTOLOGOUS AND ALLOGENEIC TRANSPLANTS.**

Two important requirements for a bone marrow transplant are the donor and the recipient. Sometimes, the donor and the recipient may be the same person. This type of transplant is called an autologous transplant. It is typically used in cases in which a person's bone marrow is generally healthy but will be destroyed due to medical treatment for diseases such as breast

cancer and Hodgkin's disease. Autologous transplants are also possible if the disease affecting the bone marrow is in remission. If a person's bone marrow is unsuitable for an autologous transplant, the bone marrow must be derived from another person in an allogeneic transplant.

An allogeneic bone marrow donor may be a family member or an unrelated donor. The donated bone marrow/peripheral stem cells must perfectly match the patient's bone marrow. The matching process is called human leukocyte antigens (HLA). Antigens are markers

## KEY TERMS

**ABO antigen**—Protein molecules located on the surfaces of red blood cells that determine a person's blood type: A, B, or O.

**Acute myelogenous leukemia (AML)**—Also called acute myelocytic leukemia, a malignant disorder where myeloid blast cells accumulate in the marrow and bloodstream.

**Allogeneic**—Referring to bone marrow transplants between two different, genetically dissimilar people.

**Anemia**—Decreased red cell production that results in a deficiency in oxygen-carrying capacity of the blood.

**Antigen**—A molecule that is capable of provoking an immune response.

**Aplastic anemia**—A disorder in which the body produces inadequate amounts of red blood cells and hemoglobin due to underdeveloped or missing bone marrow.

**Autologous**—Referring to bone marrow transplants in which recipients serve as their own donors.

**Blank**—If an individual has inherited the same HLA antigen from both parents, the HLA typing is designated by the shared HLA antigen followed by a "blank"(-).

**Blast cells**—Blood cells in early stage of cellular development.

**Blast crisis**—Stage of chronic myelogenous leukemia where large quantities of immature cells are produced by the marrow, and it is not responsive to treatment.

**Bone marrow**—A spongy tissue located within flat bones, including the hip and breast bones and the skull. This tissue contains stem cells, the precursors of platelets, red blood cells, and white blood cells.

**Bone marrow biopsy**—A test involving the insertion of a thin needle into the breastbone or, more commonly, the hip, in order to aspirate (remove) a sample of the marrow. A small piece of cortical bone may also be obtained for biopsy.

**Bone marrow transplant**—Healthy marrow is infused into people who have had high-dose chemotherapy for one of the many forms of leukemias, immunodeficiencies, lymphomas, anemias, metabolic disorders, and sometimes solid tumors.

**Chemotherapy**—Medical treatment of a disease, particularly cancer, with drugs or other chemicals.

**Chest x ray**—A diagnostic procedure in which a very small amount of radiation is used to produce an image of the structures of the chest (heart, lungs, and bones) on film.

**Chronic myelogenous leukemia (CML)**—Also called chronic myelocytic leukemia, a malignant disorder

that involves abnormal accumulation of white cells in the marrow and bloodstream.

**Cytomegalovirus (CMV)**—Virus that can cause pneumonia in post bone marrow transplant patients.

**Computed tomography scan (CT or CAT)**—Computed axial tomography uses x rays and computers to produce an image of a cross-section of the body.

**Conditioning**—Process of preparing a patient to receive marrow donation, often through the use of chemotherapy and radiation therapy.

**Confirmatory typing**—Repeat tissue typing to confirm the compatibility of the donor and patient before transplant.

**Donor**—A healthy person who contributes bone marrow for transplantation.

**Echocardiogram**—An imaging procedure used to create a picture of the heart's movement, valves and chambers. The test uses high-frequency sound waves that come from a hand wand placed on the chest. Echocardiogram may be used in combination with Doppler ultrasound to evaluate the blood flow across the heart's valves.

**Electrocardiogram (ECG, EKG)**—A test that records the electrical activity of the heart using small electrode patches attached to the skin on the chest.

**Graft versus host disease**—A life-threatening complication of bone marrow transplants in which the donated marrow causes an immune reaction against the recipient's body.

**Histocompatibility**—The major histocompatibility determinants are the human leukocyte antigens (HLA), and characterize how well the patient and donor are matched.

**Human leukocyte antigen (HLA)**—A group of protein molecules located on bone marrow cells that can provoke an immune response. A donor's and a recipient's HLA types should match as closely as possible to prevent the recipient's immune system from attacking the donor's marrow as a foreign material that does not belong in the body.

**Hodgkin's disease**—A type of cancer involving the lymph nodes and potentially affecting non-lymphatic organs in the later stage.

**Immunodeficiency**—A disorder in which the immune system is ineffective or disabled due either to acquired or inherited disease.

**Leukemia**—A type of cancer that affects leukocytes, a particular type of white blood cell. A characteristic symptom is excessive production of immature or otherwise abnormal leukocytes.

**Lymphoma**—A type of cancer that affects lymph cells and tissues, including certain white blood cells (T cells and B cells), lymph nodes, bone marrow, and the spleen. Abnormal cells (lymphocyte/leukocyte) multiply uncontrollably.

**Match**—How similar the HLA typing, out of a possible six antigens, is between the donor and the recipient.

**Mixed lymphocyte culture (MLC)**—Test that measures level of reactivity between donor and recipient lymphocytes.

**Myelodysplasia**—Also called myelodysplastic syndrome, it is a condition in which the bone marrow does not function normally and can affect the various types of blood cells produced in the bone marrow. Often referred to as a preleukemia and may progress and become acute leukemia.

**Myelofibrosis**—An anemic condition in which bone marrow cells are abnormal or defective and become fibrotic.

**Neuroblastoma**—Solid tumor in children, may be treated by BMT.

**Non-myeloablative allogeneic bone marrow transplant**—Also called “mini” bone marrow transplants. This type of bone marrow transplant involves receiving low-doses of chemotherapy and radiation therapy, followed by the infusion of a donor’s bone marrow or peripheral stem cells. The goal is to suppress the patient’s own bone marrow with low-dose chemotherapy and radiation therapy to allow the donor’s cells to engraft.

**Peripheral stem cells**—Stem cells that are taken directly from the circulating blood and used for transplantation. Stem cells are more concentrated in the bone marrow, but they can also be extracted from the bloodstream.

**Peripheral stem cell transplant**—The process of transplanting peripheral stem cells instead of using bone marrow. The stem cells in the circulating blood that are similar to those in the bone marrow are given to the patient after treatment to help the bone marrow recover and continue producing healthy blood cells. A peripheral stem cell transplant may also be used to supplement a bone marrow transplant.

**Platelets**—Fragments of a large precursor cell, a megakaryocyte found in the bone marrow. These fragments adhere to areas of blood vessel damage and release chemical signals that direct the formation of a blood clot.

**Pulmonary function test**—A test that measures the capacity and function of the lungs, as well as the blood’s ability to carry oxygen.

**Radiation therapy**—The use of high-energy radiation from x rays, cobalt, radium, and other sources to kill cancer cells and shrink tumors. Radiation may come from a machine outside the body (external beam radiation therapy) or from materials called radioisotopes. Radioisotopes produce radiation and are placed in or near the tumor or in the area near the cancer cells. This type of radiation treatment is called internal radiation therapy, implant radiation, interstitial radiation, or brachytherapy. Systemic radiation therapy uses a radioactive substance, such as a radio-labeled monoclonal antibody that circulates throughout the body.

**Recipient**—The person who receives the donated blood marrow.

**Red blood cells**—Cells that carry hemoglobin (the molecule that transports oxygen) and help remove wastes from tissues throughout the body.

**Remission**—Disappearance of the signs and symptoms of cancer. When this happens, the disease is said to be “in remission.” A remission can be temporary or permanent.

**Sickle cell disease**—An inherited disorder characterized by a genetic flaw in hemoglobin production. (Hemoglobin is the substance within red blood cells that enables them to transport oxygen.) The hemoglobin that is produced has a kink in its structure that forces the red blood cells to take on a sickle shape, inhibiting their circulation and causing pain. This disorder primarily affects people of African descent.

**Stem cells**—Unspecialized cells, or “immature” blood cells, that serve as the precursors of white blood cells, red blood cells, and platelets.

**Syngeneic**—Referring to a bone marrow transplant from one identical twin to the other.

**Thalassemia**—A group of inherited disorders that affects hemoglobin production. Because hemoglobin production is impaired, a person with this disorder may suffer mild to severe anemia. Certain types of thalassemia can be fatal.

**Umbilical cord blood transplant**—A procedure in which the blood from a newborn’s umbilical cord, which is rich in stem cells, is used as the donor source for bone marrow transplants. Currently, umbilical cord blood transplants are mainly used for sibling bone marrow transplants or to store blood for an anonymous donation. In most cases, umbilical cord blood does not contain enough stem cells to safely use for adult bone marrow transplants.

**White blood cells**—A group of several cell types that occur in the bloodstream and are essential for a properly functioning immune system.



in cells that stimulate antibody production. HLA antigens are proteins on the surface of bone marrow cells. HLA testing is a series of blood tests that evaluate the closeness of tissue between the donor and recipient. If the donor and the recipient have very dissimilar antigens, the recipient's immune system regards the donor's bone marrow cells as invaders and launches a destructive attack against them. Such an attack negates any benefits offered by the transplant.

**NON-MYELOABLATIVE ("MINI") ALLOGENEIC TRANSPLANTS.** A "mini" transplant involves receiving low-doses of chemotherapy and radiation therapy, followed by the infusion of a donor's bone marrow or peripheral stem cells. The goal is to suppress the patient's own bone marrow with low-dose chemotherapy and radiation therapy to allow the donor's cells to engraft. If there are cancer cells remaining in the patient's body, the donated cells are able to identify the cancer cells as foreign and trigger an immune response, killing the cancer cells. This is called the graft-versus-tumor effect. Mini transplants are still under investigation, but are promising for the future.

**PERIPHERAL BLOOD STEM CELL TRANSPLANTS.** A relatively recent development in stem cell transplantation is the use of peripheral blood stem cells instead of cells from the bone marrow. Peripheral blood stem cells (PBSCs) are obtained from circulating blood rather than from bone marrow, but the amount of stem cells found in the peripheral blood is much smaller than the amount of stem cells found in the bone marrow. Peripheral blood stem cells can be used in either autologous or allogeneic transplants. The majority of PBSC transplants are autologous. However, clinical studies indicate that PBSCs are being used more frequently than bone marrow for allogeneic bone marrow transplantation.

The advantages of PBSC transplants when compared to bone marrow transplants are that, in allogeneic transplantation, hematopoietic and immune recovery are faster with PBSCs. In autologous transplantation, the use of PBSCs can result in faster blood count recovery. Also, some medical conditions exist in which the recipient cannot accept bone marrow transplants, but can accept PBSC transplants. A possible disadvantage to PBSC transplant versus bone marrow transplantation is that so much more fluid volume is necessary to collect enough PBSCs that, at the time that the new stem cells are infused into the recipient, the fluid can collect in the lungs. Also, the time commitment for the donor for a PBSC transplant is considerable. When the PBSCs are being collected,

several outpatient sessions are needed and each session lasts approximately between two and four hours.

**UMBILICAL CORD BLOOD TRANSPLANT.** Umbilical cord blood transplant is a relatively new procedure in which umbilical cord blood from a newborn is used as the donor source. Umbilical cord blood is rich in stem cells, the cells that are needed for transplantation, and these cells are theoretically "immunologically naïve," reducing chances of rejection and making it a good source for donation. The matching criteria are the same as for bone marrow. Most programs to date use this procedure for a sibling or store cord blood for anonymous donation. Umbilical cord blood can be an excellent source for children. One potential problem with umbilical cord blood transplantation is the low volume of stem cells contained in the umbilical cord. In many instances, there is inadequate volume to safely use for a transplant in an adult recipient.

### *The transplant procedure*

**HLA MATCHING.** There are only five major HLA classes or types—designated HLA-A, -B, -C, -D, and class III—but much variation within the groupings. For example, HLA-A from one individual may be similar to, but not the same as, HLA-A in another individual; such a situation can render a transplant from one to the other impossible.

HLA matching is more likely if the donor and recipient are related, particularly if they are siblings; however, an unrelated donor may be a potential match. The only case in which matching HLA types between two people is not an issue is if the recipient has an identical twin. Identical twins carry the same genes, therefore, the same antigens. A bone marrow transplant between identical twins is called a syngeneic transplant.

**BONE MARROW TRANSPLANTATION.** The bone marrow extraction, or harvest, is the same for autologous and allogeneic transplants. Harvesting is done under **general anesthesia**, and discomfort is usually minimal afterwards. Bone marrow is drawn from the iliac crest (the part of the hip bone on either side of the lower back) with a special needle and a syringe. Several punctures are usually necessary to collect the needed amount of bone marrow, approximately 1–2 quarts. (This amount is only a small percentage of the total bone marrow and is typically replaced within four weeks.) The donor remains at the hospital for 24–48 hours and can resume normal activities within a few days.



If the bone marrow is meant for an autologous transplant, it is stored at -112–320°F (-80–196°C) until it is needed. If a patient's own bone marrow can be used for transplantation or if a donor is not found, peripheral stem cells may be harvested from the patient's circulating blood. Bone marrow for an allogeneic transplant is sometimes treated to remove the donor's T cells (a type of white blood cell) or to remove ABO (blood type) antigens; otherwise, it is transplanted without modification.

The bone marrow or peripheral stem cells are administered to the recipient via a catheter (a narrow, flexible tube) inserted into a large vein in the chest. The donor cells look like a bag of blood and are infused for about 20–30 minutes. During the infusion, the patient's blood pressure, pulse, and breathing are monitored. From the bloodstream, the marrow migrates to the cavities within the bones where bone marrow is normally stored. If the transplant is successful, the bone marrow begins to produce normal blood cells once it is in place, or engrafted.

#### **PERIPHERAL BLOOD STEM CELL TRANSPLANTATION.**

Before collection for a PBSC transplant, donors receive four injections daily of the drug G-CSF, or filgrastim. (Patients can give it to themselves at home, if necessary.) These pretreatments stimulate the body to release stem cells into the blood. After these pretreatments, the donors' experience is similar to that of a whole blood donor's experience—PBSC donors' blood is collected at a clinic or hospital as an outpatient procedure. The differences are that several sessions will be needed over days or weeks, and the blood is collected in a process called apheresis. The blood travels from one arm into a blood cell separator that removes only the stem cells, and the rest of the blood is returned back to the donor in the other arm. The cells are then frozen for later use.

The PBSCs are administered to the recipient using the same methods as those used in bone marrow transplantation. As stated, the amount of fluid with PBSCs infused into the recipient's body can be an issue.

#### **Costs**

Bone marrow transplantation is an expensive procedure. (Bone marrow donors are volunteers and do not pay for any part of the procedure.) Insurance companies and health maintenance organizations (HMOs) may not cover the costs. Many insurance companies require precertification letters of medical necessity. As soon as bone marrow transplantation is discussed as a treatment option, it is important for the

patient to contact his or her insurance provider to determine what costs will be covered.

### **Diagnosis/Preparation**

Several tests are performed before the bone marrow transplant to identify any potential problems ahead of time. Tests include:

- tissue typing and a variety of blood tests
- chest x ray
- pulmonary function tests
- computed tomography scan (CT or CAT)
- heart function tests, including an electrocardiogram and echocardiogram
- bone marrow biopsy
- skeletal survey

In addition, a complete dental exam is needed before the bone marrow transplant to reduce the risk of infection. Other precautions will be taken before the transplant to reduce the patient's risk of infection.

A triple lumen, central venous catheter (a slender, hollow flexible tube) is surgically inserted into a large vein in the chest during a simple outpatient procedure. The catheter is used to draw blood and infuse chemotherapy and other medications, as well as donor cells, blood product, fluids, and sometimes nutritional solutions. The central venous catheter usually stays in place for about six months after the bone marrow transplant.

Hormone-like medications called colony-stimulating factors may be given before the transplant to stimulate the patient's white blood cells. These medications stimulate the white blood cells to multiply, mature, and function. These medications also help the patient's white blood cells recover from chemotherapy and reduce the risk of infection.

A bone marrow transplant recipient can expect to spend three to four weeks in the hospital, depending on the rate of recovery. In preparation for receiving the transplant, the recipient undergoes "conditioning," a preparative regimen (also called marrow ablation) in which the bone marrow and abnormal cells are destroyed. Conditioning rids the body of diseased cells and makes room for the marrow or peripheral stem cells to be transplanted. It typically involves chemotherapy and/or radiation treatment, depending on the disease being treated. Unfortunately, this treatment also destroys healthy cells and has many side effects such as extreme weakness, nausea, vomiting,

and diarrhea. These side effects may continue for several weeks.

### Aftercare

A two- to four-week waiting period follows the marrow transplant before its success can begin to be evaluated. The marrow recipient is kept in isolation during this time to minimize potential infections. The recipient also receives intravenous antibiotic, antiviral, and antifungal medications, as well as blood and platelet transfusions to help fight off infection and prevent excessive bleeding. Blood tests are performed daily to monitor the patient's kidney and liver function, as well as nutritional status. Other tests are performed as necessary. Further side effects, such as nausea and vomiting, can be treated with other medications. Once blood counts are normal and the side effects of the transplant abate, the recipient is taken off **antibiotics** and usually no longer needs blood and platelet transfusions.

Following **discharge from the hospital**, the recipient is monitored through home visits by nurses or outpatient visits for up to a year. For the first several months out of the hospital, the recipient needs to be careful in avoiding potential infections. For example, contact with other people who may be ill should be avoided or kept to a minimum. Further blood transfusions and medications may be necessary, but barring complications, the recipient can return to normal activities about six to eight months after the transplant.

### Risks

The procedure has a lower success rate the greater the recipient's age. Complications are exacerbated for people whose health is already seriously impaired, as in late-stage cancers.

Bone marrow transplants are accompanied by serious and life-threatening risks. Furthermore, they are not always an absolute assurance of a cure for the underlying ailment; a disease may recur in the future.

Even in the absence of complications, the transplant and associated treatments are hard on the recipient. Bone marrow transplants are debilitating. A person's ability to withstand the rigors of the transplant is a key consideration in deciding to use this treatment.

In the short term, there is the danger of pneumonia or other infectious disease, excessive bleeding, or liver disorder caused by blocked blood vessels. The

transplant may be rejected by the recipient's immune system, or the donor bone marrow may launch an immune-mediated attack against the recipient's tissues. This complication is called acute graft-versus-host disease, and it can be a life-threatening condition. Characteristic signs of the disease include fever, rash, diarrhea, liver problems, and a compromised immune system.

Approximately 25–50% of bone marrow transplant recipients develop long-term complications. Chronic graft-versus-host disease symptoms include skin changes, such as dryness, altered pigmentation, and thickening, abnormal **liver function tests**, dry mouth and eyes, infections, and weight loss. Other long-term complications include cataracts (due to radiation treatment), abnormal lung function, hormonal abnormalities resulting in reduced growth or hypothyroidism, secondary cancers, and infertility.

### Normal results

In a successful bone marrow transplant, the donor's marrow migrates to the cavities in the recipient's bones and produces normal numbers of healthy blood cells. Bone marrow transplants can extend a person's life, improve quality of life, and may aid in curing the underlying ailment.

### Morbidity and mortality rates

Approximately 30% of people receiving allogeneic transplants do not survive. Autologous transplants have a much better survival rate—nearly 90%—but are not appropriate for all types of ailments requiring a bone marrow transplant. Furthermore, autologous transplants have a higher failure rate with certain diseases, specifically leukemia. At two years, the survival rate for patients with chronic myelogenous leukemia is 52% if they received a transplant in a chronic phase of their disease, 30% for patients in an accelerated phase and 15% for patients in the blast phase.

### Alternatives

Complementary therapies are used along with standard cancer treatments. These treatments are aimed at bringing about some overall improvement in general health and well being. Complementary therapies can be helpful in managing symptoms and improving quality of life. They can be used to help alleviate pain; reduce nausea; strengthen muscles; and decrease depression, anxiety, and stress. It is

## WHO PERFORMS THIS PROCEDURE AND WHERE IS IT PERFORMED?

Transplant physicians specially trained in bone marrow transplantation should perform this procedure. Bone marrow transplant physicians have extensive experience in hematology/oncology and bone marrow transplant.

Selecting a transplant center that has a multidisciplinary team of specialists is important. The bone marrow transplant team should include transplant physicians, infectious disease specialists, pharmacologists, registered nurses, and transplant coordinators. Other transplant team members may include registered dietitians, social workers, and financial counselors.

When selecting a transplant center, the patient should find out where the center is accredited. Some examples of accrediting organizations include The Foundation for the Accreditation of Cellular Therapy, the American Association of Blood Banking, the National Marrow Donor Program, and other state-level accreditation organizations.

Choosing a transplant center with experience is important. Here are some questions to consider when choosing a transplant center:

- How many bone marrow transplants are performed annually, and what are the outcomes/survival rates of those transplants?
- Does the transplant center perform transplants for the patient's type of disease? How many has it performed to date?
- Does the transplant center have experience treating patients the same age as the patient considering transplant?
- What is the required patient and unrelated donor HLA matching level at this center?
- How much does a typical bone marrow transplant cost at this facility?
- Is financial help available?
- If the transplant center is far from the patient's home, will accommodations be provided for caregivers?

important to distinguish between alternative therapies (unproven methods promoted for use instead of mainstream treatment) and complementary therapies, which are used with standard treatment. Complementary

therapies are noninvasive and soothing. However, before trying them, patients should check with their oncologist to make sure the complementary therapy will not interfere with standard cancer therapy or cause harm. Examples of complementary therapies are massage therapy, aromatherapy, meditation, yoga, **bio-feedback**, music, art and dance therapies, and group and individual therapy or counseling.

Hormone therapy is the treatment of cancer by removing, blocking, or adding hormones. Hormones are chemical substances produced by glands in the body that enter the bloodstream and cause effects in other tissues. Hormone therapies may be used to treat breast and prostate cancers. Hormone therapy may also be used in some situations for other cancers.

Immunotherapy, also called biological therapy, is a type of treatment that uses the body's immune system to fight cancer. The therapy mainly consists of stimulating the immune system with highly purified proteins that help it do its job more effectively.

Radiation therapy is the use of high-energy x rays, electron beams, or radioactive isotopes to attack cancer. Radiation therapy causes cancer cell death by ionization or by damaging the chromosomes in the cancer cells so they cannot multiply. Radiation therapy is a local treatment aimed directly at the cancer. Even though the radiation is aimed only at the cancer, it must often pass through skin and other organs to reach the tumor. Thus, some healthy cells may become damaged, too. The body however is able to repair the healthy cells that have been damaged and restore them to their proper function. Aside from its use as a single treatment, radiation therapy has been shown to enhance the effects of chemotherapy. It can be used in combination with chemotherapy to shrink a tumor. Successful radiation therapy depends on delivering the proper amount of radiation to the cancer in the best, and most effective way.

### Resources

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- Khatiri, V. P., and J. A. Asensio. *Operative Surgery Manual*. 1st ed. Philadelphia: Saunders, 2003.
- Townsend, C. M., et al. *Sabiston Textbook of Surgery*. 17th ed. Philadelphia: Saunders, 2004.

#### ORGANIZATIONS

- American Cancer Society. 1599 Clifton Road, NE, Atlanta, GA 30329. (800) 227 2345, (404) 320 3333. <http://www.cancer.org> (accessed March 7, 2008).

## QUESTIONS TO ASK THE DOCTOR

- What type of transplant is recommended for my condition?
- What are the potential benefits of bone marrow transplantation?
- Where does transplanted bone marrow come from?
- What types of tests are required to screen me for the bone marrow transplant?
- What is HLA/histocompatibility matching?
- What types of tests are used to screen potential bone marrow or peripheral stem donors?
- Are bone marrow or peripheral stem cell donors compensated?
- After my bone marrow transplant, can I contact an unrelated donor? How can I do this?
- Will my insurance provider cover the expenses of my bone marrow transplant?
- What types of questions should I ask my insurance provider to determine if the medical expenses of my bone marrow transplant will be covered?
- Whose insurance covers the medical expenses of the donor?
- How long does the insurance clearance process take?
- After bone marrow transplantation is approved as a treatment option for me, how long will I have to wait before I can receive the bone marrow transplant?
- What type of preparative regimen will I have before the bone marrow transplant?
- What are the side effects of the preparative regimen?
- What types of precautions must I follow before and after my bone marrow transplant?
- Will I have to have blood transfusions during the transplantation process?
- What are the risks and potential complications of bone marrow transplantation?
- What is Graft-versus-Host disease (GVHD) and can it be prevented?
- What are the signs of GVHD, rejection, and infection?
- How and when will I know if the bone marrow transplant was successful?
- How long will I have to stay in the hospital?
- What types of resources are available to me during my hospital stay and during my recovery at home?
- What types of medications will I have to take after my bone marrow transplant? How long will I have to take them?
- After I go home, when can I resume my normal activities?
- What type of follow-up care is recommended? How often will I need to go to follow-up appointments?
- Can I receive follow-up care from my primary physician, or do I need to go back to the center where I had my bone marrow transplant?
- If I live far away from my transplant center, do I have to stay near the transplant center during my recovery after discharge? If yes, for how long? Will I receive help in making accommodations?

American Society for Blood and Marrow Transplantation (ASBMT). 85 W. Algonquin Road, Suite 550 Arlington Heights, IL 60005. (847) 427 0224. [mail@asbmt.org](mailto:mail@asbmt.org).

BMT Infonet (Blood and Marrow Transplant Information Network). 2900 Skokie Valley Road, Suite B, Highland Park, IL 60035. (847) 433 3313, (888) 597 7674. [help@bmtinfonet.org](mailto:help@bmtinfonet.org). <http://www.bmtinfonet.org> (accessed March 7, 2008).

CancerCare. Health Resources and Services Administration. 5600 Fishers Lane, Rm. 14 45, Rockville, MD 20857. (301) 443 3376. (800) 813 HOPE (4673). <http://www.cancerca.org> (accessed March 7, 2008).

International Bone Marrow Transplant Registry/Autologous Blood and Marrow Transplant Registry N.

America. Health Policy Institute, Medical College of Wisconsin, 8701 Watertown Plank Road, P.O. Box 26509, Milwaukee, WI 53226. (414) 456 8325. [ibmtr@mcw.edu](mailto:ibmtr@mcw.edu).

Leukemia & Lymphoma Society, Inc. 1311 Mamaroneck Avenue White Plains, NY 10605. (914) 949 5213. <http://www.leukemia-lymphoma.org> (accessed March 7, 2008).

Lymphoma Research Foundation of America. 8800 Venice Boulevard, Suite 207, Los Angeles, CA 90034. (800) 500 9976. (310) 204 7040. [helpline@lymphoma.org](mailto:helpline@lymphoma.org). <http://www.lymphoma.org> (accessed March 7, 2008).

National Bone Marrow Transplant Link. 20411 W. 12 Mile Road, Suite 108, Southfield, MI 48076. (800) LINK BMT (800 546 5268).



National Foundation for Transplants. 1102 Brookfield, Suite 200, Memphis, TN, 38110. (800) 489 3863 or (901) 684 1697. <http://www.transplants.org> (accessed March 7, 2008).

National Marrow Donor Program. Suite 500, 3001 Broadway Street Northeast, Minneapolis, MN 55413 1753. (800) MARROW 2. <http://www.marrow.org> (accessed March 7, 2008).

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Bone repair see **Orthopedic surgery**

## Bone x rays

### Definition

Bone X rays are a diagnostic imaging test in which ionizing radiation passing through the bones enables an image to be produced on film. An x ray (radiograph) can produce an image of a bone from various and multiple angles. A physician may view an x-ray film to help diagnose fractures in patients and then consider treatment options based on the findings. An x ray may be taken of many bones in the body including the hand, foot, wrist, spine, rib cage, spine, and ankle.

### Purpose

Bone x rays are ordered to detect bone disease or injury, such as in the case of broken bones, tumors, and other problems. They can determine bone density, texture, erosion, and changes in bone relationships. Bone x rays also evaluate the joints for such diseases as arthritis. In addition, x rays may be taken to see if a joint has been dislocated, to guide a surgeon during an orthopedic surgical procedure such as a total joint replacement operation, to visualize foreign objects, or to check bone alignment before and after cast application or repair via screw and plate orthopedic procedures.

### Description

X rays are the result of the collision between electrons and a protons. German physicist Wilhelm

Conrad Röntgen (1845–1923), discovered what he called X-radiation, in 1895. This form of radiation was noted to have properties allowing transparency and fluorescence that absorbed visible light and contrasting shadows. Experiments with this new form of radiation revealed the distinction between bone and soft tissues in the body, such as in the hand. Röntgen's first x ray was of his wife's hand, which showed bones, soft tissue, and metal from the ring she was wearing. His discovery of x rays heralded a significant and valuable diagnostic tool used in the field of medicine. Röntgen was awarded the Nobel Prize for Physics in 1901 for his discovery. He was the first recipient to be honored in this category. This Nobel Laureate was honored "in recognition of the extraordinary services he has rendered by the discovery of the remarkable rays subsequently named after him."

X rays are a common diagnostic test in which a form of energy called x ray radiation penetrates the patient's body. In bone x rays, electrical current passes through an x-ray tube and produces a beam of ionizing radiation that passes through the bone(s) being examined. This produces a picture of the inside of the body on film. The doctor reads the developed x ray on a wall-mounted light box or on a computer monitor.

Digital x rays are a new type of exam in which conventional equipment is used to take the x-ray picture, but the image is produced via computer. In a digital x ray, the image is created on a reusable plate. After being read by a laser reader, the information is sent in digital form to a storage unit that is connected to a computer network. The radiologist reads the x ray from there. An electronic report can then be sent to the patient's doctor. Electronic reports can also be generated with non-digital x-ray exams.

X rays can detect problems with bones that result from injury or disease caused by malfunction in the patient's bone chemistry. Bone injuries, especially broken bones (fractures), are common and can be accurately diagnosed by evaluation of bone x rays. X rays are especially helpful in diagnosing simple and incomplete fractures, which cannot be detected during a **physical examination**. X rays can also be used to check for bone position and alignment in a fracture. Some bone diseases can be definitively diagnosed with bone x rays, while others require additional, more sophisticated imaging tests.



Osteoporosis, a common bone disease, can be detected in bone x rays, but other tests, such as bone densitometry, may need to be ordered to determine the extent of the disease. In some cases, a bone biopsy (microscopic analysis of a small amount of tissue) is also done. For arthritis, a common ailment, x rays of the bone are occasionally used in conjunction with blood tests. In bone tumors, bone x rays can be helpful, but they may not be definitive when used alone.

Bone x rays are taken by a technologist or radiologist and interpreted by a radiologist. They are taken in a doctor's office, in a hospital, or in an outpatient clinic. Bone x rays generally take less than 10 minutes to complete. There is no pain or discomfort associated with the test, but some people find it difficult to remain still throughout the procedure.

During the test, the patient lies on a table. The technician taking the x ray checks the patient's position and places the x-ray machine over the part of the body being scanned. After asking the patient to remain still, the technician steps out of the area and presses a button to take the picture.

### Preparation

The patient is asked to remove clothing, jewelry, and any other metal objects from the part of the body being x rayed. If appropriate, a lead shield is placed over another part of the body to minimize exposure to the radiation that is being used.

### Aftercare

The patient can immediately resume normal activities once the technician has checked that the x rays have processed well and that none need to be repeated. This takes just a few minutes.

### Risks

The human body contains some natural radiation and is also exposed to radiation in the environment. There is a slight risk from exposure to radiation during bone x rays; however, the amount of radiation is small and the risk of harm is very low. If reproductive organs are to be exposed to large amounts of radiation, genetic alterations could occur in a developing fetus. Excessive or repeated doses of radiation can cause changes in other types of body tissue. No radiation remains in the body after the x ray.

## KEY TERMS

**Arthritis**—A disease of the joints that arises from wear and tear, age, and, less often, from inflammation.

**Bone densitometry**—A test to measure bone density.

**Ionizing radiation**—Energy from radio, ultraviolet, or x rays, that produces charged particles in the recipient matter.

**Osteoporosis**—A disease which occurs primarily in postmenopausal women in which the amount of bone is reduced or skeletal tissue wastes away.

### Normal results

Normal bones show no fractures, dislocations, or other abnormalities.

Results that indicate the presence of bone injury or disease differ in appearance, according to the nature of the injury or disease. For example, fractures show up as clear breaks in the bones, while osteoporotic bone has the same shape as normal bone on an x ray, but is less dense.

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#### OTHER

RadiologyInfo. <http://www.radiologyinfo.org>.

#### ORGANIZATIONS

Radiological Society of North America, 820 Jorie Blvd., Oak Brook, IL, 60523 2251, (630) 571 2670, <http://www.rsna.org>.

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## Bowel preparation

### Definition

A bowel preparation (bowel prep) involves dietary changes and the use of cathartics, laxatives, and/or enemas to clean out the colon prior to tests or procedures involving the abdomen and gastrointestinal tract. It may also include the administration of **antibiotics** to lessen the chance of infection during surgery.

### Purpose

Completing a bowel prep is important prior to a radiological examination because stool in the intestine may interfere with viewing other structures/organs within the abdomen. Prior to abdominal surgery, a careful bowel prep is crucial, since the risk of severe, life-threatening infection is increased if stool remains in the colon. Because stool contains a high bacteria count, even a microscopic nick of the intestine during the course of surgery could result in contamination of the surgical field, and the development of a severe infection.

### Description

Although a number of different regimens can be followed, the basic methodology is as follows. A patient who is going to undergo a test (such as **barium enema** or endoscopy) or abdominal surgery is asked to stop eating solid foods some hours prior to their surgery. Depending on the type of surgery and the timing of the surgery, they may be allowed to continue with a full liquid or clear liquid diet. At some point just prior to the surgery, they will be asked not to take anything at all by mouth.

During the twelve or so hours prior to the test or procedure, a series of preparations (in pill or liquid form) will be used in order to make sure that all stool is evacuated from the intestine. Enemas may also be used to make sure that the bowel is completely cleared of stool. Further protection from infection may involve the administration of either oral antibiotics over the twelve hours prior to surgery, or intravenous antibiotics in the several hours just prior to surgery.

### Aftercare

Some people, especially those who are already in a debilitated state, may become weak or faint during the course of a bowel preparation. People at risk for this outcome should have someone stay with them as they perform the bowel prep, or should talk to their

## KEY TERMS

**Cathartic**—An agent which stimulates defecation.

**Enema**—A liquid which is injected through the anus into the lower intestine in order to stimulate defecation.

**Laxative**—An agent which stimulates defecation.

healthcare providers about having the bowel prep while an inpatient.

### Risks

Most healthy patients can follow a bowel prep regimen in their own home. However, some patients may require hospitalization to complete their bowel prep if they are very weak or ill with a condition (such as kidney disease or congestive heart failure) that may require close monitoring of their hydration and electrolyte status during the course of the bowel prep.

### Normal results

Normal results occur when the bowel is completely cleared of stool prior to a procedure or operation.

### Resources

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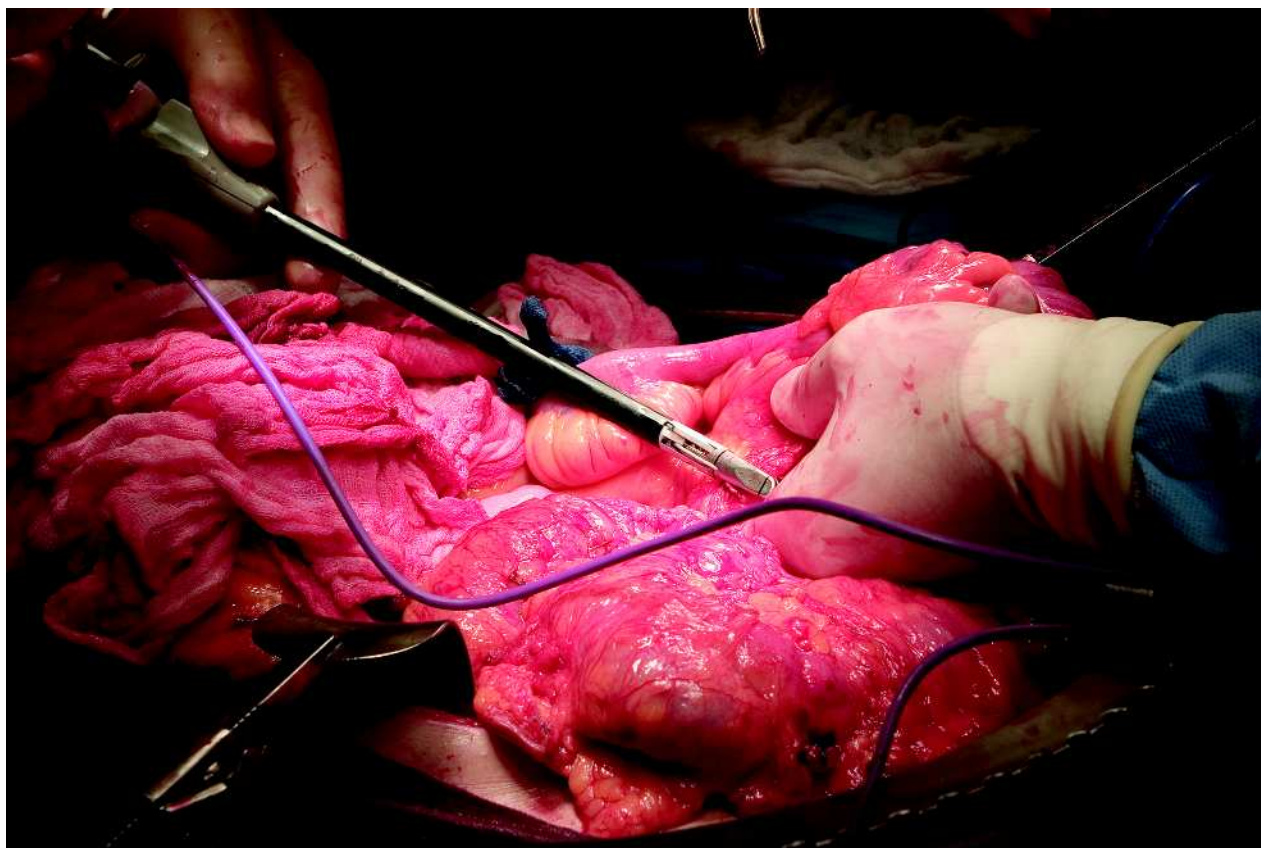
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Rosalyn Carson-DeWitt, MD

## Bowel resection

### Definition

Bowel resection is a surgical procedure in which a diseased part of the large intestine is removed. The procedure is also known as colectomy, colon removal,



**Surgeons removing a portion of the large intestine.** (Copyright Barry Slaven, MD, PhD / Phototake. Reproduced by permission.)

colon resection, or resection of part of the large intestine.

### Purpose

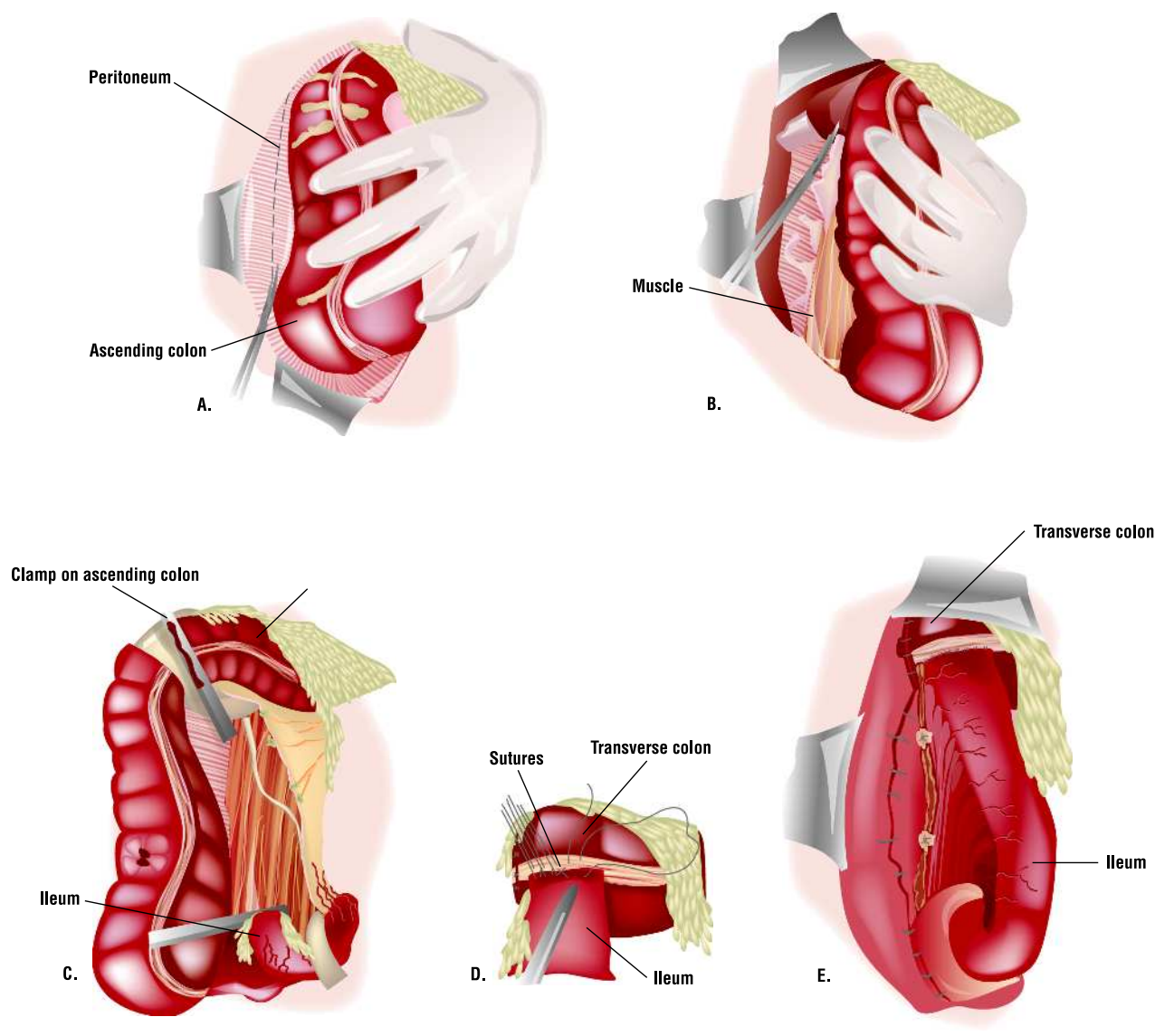
The large bowel, also called the large intestine, is a part of the digestive system. It runs from the small bowel (small intestine) to the rectum, which receives waste material from the small bowel. The large bowel's major function is to store waste and to absorb water from waste material. It consists of the following sections, any of which may become diseased:

- **Colon.** The colon averages some 60 in (150 cm) in length. It is divided into four segments: the ascending colon, transverse colon, descending colon, and sigmoid colon. There are two bends (flexures) in the colon. The hepatic flexure is where the ascending colon joins the transverse colon. The splenic flexure is where the transverse colon merges into the descending colon.
- **Cecum.** This is the first portion of the large bowel that is joined to the small bowel. The appendix lies at the lowest portion of the cecum.

- **Ascending colon.** This segment is about 8 in (20 cm) in length, and it extends upwards from the cecum to the hepatic flexure near the liver.
- **Transverse colon.** This segment is usually more than 18 in (46 cm) in length and extends across the upper abdomen to the splenic flexure.
- **Descending colon.** This segment is usually less than 12 in (30 cm) long and extends from the splenic flexure downwards to the start of the pelvis.
- **Sigmoid colon.** An S-shaped segment that measures about 18 in (46 cm); it extends from the descending colon to the rectum.

The wall of the colon is composed of four layers:

- **Mucosa.** This single layer of cell lining is flat and regenerates itself every three to eight days. Small glands lie beneath the surface.
- **Submucosa.** The area between the mucosa and circular muscle layer that is separated from the mucosa by a thin layer of muscle, the muscularis mucosa.
- **Muscularis propria.** The inner circular and outer longitudinal muscle layers.

**Bowel resection (Colectomy)**

To remove a portion of the colon, or large intestine, and incision is made in the abdomen to expose the area (A). Tissues and muscles connecting the colon to surrounding organs are severed (B). The area to be removed is clamped and severed (C). The remaining portions of the bowel, the ileum (small intestine) and transverse colon, are connected with sutures (D). Muscles and tissues are repaired (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

- **Serosa.** The thick outer layer that covers the bowel and is single celled. It is similar to the peritoneum, the layer of cells that lines the abdomen.

The large intestine is also responsible for bacterial production and absorption of vitamins. Resection of a portion of the large intestine (or of the entire organ) may become necessary when it becomes diseased. The exact reasons for large bowel resection in

any given patient may be complex and are always carefully evaluated by the treating physician or team. The procedure is usually performed to treat the following disorders or diseases of the large intestine:

- **Cancer.** Colon cancer is the second most common type of cancer diagnosed in the United States. Colon and rectum cancers, which are usually referred to as



colorectal cancer, develop on the lining of the large intestine. Bowel resection may be indicated to remove the cancer.

- **Diverticulitis.** This condition is characterized by the inflammation of a diverticulum, especially of diverticula occurring in the colon, which may undergo perforation with abscess formation. The condition may be relieved by resecting the affected bowel section.
- **Intestinal obstruction.** This condition involves a partial or complete blockage of the bowel that results in the failure of the intestinal contents to pass through. It is usually treated by decompressing the intestine with suction, using a nasogastric tube inserted into the stomach or intestine. In cases where decompression does not relieve the symptoms, or if tissue death is suspected, bowel resection may be considered.
- **Ulcerative colitis.** This condition is characterized by chronic inflammation of the large intestine and rectum resulting in bloody diarrhea. Surgery may be indicated when medical therapy does not improve the condition. Removal of the colon is curative and also removes the risk of colon cancer. About 25–40% of ulcerative colitis patients must eventually have their colons removed because of massive bleeding, severe illness, rupture of the colon, or risk of cancer.
- **Traumatic injuries.** Accidents may result in bowel injuries that require resection.
- **Pre-cancerous polyps.** A colorectal polyp is a growth that projects from the lining of the colon. Polyps of the colon are usually benign and produce no symptoms, but they may cause rectal bleeding and develop into malignancies over time. When polyps have a high chance of becoming cancerous, bowel resection may be indicated.
- **Familial adenomatous polyposis (FAP).** This is a hereditary condition caused by a faulty gene. Most people discover that they have it at a young age. People with FAP grow many polyps in the bowel. These are mostly benign, but because there are so many, it is really only a question of time before one becomes cancerous. Since people with FAP have a very high risk of developing bowel cancer, bowel resection is thus often indicated.
- **Hirschsprung's disease (HD).** This condition usually occurs in children. It causes constipation, meaning that bowel movements are difficult. Some children with HD cannot have bowel movements at all; the stool creates a blockage in the intestine. If HD is not treated, stool can fill up the large intestine and cause

serious problems such as infection, bursting of the colon, and even death.

## Description

Bowel resection can be performed using an open surgical approach (colectomy) or laparoscopically.

### *Colectomy*

Following adequate bowel preparation, the patient is placed under **general anesthesia**, which ensures that the patient is deep asleep and pain free during surgery. Because the effects of gravity to displace tissues and organs away from the site of operation are important, patients are carefully positioned, padded, and strapped to the operating table to prevent movement as the patient is tilted to an extreme degree. The surgeon starts the procedure by making a lower midline incision in the abdomen or, alternatively, it may be preferable to perform a lateral lower transverse incision instead. The operation proceeds with the removal of the diseased portion of the large intestine, and then the two healthy ends are sutured or stapled back together before closing the incision. The amount of bowel removed can vary considerably, depending on the reasons for the operation. When possible, the procedure is performed to maintain the continuity of the bowel so as to preserve normal passage of stool.

If the bowel has to be relieved of its normal digestive work while it heals, a temporary opening of the colon onto the skin of abdominal wall, called a **colostomy**, may be created. In this procedure, the end of the colon is passed through the abdominal wall and the edges are sutured to the skin. A removable bag is attached around the colostomy site so that stool may pass into the bag, which can be emptied several times during the day. Most colostomies are temporary and can be closed with another operation at a later date. However, if a large portion of the intestine is removed, or if the distal end of the colon is too diseased to reconnect to the proximal intestine, the colostomy is permanent.

### *Laparoscopic bowel resection*

The benefits of laparoscopic bowel resection when compared to open colectomies include reduced post-operative pain, shorter hospitalization periods, and a faster return to normal activities. The procedure is also minimally invasive. When performing a laparoscopic procedure, the surgeon makes three or four small incisions in the abdomen or in the umbilicus (belly



## KEY TERMS

**Anesthesia**—A combination of drugs administered by a variety of techniques by trained professionals that provide sedation, amnesia, analgesia, and immobility adequate for the accomplishment of the surgical procedure with minimal discomfort, and without injury, to the patient.

**Anus**—The terminal orifice of the bowel.

**Cancer**—The uncontrolled growth of abnormal cells that have mutated from normal tissues.

**Colectomy**—The surgical removal of the colon or part of the colon.

**Colon**—Also called the large intestine, it is responsible for forming, storing and expelling waste matter.

**Colostomy**—The surgical construction of an artificial anus between the colon and the surface of the abdomen.

**Diverticulum**—A small, pouch-like structure that sometimes forms in the walls of the intestines and can trap particles of food and become very inflamed and painful.

**Enema**—A liquid injected into the rectum.

**Mesentery**—The membranes, or one of the membranes (consisting of a fold of the peritoneum and enclosed tissues), that connect the intestines and their appendages with the dorsal wall of the abdominal cavity.

**Ostomy**—An operation to create an opening from an area inside the body to the outside.

**Polyp**—Growth, usually benign, protruding from a mucous membrane such as that lining the walls of the intestines.

**Resection**—Removal of a portion, or all, of an organ or other structure.

button). He inserts specialized **surgical instruments**, including a thin, telescope-like instrument called a laparoscope, in an incision. The abdomen is then filled with gas, usually carbon dioxide, to help the surgeon view the abdominal cavity. A camera is inserted through one of the tubes and displays images on a monitor located near the operating table to guide the surgeon during the procedure. Once an adequate view of the operative field is obtained, the actual dissection of the colon can start. Following the procedure, the small incisions are closed with sutures or surgical tape.

All colon surgery involves only three maneuvers that may vary in complexity depending on the region of the bowel and the nature of the disease. The three maneuvers are retraction of the colon, division of the attachments to the colon, and dissection of the mesentery.

In a typical procedure, after retracting the colon, the surgeon proceeds to divide the attachments to the liver and the small bowel. Once the mesenteric vessels have been dissected and divided, the colon is divided with special stapling devices that close off the bowel while at the same time cutting between the staple lines. Alternatively, a laparoscopically assisted procedure may be selected, in which a small abdominal wall incision is made at this point to bring the bowel outside of the abdomen, allowing open bowel resection and reconnection using standard instruments. This technique is popular with many surgeons because an incision must be made to remove the bowel specimen from the abdomen, which allows the most time-consuming and risky parts of the procedure (from an infection point of view) to be done outside the body with better control of the colon.

## Diagnosis/Preparation

Key elements of the **physical examination** before surgery focus on a thorough examination of the abdomen, groin, and rectum. Other common diagnostic tools used to evaluate medical conditions that may require bowel resection include imaging tests such as gastrointestinal barium series, **angiography**, computerized tomography (CT), **magnetic resonance imaging** (MRI), and endoscopy.

As with any surgery, the patient is required to sign a consent form. Details of the procedure are discussed with the patient, including goals, technique, and risks. Blood and urine tests, along with various imaging tests and an **electrocardiogram** (EKG), may be ordered. To prepare for the procedure, the patient is asked to completely clean out the bowel. This is a crucial step if the bowel is to be opened safely within the peritoneal cavity, or even manipulated safely through small incisions. To empty and cleanse the bowel, the patient is usually placed on a low-residue diet for several days prior to surgery. A liquid diet may be ordered for at least the day before surgery, with nothing taken by mouth after midnight. A series of enemas and/or oral preparations (Golytely or Colyte) may be ordered to empty the bowel of stool. Preoperative bowel preparation involving mechanical cleansing

and administration of intravenous **antibiotics** immediately before surgery is the standard practice.

The patient may also be given a prescription for oral antibiotics (neomycin, erythromycin, or kanamycin sulfate) the day before surgery to decrease bacteria in the intestine and to help prevent post-operative infection. A nasogastric tube is inserted through the nose into the stomach during surgery and may be left in place for 24–48 hours after surgery. This removes the gastric secretions and prevents nausea and vomiting. A urinary catheter (a thin tube) may be inserted to keep the bladder empty during surgery, giving more space in the surgical field and decreasing chances of accidental injury.

### Aftercare

**Postoperative care** for the patient involves monitoring blood pressure, pulse, respiration, and temperature. Breathing tends to be shallow because of the effect of anesthesia and the patient's reluctance to breathe deeply and experience pain that is caused by the abdominal incision. The patient is instructed how to support the operative site during deep breathing and coughing, and is given pain medication as necessary. Fluid intake and output is measured, and the operative site is observed for color and amount of wound drainage. The nasogastric tube will remain in place, attached to low intermittent suction until bowel activity resumes. Fluids and electrolytes are infused intravenously until the patient's diet can gradually be resumed, beginning with liquids and advancing to a regular diet as tolerated. The patient is generally out of bed approximately eight to 24 hours after surgery. Most patients will stay in the hospital for five to seven days, although laparoscopic surgery can reduce that stay to two to three days. Postoperative weight loss follows almost all bowel resections. Weight and strength are slowly regained over the next few months. Complete recovery from surgery may take two months. Laparoscopic surgery can reduce this time to one to two weeks.

The treating physician should be informed of any of the following problems after surgery:

- increased pain, swelling, redness, drainage, or bleeding in the surgical area
- headache, muscle aches, dizziness, or fever
- increased abdominal pain or swelling; constipation; nausea or vomiting; rectal bleeding; or black, tarry stools

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Bowel resection surgery is performed by a colorectal surgeon, who is a medical doctor fully trained in general surgery and certified by the American Board of Surgery (ABS) as well as by the American Society of Colon and Rectal Surgeons (ASCRS). The surgeon must pass the American Board of Surgery Certifying Examination and complete an approved colorectal training program. The surgeon is then eligible to take the qualifying examination in colorectal surgery after completing training. There is also a certifying examination that is taken after passing the qualifying examination. The surgeon is required to recertify in surgery in order to recertify in colon and rectal surgery (every 10 years).

Bowel resection surgery is a major operation performed in a hospital setting. The cost of the surgery varies significantly between surgeons, medical facilities, and regions of the country. Patients who are sicker or need more extensive surgery will require more intensive and expensive treatment.

### Risks

Potential complications of bowel resection surgery include:

- excessive bleeding
- surgical wound infection
- incisional hernia (an organ projecting through the surrounding muscle wall; it occurs through the surgical scar)
- thrombophlebitis (inflammation and blood clot to veins in the legs)
- narrowing of the opening (stoma)
- pneumonia
- pulmonary embolism (blood clot or air bubble in the lung blood supply)
- reaction to medication
- breathing problems
- obstruction of the intestine from scar tissue

### Normal results

Complete healing is expected without complications after bowel resection, but the period of time required for recovery from the surgery varies

## QUESTIONS TO ASK THE DOCTOR

- What alternatives to bowel resection might be indicated in my case?
- Am I a candidate for bowel resection?
- How many patients with my specific condition have you treated?
- How long will it take to recover from surgery?
- What do I need to do before surgery?
- What happens on the day of surgery?
- What type of anesthesia will be used?
- What happens during surgery, and how is the surgery performed?

depending on the initial condition that required the procedure, the patient's overall health status prior to surgery, and the length of bowel removed.

### Morbidity and mortality rates

Prognosis for bowel resection depends on the seriousness of the disease. For example, primary treatment for colorectal cancer consists of wide surgical resection of the colon cancer and lymphatic drainage after the bowel is prepared. The choice of operation for rectal cancer depends on the tumor's distance from the anus and gross extent; overall surgical cure is possible in 70% of these patients. In the case of ulcerative colitis patients, the colitis is cured by bowel resection and most people go on to live normal, active lives. As for Hirschsprung's disease patients, approximately 70–85% eventually achieve excellent results after surgery, with normal bowel habits and infrequent constipation.

### Alternatives

Alternatives to bowel resection depend on the specific medical condition being treated. For most conditions where bowel resection is advised, the only alternative is medical treatment with drugs. In cases of cancer of the bowel, drug treatment alone will not cure the disease. Occasionally, it is possible to remove a rectal cancer from within the back passage without major surgery, but this only applies to very special cases. As for other conditions such as mild or moderate ulcerative colitis, drug therapy may represent an alternative to surgery; a combination of the drugs sulfonamide, sulfapyridine, and salicylate may help control inflammation. Similarly, most acute cases of

**diverticulitis** are first treated with antibiotics and a liquid diet.

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## Bowel resection, small intestine

### Definition

A small **bowel resection** is the surgical removal of one or more segments of the small intestine.

### Purpose

The small intestine is the part of the digestive system that absorbs much of the liquid and nutrients from food. It consists of three segments: the duodenum, jejunum, and ileum. It is followed by the large intestine (colon). A small bowel resection may be performed to treat the following conditions:

- **Crohn's disease.** This condition is characterized by a chronic inflammatory condition that affects the digestive tract. If other treatment does not effectively control symptoms, the physician may recommend surgery to close fistulas or remove part of the intestine where the inflammation is worst.
- **Cancer.** Cancer of the small intestine is a rare cancer in which malignant cells are found in the tissues of the small intestine. Adenocarcinoma, lymphoma, sarcoma, and carcinoid tumors account for the majority of small intestine cancers. Surgery to remove the cancer is the most common treatment. When the tumor is large, removal of the small intestine segment containing the cancer is usually indicated.
- **Ulcers.** Ulcers are crater-like lesions on the mucous membrane of the small bowel caused by an inflammatory, infectious, or malignant condition that often requires surgery and in some cases, bowel resection.
- **Intestinal obstruction.** This condition involves a partial or complete blockage of the bowel that results in the failure of the intestinal contents to pass through. Intestinal obstruction is usually treated by decompressing the intestine with suction, using a nasogastric tube inserted into the stomach or intestine. In cases where decompression does not relieve the symptoms, or if tissue death is suspected, bowel resection may be considered.
- **Injuries.** Accidents may result in bowel injuries that require resection.
- **Precancerous polyps.** A polyp is a growth that projects from the lining of the intestine. Polyps are usually benign and produce no symptoms, but they may cause rectal bleeding and develop into malignancies over time. When polyps have a high chance of becoming cancerous, bowel resection is usually indicated.

### Demographics

According to the National Cancer Institute, adenocarcinoma, lymphoma, sarcoma, and carcinoid tumors account for the majority of small intestine cancers which, as a whole, account for only 1–2% of all gastrointestinal cancers diagnosed in the United States. About 6,110 new cases of small intestine cancer are diagnosed yearly; about 1,110 deaths occur from small intestine cancer annually.

Crohn's disease occurs worldwide with a prevalence of 10–100 cases per 100,000 people. The disorder occurs most frequently among people of European origin, is three to eight times more common among Jews than among non-Jews, and is more common among whites than nonwhites. Although the disorder can start at any age, it is most often diagnosed between 15 and 30 years of age. Some 20–30% of patients with Crohn's disease have a family history of inflammatory bowel disease.

The occurrence of polyps increases with age. The risk of cancer developing in an unremoved polyp is 2.5% at five years, 8% at 10 years, and 24% at 20 years after the diagnosis. The risk of developing bowel cancer after removal of polyps is 2.3%, compared to 8.0% for patients who do not have them removed.

### Description

The resection procedure can be performed using an open surgical approach or laparoscopically. There are three types of surgical small bowel resection procedures:

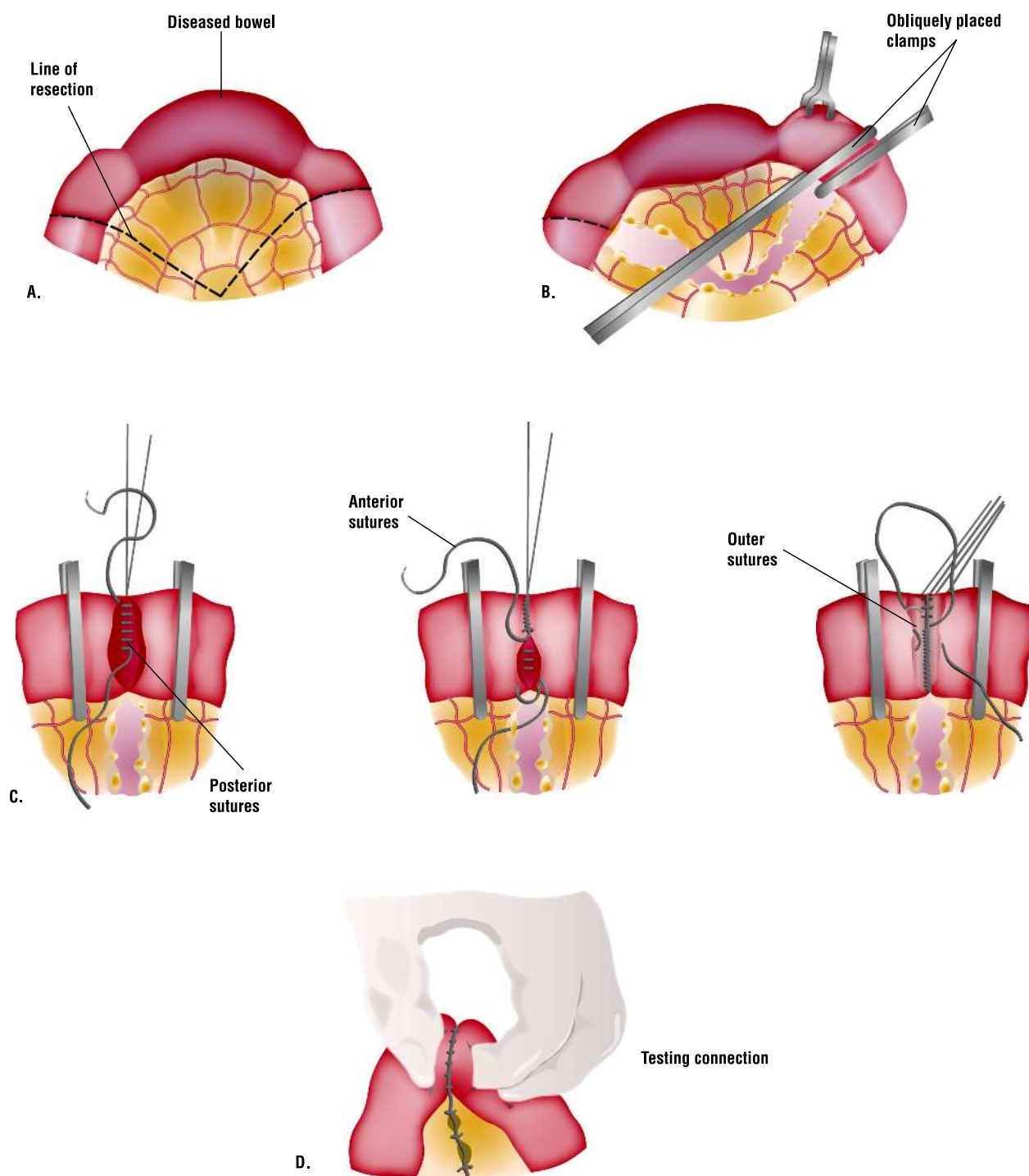
- **Duodenectomy.** Excision of all or part of the duodenum.
- **Ileectomy.** Excision of all or part of the ileum.
- **Jejunectomy.** Excision of all or a part of the jejunum.

### Open resection

Following adequate **bowel preparation**, the patient is placed under general anesthesia and positioned for the operation. The surgeon starts the procedure by making a midline incision in the abdomen. The diseased part of the small intestine (ileum or duodenum or jejunum) is removed. The two healthy ends are either stapled or sewn back together, and the incision is closed. If it is necessary to spare the intestine from its normal digestive work while it heals, a temporary opening (stoma) of the intestine into the abdomen (ileostomy, duodenostomy, or jejunostomy) is made. The ostomy can be closed and repaired at a later time.



## Small bowel resection



To remove a diseased portion of the small intestine, an incision is made into the abdomen, and the area to be treated is pulled out (A). Clamps are placed around the area to be removed and the section is cut (B). Three layers of sutures repair the remaining bowel (C). (Illustration by GGS Information Services. Cengage Learning, Gale.)



## KEY TERMS

**Adenocarcinoma**—Adenocarcinoma starts in the lining of the small intestine and is the most common type of cancer of the small intestine. These tumors occur most often in the part of the small intestine nearest the stomach and often grow and block the bowel.

**Anesthesia**—A combination of drugs administered by a variety of techniques by trained professionals that provide sedation, amnesia, analgesia, and immobility adequate for the accomplishment of the surgical procedure with minimal discomfort and without injury to the patient.

**Cancer**—The uncontrolled growth of abnormal cells which have mutated from normal tissues.

**Colon**—Also called the large intestine, the colon has six major segments: caecum, ascending colon, transverse colon, descending colon, sigmoid colon, and rectum. Its length is approximately 5 ft (1.5 m) in the adult and it is responsible for forming, storing, and expelling waste matter.

**Crohn's disease**—Chronic inflammatory process, primarily involving the intestinal tract, that most commonly affects the last part of the small intestine (ileum) and/or the large intestine (colon and rectum).

**Duodenectomy**—Excision of the duodenum.

**Ileectomy**—Excision of the ileum.

**Jejunectomy**—Excision of all or a part of the jejunum.

**Leiomyosarcoma**—Leiomyosarcomas are cancers that start growing in the smooth muscle lining of the small intestine.

**Lymphoma**—A lymphoma starts from lymph tissue in the small intestine. Lymph tissue is part of the body's immune system, which helps the body fight infections. Most of these tumors are a type of lymphoma called non-Hodgkin's lymphomas.

**Ostomy**—An operation to create an opening from an area inside the body to the outside.

**Polyp**—Growth, usually benign, protruding from a mucous membrane, such as that lining the walls of the intestines.

**Resection**—Removal of a portion or all of an organ or other structure.

**Small intestine**—The small intestine consists of three sections: duodenum, jejunum and ileum, all of which are involved in the absorption of nutrients. The total length of the small intestine is approximately 22 ft (6.5 m).

### *Laparoscopic bowel resection*

Laparoscopic small bowel resection features insertion of a thin, telescope-like instrument called a laparoscope through a small incision made at the umbilicus (belly button). The laparoscope is connected to a small video camera unit that shows the operative site on video monitors located in the operating room. The abdomen is inflated with carbon dioxide gas to allow the surgeon a clear view of the operative area. Four to five additional small incisions are made in the abdomen for insertion of specialized surgical instruments that the surgeon uses to perform the surgery. The small bowel is clamped above and below the diseased section and this section is removed. The small bowel ends are reattached using staples or sutures. Following the procedure, the small incisions are closed with sutures or surgical tape.

### **Diagnosis/Preparation**

As with any surgery, the patient is required to sign a consent form. Details of the procedure are discussed

with the patient, including goals, technique, and risks. Blood and urine tests, along with various imaging tests and an electrocardiogram (EKG), may be ordered as required. To prepare for the procedure, the patient is asked to completely clean the bowel and is placed on a low residue diet for several days prior to surgery. A liquid diet may be ordered for at least the day before surgery, with nothing taken by mouth after midnight. Preoperative bowel preparation involving mechanical cleansing and administration of antibiotics before surgery is the standard practice. This involves the prescription of oral antibiotics (neomycin, erythromycin, or kanamycin sulfate) to decrease bacteria in the intestine and help prevent postoperative infection. A nasogastric tube is inserted through the nose into the stomach on the day of surgery or during surgery. This removes the gastric secretions and prevents nausea and vomiting. A urinary catheter (thin tube inserted into the bladder) may also be inserted to keep the bladder empty during surgery, giving more space in the surgical field and decreasing chances of accidental injury.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Bowel resection surgery is performed by a colorectal surgeon, who is a physician fully trained in general surgery as evidenced by certification by the American Board of Surgery (ABS). Colorectal surgeons also are certified by the American Society of Colon and Rectal Surgeons (ASCRS), the leading professional society representing more than 1,000 board certified colon and rectal surgeons and other surgeons dedicated to advancing and promoting the science and practice of the treatment of patients with diseases and disorders affecting the colon, rectum, and anus.

Bowel resection surgery is performed in a hospital setting.

## Aftercare

Once the surgery is completed, the patient is taken to a postoperative or recovery unit where a nurse monitors recovery and ensures that bandages are kept clean and dry. Mild pain at the incision site is commonly experienced and the treating physician usually prescribes pain medication. Postoperative care also involves monitoring of blood pressure, pulse, respiration, and temperature. Breathing tends to be shallow because of the effect of anesthesia and the patient's reluctance to breathe deeply and experience pain that is caused by the abdominal incision. The patient is given instruction on the way to support the operative site during deep breathing and coughing. Fluid intake and output is measured, and the operative site is observed for color and amount of wound drainage. The nasogastric tube remains in place, attached to low intermittent suction until bowel activity resumes. Fluids and electrolytes are infused intravenously until the patient's diet can gradually be resumed, beginning with liquids and progressing to a regular diet as tolerated. The patient is generally out of bed approximately eight to 24 hours after surgery. Patients are usually scheduled for a follow-up examination within two weeks after surgery. During the first few days after surgery, physical activity is restricted.

## Risks

Risks include all the risks associated with general anesthesia, namely, adverse reactions to medications and breathing problems. They also include the risks

## QUESTIONS TO ASK THE DOCTOR

- What do I need to do before surgery?
- What happens on the day of surgery?
- What type of anesthesia will be used?
- What happens during surgery, and how is the surgery performed?
- What happens after the surgery?
- What are the risks associated with a small bowel resection?
- How long will I be in the hospital?
- When can I expect to return to work and/or normal activities?
- Will there be a scar?

associated with any surgery, such as bleeding or infection. Additional risks associated specifically with bowel resection include:

- bulging through the incision (incisional hernia)
- narrowing (stricture) of the opening (stoma)
- blockage (obstruction) of the intestine from scar tissue

## Normal results

Complete healing is expected without complications after bowel resection, but the period of time required for recovery from the surgery varies depending on the condition requiring the procedure, the patient's overall health status prior to surgery, and the length of bowel removed.

## Morbidity and mortality rates

According to the National Cancer Institute, the predominant treatment for small intestine cancers is surgery when bowel resection is possible, and cure depends on the ability to completely remove the cancer. The overall five-year survival rate for resectable adenocarcinoma is 20%. The five-year survival rate for resectable leiomyosarcoma, the most common primary sarcoma of the small intestine, is approximately 50%.

Crohn's disease is a chronic incurable disease characterized by periods of progression and remission with 99% of patients suffering at least one relapse. Physicians are presently unable to predict the extent and severity of the disease over time; thus, while morbidity is very high for Crohn's disease, mortality is essentially zero.

## Alternatives

Alternatives to bowel resection depend on the specific medical condition being treated. For most conditions where bowel resection is advised, the only alternative is treatment with drugs.

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American Board of Colorectal Surgeons (ABCRS). 20600 Eureka Rd., Ste. 600, Taylor, MI 48180. (734) 282-9400. [www.abcrs.org](http://www.abcrs.org).

American Society of Colorectal Surgeons (ASCRS). 85 West Algonquin, Suite 550, Arlington Heights, IL 60005. (847) 290-9184. [www.fascrs.org](http://www.fascrs.org).

United Ostomy Association, Inc. (UOA). 19772 MacArthur Blvd., Suite 200, Irvine, CA 92612-2405. (800) 826-0826. [www.uoa.org](http://www.uoa.org).

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Bowel surgery with ostomy see **Colostomy**

Brain surgery see **Craniotomy**

Breast augmentation see **Breast implants**

## Breast biopsy

### Definition

A breast biopsy is the removal of breast tissue for examination by a pathologist. This can be accomplished surgically or by extracting tissue through a needle.

### Purpose

Breast biopsies are done to diagnose breast abnormalities. A biopsy is recommended when a significant abnormality is found by **physical examination** or an imaging test. Examples of an abnormality can include a breast lump felt during breast self-examination or tissue changes noticed from a mammogram.

Before a biopsy is performed, other simpler, less invasive tests may be done to rule out cancer. For example, a lump may be revealed simply as a fluid-filled cyst when examined by **ultrasound** imaging. If less invasive tests are not conclusive, the presence of a malignant (cancerous) or benign (noncancerous) breast condition can be definitively determined by a biopsy.

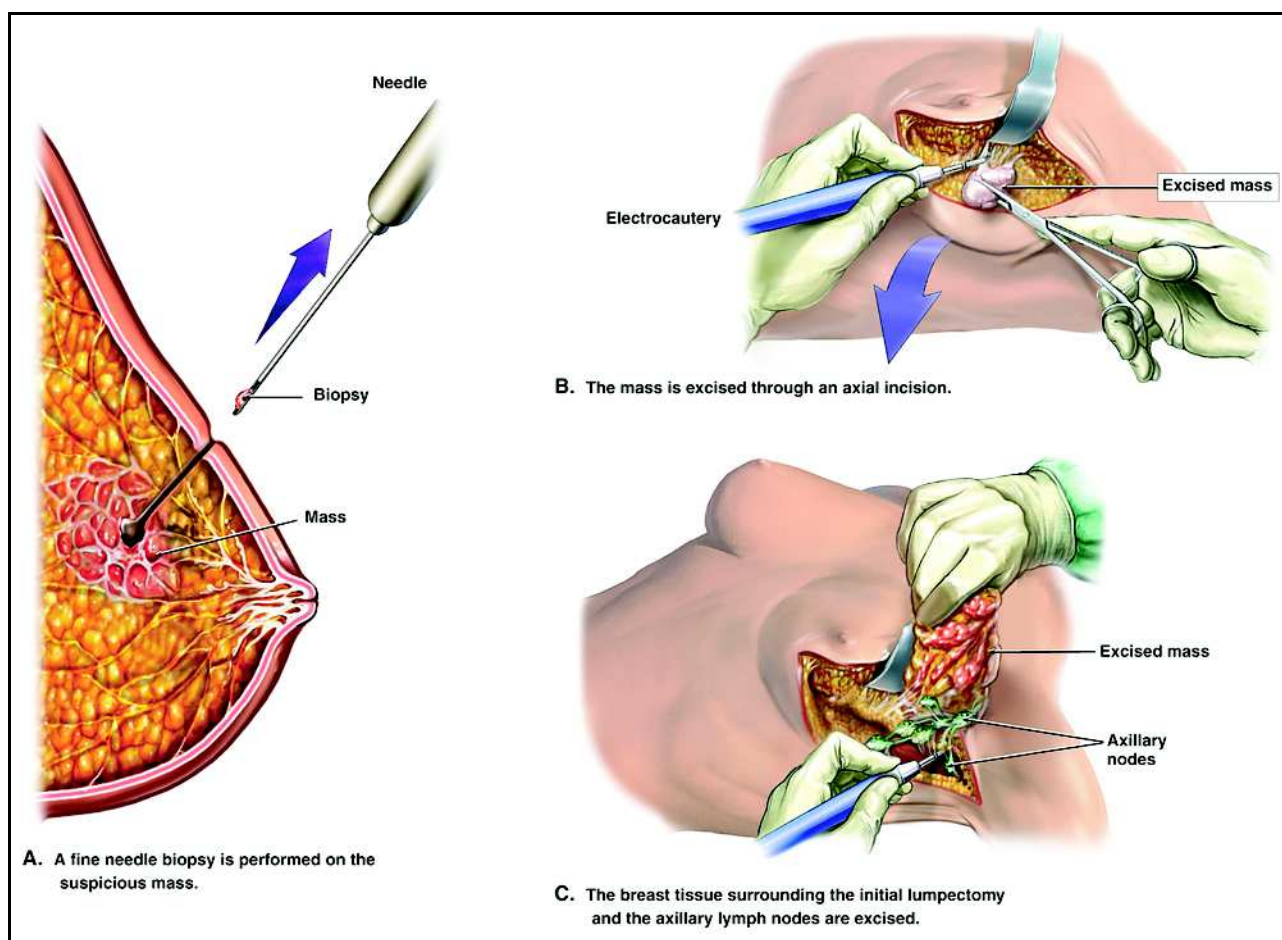
### Demographics

The American Cancer Society estimated that in 2007, 78,480 new cases of invasive breast cancer and 62,030 new cases of breast carcinoma in situ (CIS) were diagnosed in the United States. CIS is the earliest, noninvasive form of breast cancer. Approximately one of every eight women will develop breast cancer at some point in her life. Since 1990, breast cancer rates have decreased among women under age 50; however, breast cancer still causes the **death** of one of every 35 women.

In 2007, the incidence of breast cancer was highest among Caucasian women, but African American women had more aggressive tumors and were more likely to die from the disease. Hispanic, Native American, and Asian women have lower breast cancer and breast cancer death rates than Caucasians or African Americans.

### Description

In a biopsy, cells are removed from the breast and examined under the microscope to determine if they are malignant or benign. The type of biopsy recommended depends on whether the abnormality is large enough to be felt, how well it can be seen on mammogram or ultrasound, and how suspicious it feels or appears. Specialized equipment is needed for different types of biopsy, and its availability may vary.



(Nucleus Medical Art / Alamy)

### *Surgical biopsy*

There are two types of surgical breast biopsy: excisional and incisional. An excisional biopsy is a surgical procedure that removes the entire area of concern and some surrounding tissue. It is usually done as an outpatient procedure in a hospital or free-standing surgery center. The patient may be awake, but is usually given medication to make her drowsy. The area to be operated on is numbed with a local anesthetic. Infrequently, **general anesthesia** is used. An excisional biopsy usually takes under one hour to perform. Nevertheless, the total amount of time spent at the facility depends on the type of anesthesia used, whether a needle localization was done, and the extent of the surgery.

If a mass is very large, an incisional biopsy may be performed. In this case, only a portion of the area of concern is removed and sent for analysis. The procedure is the same as an excisional biopsy in other respects.

### *Needle biopsies*

A needle biopsy removes a sample of fluid and cells from suspicious area for examination. There are two main types of needle biopsies: aspiration biopsy, using a fine-gauge needle, and large-core needle biopsy. Either of these may be called a percutaneous needle biopsy. Percutaneous refers to a procedure done through the skin.

A fine-needle aspiration biopsy (FNAB) uses a very thin needle to withdraw (aspirate) fluid and cells that are then examined under the microscope for abnormalities. A FNAB can be done in a doctor's office, clinic, or hospital. Local anesthetic may be used, but is sometimes not needed as its administration may be more painful than the insertion of the very thin biopsy needle. Sometimes, the area to place the needle may be located by touch without using specialized equipment. However, ultrasound guidance enables the physician to feel and see the lesion at the same



## KEY TERMS

**Core needle biopsy (CNB)**—A procedure using a larger diameter needle to remove a core of tissue from the breast.

**Ductogram**—A test used for imaging the breast ducts and diagnosing the cause of abnormal nipple discharges.

**Fine-needle aspiration biopsy (FNAB)**—A procedure using a thin needle to remove fluid and cells from a lump in the breast.

**Mammogram**—A set of x rays taken of the front and side of the breast used to help diagnose various breast abnormalities.

time. This helps ensure that the specimen is taken from the area of concern. The patient lies on her back or side. After the area is numbed, sterile gel is applied. The physician places a transducer, an instrument about the size of an electric shaver, over the skin. This produces an image from the reflection of sound waves. A special needle, usually in a spring-loaded device, is used to obtain the tissue. The actual withdrawal of fluid and cells can be visualized as it occurs.

A core needle biopsy (CNB) uses a larger diameter needle to remove small pieces of tissue. These are usually about the size of a grain of rice, although the needle diameter may vary based on the size and location of the suspicious mass. CNBs can be done in a clinic or hospital. Local anesthetic is routinely used. Ultrasound or x ray is used to guide the placement of the needle in a core needle biopsy. When larger cores are removed, a vacuum pump may be used to help withdraw the tissue.

If the suspicious area is seen best with x ray, a stereotactic device is used to guide the biopsy. X rays are taken from several angles. The information is fed into a computer that analyzes the data and guides the needle to the correct place. The patient may be sitting up, or she may be lying on her stomach, with her breast positioned through an opening in the table. The breast is held firmly but comfortably between a plastic paddle and a metal plate, similar to those used for mammograms. X rays may be taken before, during, and after the tissue is drawn into the needle to confirm that the correct spot is biopsied. This procedure is called a stereotactic core biopsy, or a mammotomy.

A pathologist examines the sample tissue for malignant cells, indicating the presence of cancer. If a fine-needle aspiration biopsy is performed, the

pathologist looks at individual cells under the microscope to see if they appear abnormal. CNBs and surgical biopsy often provide more information than FNABs and are able to give more information on the type of cancer, whether it has invaded surrounding tissue, and how likely it is to spread quickly. The biopsy can also reveal some conditions that are not malignant but indicate high risk for future development of breast cancer. If these are identified, more frequent breast monitoring is recommended.

## Diagnosis/Preparation

Sometimes an abnormality can be felt during a breast self-examination or an examination by a health-care professional. If an abnormality is not felt, there are other signs that indicate the need for medical attention. These include:

- severe breast pain
- changes in the size of a breast or nipple
- changes in the shape of both breast and nipple
- pitting, dimpling, or redness of the breast skin
- nipple redness, irritation, or inversion
- changes in the pattern of veins visible on the surface of the breast
- some types of nipple discharge

If the abnormality cannot be located easily, a wire localization may be done before the actual biopsy. After local anesthetic is administered, a fine wire is placed in the area of concern. Either x ray or ultrasound guidance is used to place the wire, and then the biopsy needle can follow the wire to the area of concern. The patient is awake and usually sitting up during this procedure.

A surgical breast biopsy may require that patient have nothing to eat or drink for some time before the operation. This will typically be from midnight the night before the procedure, if general anesthesia is planned. No food restrictions are necessary for needle biopsies, although it is advisable to eat lightly before the procedure. This is especially important if the patient will be lying on her stomach for a stereotactic biopsy.

## Aftercare

After a surgical biopsy, the incision is closed with sutures and covered with a bandage. The bandage is usually removed within two days. Sutures are removed about one week later. Depending on the extent of the operation, normal activities can be resumed in one to three days. Vigorous **exercise** may be limited for one to three weeks.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A surgeon, or a radiologist, which is a medical doctor who specializes in the use of imaging techniques for diagnosis or treatment, usually performs breast biopsy. A pathologist, who is a medical doctor who has completed specialized training in the diagnosis of diseases from microscopic analysis of cells and tissues, analyzes the extracted tissue samples. Surgical biopsies are generally performed at a hospital or surgery center. Because needle biopsies are less invasive, they may be performed at a doctor's office, clinic, or hospital.

The skin opening for a needle biopsy is minimal. It may be closed with thin, clear tape or covered with a small bandage. The patient can return to her usual routine immediately after the biopsy. Strenuous activity or heavy lifting should be avoided for 24 hours. Any **bandages** can be removed one or two days after the biopsy.

### Risks

Infection is always a possibility when the skin is broken, although this rarely occurs in breast biopsies. Redness, swelling, or severe pain at the biopsy site indicates a possible infection and a reason for concern. Another possible consequence of a breast biopsy is a hematoma, which is a collection of blood at the biopsy site. The body usually resorbs this blood naturally without treatment. If the hematoma is very large and uncomfortable, it may need to be drained. A surgical breast biopsy may produce a visible scar on the breast. Scarring may make future mammograms harder to interpret accurately.

A false negative pathology report is another risk. In a false negative report, no cancer is found when cancer is actually present. The incidence of false negative biopsy findings varies with the biopsy technique. In general, fine-needle aspiration biopsies have the highest rate of false negative results. Different facilities also have varying rates of false negative readings, depending somewhat on the experience of their pathologist.

### Normal results

A normal pathology report indicates no malignancy is present. The tissue sample may be classified

## QUESTIONS TO ASK THE DOCTOR

- Why is a biopsy recommended?
- What type of biopsy will I have?
- How long will the procedure take?
- When will I find out the results?
- What will happen if the results are positive for cancer?

as a benign breast condition. Many women develop nonmalignant tumors of the breast (fibroadenoma) or harmless fluid-filled cysts. Some noncancerous conditions are more likely to develop into cancer. Women with these benign conditions should have more frequent breast health check-ups. Some studies have found that about 80% of all breast biopsies result in a negative (noncancer) pathology report.

### Morbidity and mortality rates

The reported rate of complications for image-guided biopsies is approximately 2%. Excessive bleeding occurs after approximately 0.5% of fine needle biopsies, 3% of small needle biopsies, and 5–10% of large needle biopsies. Infection occurs in approximately 1% of biopsy sites. Organ damage such as a collapsed lung (pneumothorax) occurs in approximately 0.5% of biopsies. The rate of complications varies considerably among individual physicians and facilities.

### Alternatives

While a biopsy is the only way to determine definitively if a breast abnormality is cancerous, other less invasive procedures may be done to try to rule out cancer so that a biopsy is not necessary. These include **mammography**, ultrasound imaging, and ductography (used for imaging the breast ducts and diagnosing the cause of abnormal nipple discharges).

### Resources

#### ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd., NE, Atlanta, GA 30329 4251. (800) 227 2345. <http://www.cancer.org> (accessed March 8, 2008).

National Cancer Institute. NCI Public Inquiries Office, 6116 Executive Boulevard Room 3036A, Bethesda, MD 20892 8322. (800) 422 6237. TTY: (800) 332 8615 <http://www.nci.nih.gov> (accessed March 8, 2008).

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## Breast implants

### Definition

Breast implantation is a surgical procedure for enlarging, or augmenting, the breast. Implants are breast-shaped pouches that are saccular in shape, made of a silicone outer shell, and filled with silicone gel or saline (salt water).

### Purpose

Breast implantation is usually performed to make normal breasts larger for cosmetic purposes. Sometimes a woman having **breast reconstruction** after a **mastectomy** will need the remaining breast enlarged to make the breasts more symmetrical. Breasts that are very unequal in size due to trauma or congenital deformity may also be equalized with an enlargement procedure.

Male-to-female transsexuals may use breast implantation to achieve the physical appearance of a female.

### Demographics

Breast enlargement is the second-most-common cosmetic surgical procedure practiced on women in the United States. It increased by approximately 350% between 1992 and 2006. According to the American Society of Plastic and Reconstructive Surgeons, almost 150,000 breast augmentation procedures are performed each year.

Presently, more than two million, or approximately 8%, of women in the United States have breast implants. The majority of breast implant recipients

## KEY TERMS

**Breast augmentation**—A surgery to increase the size of the breasts.

**Contracture**—Tissue change that is characterized by shortening of length, usually producing wrinkles or areas of thickening.

**Transsexual**—Person desiring to acquire the external appearance of a member of the opposite gender.

are Caucasian women (95%), followed by African-American women (4%). The remaining women that have breast implants are Asian (0.5%) and other non-specified races (0.5%).

### Description

Cosmetic breast enlargement or augmentation is usually performed as an outpatient procedure. It may be done under local or **general anesthesia**, depending on patient and physician preference. The incision is typically made through the armpit (axilla), along the fold line under the breast, or around the areola (the darkened area around the nipple); these techniques create the most inconspicuous scars. The implant is placed in one of two locations: between the breast tissue and underlying chest muscle, or under the chest muscle. The operation takes approximately one to two hours. The cost of a cosmetic procedure is rarely covered by insurance; however, if enlargement is part of breast reconstruction after a mastectomy, health plans may pay for some or all of it. The surgeon's fee ranges from \$3,500 to \$5,000, and up. The procedure may also be called breast augmentation or augmentation mammoplasty.

### Diagnosis/Preparation

The diagnosis for breast reconstruction is almost always visual. The underlying medical reasons include equalizing otherwise normal breasts that are markedly different in size, replacing all or part of breast tissue that has been removed during the course of cancer treatment, or replacing breast mass that has been lost due to injury. Underlying cosmetic reasons include personal preference for larger breasts among genetic females or the creation of breasts in male-to-female transsexuals.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Breast augmentation is normally performed by a surgeon with advanced training in plastic and reconstructive procedures. It is typically performed as an outpatient procedure.

Before any surgery is performed, the woman should have a clear understanding of what her new breasts will look like. She and her physician should agree about the desired final result. Many surgeons find it helpful to have the patient review before and after pictures of other patients, to clarify expectations. Computer modeling is often used to assess expected results.

A person who is in poor health or has a severe or chronic disease is not a good candidate for this procedure.

### Aftercare

Many normal activities such as driving may be restricted for up to one week. Sutures are usually removed in seven to 10 days. Typically, a woman can resume all routines, including vigorous **exercise**, in about three weeks. The scars will be red for approximately one month, but will fade to their final appearance within one to two years.

### Risks

Risks associated with this procedure are similar to those of any surgical procedure. These risks include bleeding, infection, reaction to anesthesia, or unexpected scarring. A breast enlargement may also result in decreased sensation in the breast or interference with breast-feeding. Implants can make it more difficult to read and interpret mammograms, possibly delaying breast cancer detection. Also, the implant itself can rupture and leak, or become displaced. A thick scar that normally forms around the implant, called a capsule, can become very hard. This is called capsular contracture, and may result in pain and possible altered appearance of the breast. The chances that these problems will occur increase with the age of the implant.

There has been intermittent publicity about possible health risks associated with breast implants. Most concerns have focused on silicone gel-filled implants that leaked or ruptured. In 1992, the U.S.

## QUESTIONS TO ASK THE DOCTOR

- What will be the resulting appearance?
- Is the surgeon board certified in plastic and reconstructive surgery?
- How many procedures has the surgeon performed?
- What is the surgeon's complication rate?

Food and Drug Administration (FDA) restricted the use of this type of implant and ordered further studies. The FDA lifted the ban on silicone implants in 2007 although saline-filled implants are still more commonly used for cosmetic breast surgery. Studies have shown no evidence of long-term health risks from intact silicone implants; however, research on possible links between these implants and autoimmune or connective tissue diseases is continuing.

### Normal results

Breasts of expected size and appearance are the normal results of this surgery. Normal scar formation should be expected. With any silicone prosthesis, a capsule usually forms around it. In some instances, a mild form of capsular contraction ensues. Mild ridges that can be felt under the skin categorize this condition. The capsule contracts, which occurs occasionally, and can result in a hardening of the breast. There is no way to predict who will excessively scar.

### Morbidity and mortality rates

In addition to scarring, other risks include infection, excessive bleeding, problems associated with anesthesia, rupturing of the implant, and leakage. There have been approximately 120,000 reports of ruptured silicone implants. Approximately 50,000 reports of breakage have been received for saline implants.

Deaths associated with breast augmentation are extremely rare. Most postsurgical mortality has been attributed to anesthesia errors or overdoses of pain medications.

### Alternatives

Alternatives to breast implant surgery include using external breast forms that fit into brassiere cups or are attached to the skin of the chest. Creams that allege to increase breast size usually produce no



noticeable results. The use of creams containing hormones can lead to long-term hormonal imbalance. Reputable experts do not generally recommend these preparations for breast enlargement.

## Resources

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## ORGANIZATIONS

- American Board of Plastic Surgery, Seven Penn Center, Suite 400, 1635 Market Street, Philadelphia, PA, 19103 2204, (215) 587 9322, <http://www.abplsurg.org>.
- American College of Surgeons, 633 North Saint Claire Street, Chicago, IL, 60611, (312) 202 5000, <http://www.facs.org>.
- American Society for Aesthetic Plastic Surgery, 11081 Winners Circle, Los Alamitos, CA, 90720, (888) 272 7711, <http://www.surgery.org/>.
- American Society of Plastic Surgeons, 444 E. Algonquin Rd., Arlington Heights, IL, 60005, (847) 228 9900, <http://www.plasticsurgery.org>.

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Breast radiography see **Mammography**

## Breast reconstruction

### Definition

Breast reconstruction consists of a series of surgical procedures performed to recreate a breast. Reconstructions are commonly begun after portions of one or both breasts are removed as a treatment for breast cancer. A breast may have to be refashioned for other reasons such as trauma or to correct abnormalities that occur during breast development.

### Purpose

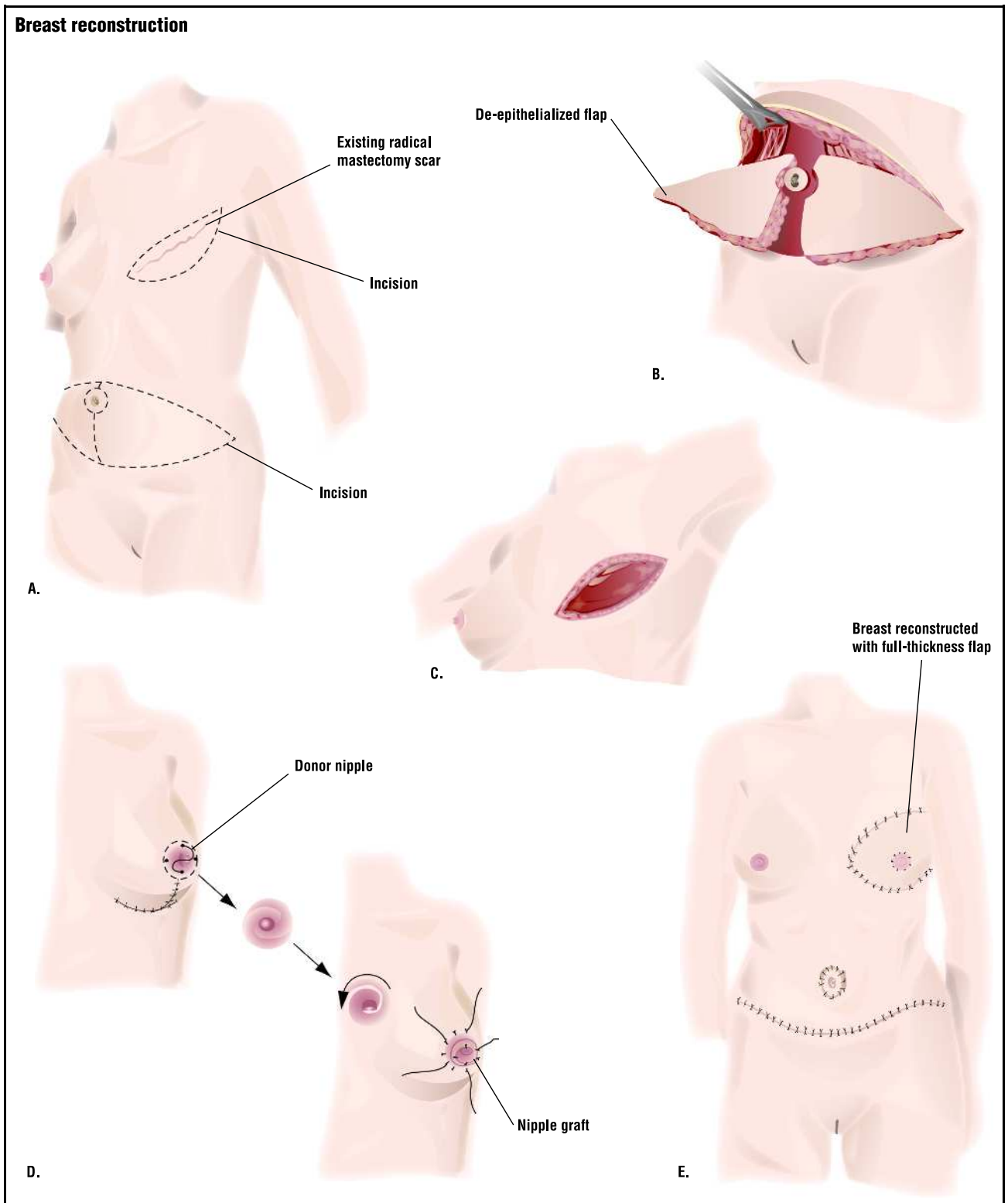
Many experts consider reconstruction to be an integral component of the therapy for breast cancer. A naturally appearing breast offers a sense of wholeness and normalcy, which can aid in the psychological recovery from breast cancer. It eliminates the need for an external prosthesis (false breast), which many women find to be physically uncomfortable as well as inconvenient.

### Demographics

Breast surgery, including reconstruction, is the second most commonly performed cosmetic surgical procedure practiced on women in the United States. According to the American Society of Plastic and Reconstructive Surgeons, more than 200,000 breast augmentation or reconstruction procedures are performed each year.

Presently, more than 2.1 million, or approximately 8%, of women in the United States have **breast implants**. The majority of breast implant recipients are

## Breast reconstruction



Breast reconstruction is often performed after a mastectomy. In an autologous procedure, a section of tissue from the patient's abdomen (B) is used to create a natural-looking new breast. In a separate procedure, a layer of the patient's existing nipple can be grafted onto the new breast (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Autologous**—From the same person; an autologous breast reconstruction uses the woman's own tissues, while an autologous blood transfusion is blood removed then transfused back to the same person at a later time.

**Capsular contracture**—Thick scar tissue around a breast implant, which may tighten and cause discomfort and/or firmness.

**Flap**—A section of tissue moved from one area of the body to another.

**Free flap**—A section of tissue is detached from its blood supply, moved to another part of the body, and reattached by microsurgery to a new blood supply.

**Mastectomy**—Removal of all or a portion of breast tissue.

**Mastopexy**—Surgical procedure to lift up a breast; may be used on opposite breast to achieve symmetrical appearance with a reconstructed breast.

**Pedicle flap**—Also called an attached flap; a section of tissue, with its blood supply intact, which is maneuvered to another part of the body.

Caucasian women (95%), followed by African-American women (4%). The remaining women that have breast implants are Asian (0.5%) and other non-specified races (0.5%).

## Description

Breast reconstruction is performed in two stages, with the ultimate goal of creating a breast that looks and feels as natural as possible. It is important to remember that while a good result may closely mimic a normal breast, there will inevitably be scars and some loss of sensation. The reconstructed breast cannot exactly match the original.

The first step is to create a structure called a breast mound. This can be accomplished using artificial materials called breast implants, or by using tissues from other parts of the woman's body. The second step involves creating a balance between the newly constructed breast and the breast on the opposite side. The nipple and areolar complex (darker area around the nipple) are recreated. This is usually done several months after the mound is created, to allow swelling to subside. Other procedures may be necessary, such as lifting the opposite breast (mastopexy) or

making it larger or smaller to match the reconstructed breast.

## Immediate or delayed reconstruction

While immediate reconstruction (IR) is not recommended for women with breast cancer who need to undergo other, more important treatments, breast reconstruction can be done almost anytime. It can be delayed, or it can be completed during the same procedure as the **mastectomy**. There are psychological benefits to IR. The ability to return to normal activities and routines is often enhanced when reconstruction follows immediately after mastectomy. A better final appearance may result from IR. There is less skin removal, often resulting in a shorter scar. The surgeon is better able to preserve the normal boundaries of the breast, so it is easier to more closely match the opposite breast.

The cost of IR is generally lower than the cost of delayed reconstruction (DR). There is one less operation and hospital stay. Surgeon's fees may be lower for a combined procedure than for two separate surgeries.

There are disadvantages of IR as well. The surgery itself is longer, resulting in more time under anesthesia. Postoperative pain and recovery time will be greater than for mastectomy alone.

Other authorities contend that delayed reconstruction (DR) offers different physical and psychological advantages. The initial mastectomy procedure alone takes less time, and has a shorter recovery period and less pain than mastectomy and IR. The woman has more time to adjust to her diagnosis and recover from additional therapy. She is better able to review and evaluate her options and to formulate realistic goals for reconstruction. Some **reconstructive surgery** requires blood transfusions. With DR, the patient can donate her own blood ahead of time (**autologous blood donation**), and/or arrange to have family and friends donate blood for her use (directed donation).

The psychological stress of living without a breast is a disadvantage of DR. The extra procedure needed to perform DR results in higher costs. Although initial recovery is faster, an additional recuperation period is required after the delayed operation.

## Type of reconstruction

There are two basic choices for breast reconstruction. The breast tissue can be replaced with an implant, or the breast is created using some of the woman's own tissues (autologous reconstruction).

**ARTIFICIAL IMPLANTS.** In general, implant procedures take less time and are less expensive than autologous ones. Implants are breast-shaped pouches. They are made of silicone outer shells, which may be smooth or textured. The inside contains saline (salt water). Implants made prior to 1992 were filled with silicone gel. In 1992, the U.S. Food and Drug Association (FDA) discontinued the use of silicone as a filling material. In 2006, the FDA again allowed silicone gel for use in implants.

An implant may be a fixed-volume type, which cannot change its size. Implants that have the capacity to be filled after insertion are called tissue expanders. These may be temporary or permanent.

The initial procedure for any implant insertion uses the mastectomy incision to make a pocket of tissue, usually underneath the chest wall muscle. In DR, the mastectomy scar may be reopened and used for this purpose, or a more cosmetic incision may be made. The implant is inserted into the pocket, the skin is stretched as needed, and sutured closed.

If there is inadequate tissue to achieve the desired size, or a naturally sagging breast is desired, a tissue expander is used. It resembles a partially deflated balloon, with an attached valve or port through which saline can be injected. After the initial surgical incision is healed, the woman returns to the doctor's office on a weekly or bi-weekly basis to have small amounts of saline injected. Injections can continue for about six to eight weeks, until the preferred size is obtained. In some cases, it may initially be overfilled and later partially deflated to allow for a more pliable, natural result. A temporary tissue expander is removed after several months and replaced with a permanent implant.

IR surgery using an implant takes approximately two to three hours, and usually requires up to a three-day hospital stay. Implant insertion surgery that is accomplished as part of DR takes one to two hours and can sometimes be done as an outpatient procedure. Alternatively, it may entail overnight hospitalization.

**AUTOLOGOUS RECONSTRUCTION.** Attached flap and free flap are two types of surgery where a woman's own tissue is used in reconstruction. An attached flap uses skin, muscle, and fat, leaving blood vessels attached to their original source of blood. The flap is maneuvered to the reconstruction site, keeping its original blood supply for nourishment; this is also known as a pedicle flap. The second kind of surgery is called a free flap, which also uses skin, muscle, and fat, but the surgeon severs the blood vessels and reattaches them to other vessels where the new breast is to

be created. The surgeon uses a microscope to accomplish the delicate task of sewing blood vessels together (anastomosis). Sometimes, the term **microsurgery** is used to refer to free flap procedures. Either type of surgery may also be called a myocutaneous flap. This refers to the skin and muscle used.

The skin and muscle used in autologous reconstruction can come from one of several possible places on the body, including the abdomen (tummy tuck flap), the back (latissimus dorsi flap), or the buttocks (gluteus maximus free flap).

### *Finishing the reconstruction*

Other procedures may be necessary to achieve the goal of symmetrical breasts. It may be necessary to make the opposite breast larger (augmentation), smaller (reduction), or higher (mastopexy). These, or any other refinements, should be completed before the creation of a nipple and areola. Tissue to form the new nipple may come from the reconstructed breast itself, the opposite breast, or a more distant donor site such as the inner thigh or behind the ear. The nipple and areolar construction is usually accomplished as an outpatient procedure. A final step, often done in the doctor's office, is tattooing the new nipple and areola to match the color of the opposite nipple and areola as closely as possible.

### *Insurance*

Insurance coverage varies widely for breast reconstruction. Some policies will allow procedures on the affected breast, but refuse to pay for alterations to the opposite breast. Other plans may cover the cost of an external prosthesis or reconstructive surgery, but not both. The Women's Health and Cancer Rights Act of 1998 requires group health plans and health issuers to provide medical and surgical benefits with respect to mastectomy and to cover the cost of reconstructive breast surgery for women who have undergone a mastectomy.

Implants may pose additional insurance concerns. Some companies will withdraw coverage for women with implants, or add a disclaimer for future implant-related problems. Careful reading of insurance policies, including checking on the need for pre-approval and a **second opinion**, is strongly recommended.

### **Diagnosis/Preparation**

The diagnosis for breast reconstruction is almost always made on a visual basis. The underlying medical reasons include replacing all or part of breast tissue that has been removed during the course of cancer



treatment, replacing breast mass that has been lost due to injury, or equalizing otherwise normal breasts that are markedly different in size. Underlying cosmetic reasons include personal preference for larger breasts among genetic females or the creation of breasts in male-to-female transsexuals.

Routine preoperative preparations, such as having nothing to eat or drink the night before surgery, are needed for reconstructive procedures. Blood transfusions are often necessary for autologous reconstructive surgeries. The patient may donate her own blood and/or have family and friends donate blood for her use several weeks prior to the surgery.

Emotional preparation is also important. Breast reconstruction will not resolve a psychological problem the woman had before mastectomy, nor make an unstable relationship strong. An expectation of physical perfection is also unrealistic. A woman who cites any of these reasons for reconstruction shows that she has not been adequately informed or prepared. Complete understanding of the benefits and limitations of this surgery are necessary for a satisfactory result.

Not all women are good candidates for breast reconstruction. Overall poor physical health, or specific problems such as cigarette smoking, obesity, high blood pressure, or diabetes will increase the chance of complications. Also, a difficult or prolonged recovery period or failure of the reconstruction may be a result. A woman's physical ability to cope with major surgery and recuperation should also be considered.

### Aftercare

The length of the hospital stay, recovery period, and frequency of visits to the doctor after surgery vary considerably with the different types of reconstruction. In general, autologous procedures require longer hospitalization and recovery times than implant procedures. For all surgical procedures, **bandages** and drainage tubes remain in place for at least a day. Microsurgical or free flap procedures are most closely monitored in the first day or two after surgery. The circulation to the breast may be checked as often as every hour. Complete breast reconstruction requires at least one additional surgery to create a nipple and areola. Scars may remain red and raised for a month or longer. They will fade to their final appearance within one to two years. The true, final appearance of the breasts usually will not be visible for at least one year.

### Risks

Some women have reported various types of autoimmune-related connective tissue disorders,

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Breast reconstruction is normally performed by a surgeon with advanced training in plastic and reconstructive procedures. It is commonly, but not exclusively, performed as an outpatient procedure.

which they attribute to their implants—usually involving silicone gel implants. Lawsuits have been filed against the manufacturers of these implants. In 1992, FDA issued guidelines to greatly curtail the use of silicone implants, restricting their use to women who had to replace an existing silicone gel-filled implant. The order required recipients to sign a consent form that details the potential risks of silicone gel-filled implants and become enrolled in a long-range study. Saline became the filling of choice for breast implants. Saline-filled implants were permitted for all uses, although manufacturers were ordered to continue to collect data on possible risks.

The FDA issued “A Status Report on Breast Implant Safety” in 1995, and revised it in March 1997. It noted that studies have not shown a serious increase in the risk of recognized autoimmune diseases in women with silicone gel-filled breast implants. It also addressed concerns about other complications and emphasized the need for further study of this issue.

In 2006, the FDA once again approved silicone gel-filled implants for breast reconstruction in women of all ages and breast augmentation in women aged 22 and older. The FDA required both approved manufacturers to study 40,000 women each for 10 years to assess potential health problems.

There are a number of risks common to any surgical procedure, such as bleeding, infection, anesthesia reaction, or unexpected scarring. Hematoma (accumulation of blood at the surgical site), or seroma (collection of fluid at the surgical site) can delay healing if they are not drained. Any breast reconstruction also poses a risk of asymmetry and the possible need for an unplanned surgical revision. Persistent pain is another potential complication of all types of breast reconstruction.

Implants have some unique problems that may develop. A thick scar, called a capsule, forms around the implant as part of the body's normal reaction to a foreign substance. Capsular contracture occurs when the scar becomes firm or hardened. This may cause

## QUESTIONS TO ASK THE DOCTOR

- What will be the resulting appearance?
- Is the surgeon board certified in plastic and reconstructive surgery?
- How many procedures has the surgeon performed?
- What is the surgeon's complication rate?

pain accompanied by changes in the texture or appearance of the breast. Implants can rupture and leak, deflate, or become displaced. The chances of capsular contracture or rupture increase with the age of the implant. These complications can usually be remedied with **outpatient surgery** to loosen the capsule and remove or replace the implant as needed. There is some evidence that using implants with textured surfaces may decrease the incidence of these problems. An implant tends to remain firm indefinitely. It will not grow larger or smaller as a woman's weight changes. Asymmetry can develop if a woman gains or loses a large amount of weight.

The autologous procedures all carry a risk of flap failure, which is a loss of blood supply to the tissue forming the new breast. If a large portion of the flap develops inadequate blood supply, another reconstructive technique may be necessary. Tummy tuck flap procedures can result in decreased muscle tone and weakness in the abdomen, or lead to an abdominal hernia. Arm weakness may occur after latissimus dorsi flap surgery.

### Normal results

A normal result of breast reconstruction depends on the woman's goals and expectations. It will not be the same as the breast it replaces. In general, the reconstructed breast should be similar in size and shape to the opposite breast, but will have less sensation and be less mobile than a natural breast. A reconstruction using an implant will usually be firmer and rounder than the other breast. It may feel cooler to the touch, depending on the amount of tissue over it. Scars are unavoidable, but should be as inconspicuous as possible.

### Morbidity and mortality rates

Normal scar formation should be expected. With any silicone prosthesis, a capsule usually forms around

it; however, in some instances, a mild form of capsular contraction may develop. Mild ridges that can be felt under the skin categorize this condition. If the capsule contracts, as occasionally occurs, it results in a hardening of the breast. There is no way to predict who will excessively scar. Other risks include infection, excessive bleeding, problems associated with anesthesia, rupturing of the implant, and leakage. There have been a total of 120,000 reports of ruptured silicone implants. Approximately 50,000 reports of breakage have been received for saline implants. Most studies have failed to link implants to serious or chronic diseases such as cancer and lupus, but questions remain over how often the implants rupture and what happens if the silicone enters the body. One of the approved manufacturers reported that its implants have a 14 percent likelihood of rupturing over a 10-year period. The other conducted a three-year study and reported that the rupture rate after three years was negligible.

Deaths associated with breast reconstruction are extremely rare. Most post-surgical mortality has been attributed to anesthesia errors or overdoses of pain medications.

### Alternatives

Alternatives to breast reconstruction surgery include using external breast forms that fit into brassiere cups or are attached to the skin of the chest. Creams that allege to increase breast size usually produce no noticeable results. The use of creams containing hormones can lead to long-term hormonal imbalances. Reputable experts do not generally recommend these preparations for breast enlargement.

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- American Board of Plastic Surgery, Seven Penn Center, Suite 4001635 Market Street, Philadelphia, PA, 19103 2204, (215) 587 9322, <http://www.abplsurg.org>.
- American College of Surgeons, 633 North Saint Claire Street, Chicago, IL, 60611, (312) 202 5000, <http://www.facs.org>.
- American Society for Aesthetic Plastic Surgery, 11081 Winners Circle, Los Alamitos, CA, 90720, (888) 272 7711, <http://www.surgery.org/>.
- American Society of Plastic Surgeons, 444 E. Algonquin Rd., Arlington Heights, IL, 60005, (847) 228 9900, <http://www.plasticsurgery.org>.

L. Fleming Fallon, Jr., M.D., Dr.P.H.

## Breast reduction

### Definition

Breast reduction is a surgical procedure performed to decrease the size of the breasts.

### Purpose

Women with very large breasts (macromastia, or mammary hyperplasia) seek breast reduction for relief of back, shoulder, and neck pain. They may also feel uncomfortable about their breast size and have difficulty finding clothing that will fit properly. Breast reduction may be needed after **reconstructive surgery** following the surgical removal of cancerous breast tissue (**mastectomy**), to make the breasts more symmetric.

Men who have enlarged breasts (gynecomastia) may also be candidates for breast reduction surgery. Excessive alcohol intake, marijuana use, or using anabolic steroids may cause gynecomastia. Surgery is not recommended for men who continue to use these products.

### Demographics

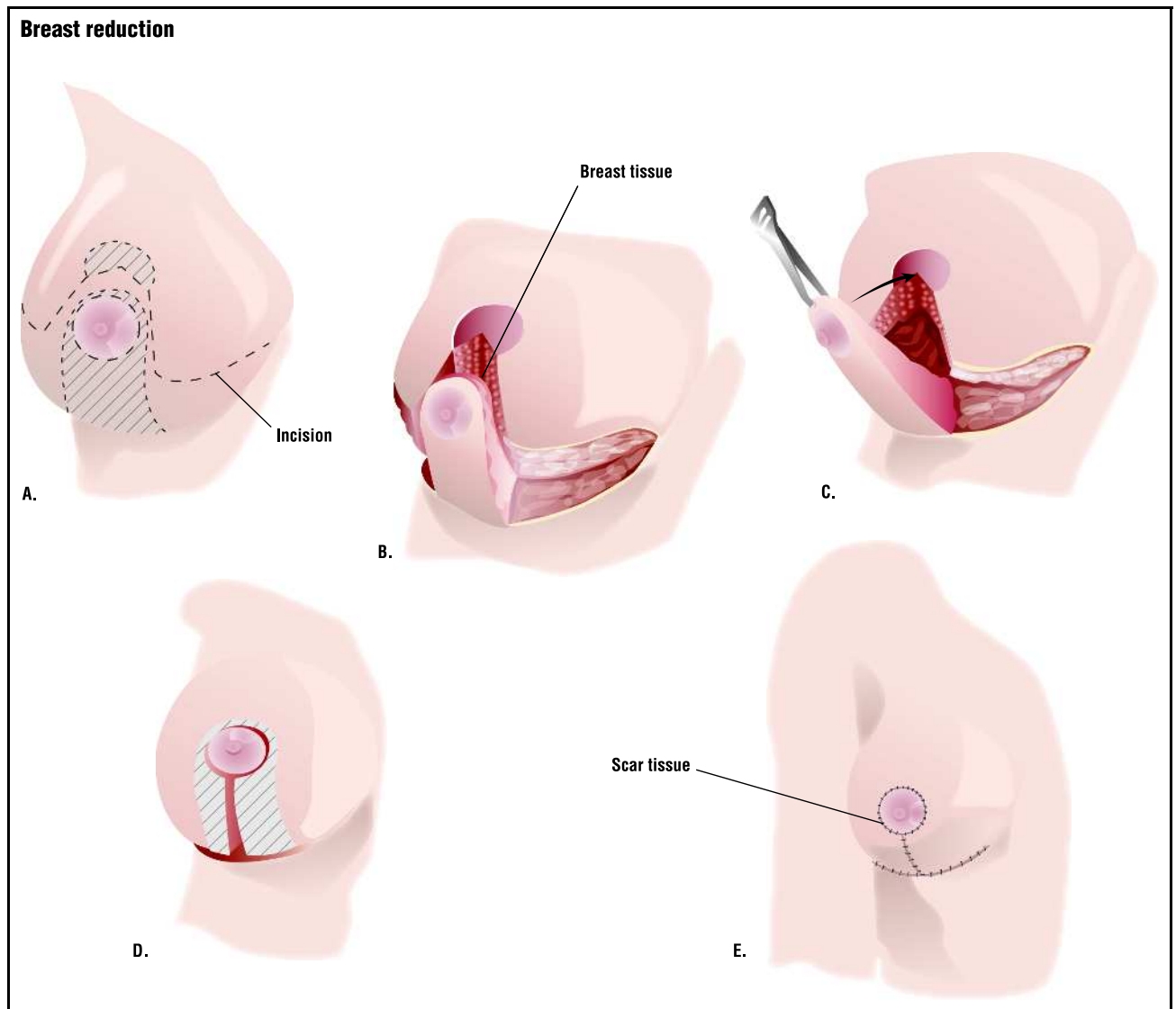
According to the American Society of Plastic Surgeons, more than 113,000 women underwent breast reduction surgery in 2003, the most recent year for which accurate data are available. The number of breast reduction procedures is increasing each year. Women most likely to undergo breast reduction range in age from 19 to 50.

### Description

Breast reduction is also called reduction mammoplasty. It is most often performed in a hospital, under general anesthetic. Studies have suggested that an outpatient procedure, using local anesthetic and mild sedation, may be appropriate for some persons. The operation requires approximately two to four hours. The most commonly made incision encircles the areola (darkened area around the nipple) and extends downward and around the underside of the breast. This produces the least conspicuous scar. Excess tissue, fat, and skin are removed, and the nipple and areola are repositioned. In certain cases, **liposuction** (fat suctioning) is used to remove extra fat from the armpit area. A hospital stay of up to three days may be needed for recovery.

Breast reduction surgery for males with gynecomastia is similar to that described for females.

If deemed medically necessary, breast reduction is covered by some insurance plans; however, a specified



In a breast reduction surgery, the breast tissue is cut along predetermined lines and excess tissue is removed (B). The nipple is placed higher on the breast (C), and the two sides of the incision are brought together (D), removing any excess skin. (E)

(Illustration by GGS Information Services. Cengage Learning, Gale.)

amount of breast tissue may need to be removed in order to qualify for coverage. As of 2007, surgeon's fees range from \$5,400 to \$6,500, or more.

### Diagnosis/Preparation

Consultation between surgeon and patient is important to ensure that there is understanding and agreement with the expected final results of the procedure. Measurements and photographs may be taken. Many doctors also recommend a mammogram before the operation to ensure that there is no cancer.

### Aftercare

After the surgery, an elastic bandage or special supportive bra is placed over gauze **bandages** and drainage tubes. The bandages and tubes are removed in a day or two. The bra is worn around the clock for several weeks. **Stitches** are removed one to three weeks after the operation. Normal activities, including sexual relations, may be restricted for several weeks. Scars will typically remain red and perhaps raised for up to several months, but will gradually fade and become less noticeable. It may take up to a year before the breasts achieve their final position and size.



## KEY TERMS

**Gynecomastia**—Overly developed or enlarged breasts in a male.

**Macromastia**—Excessive size of the breasts.

**Mammary hyperplasia**—Increased size of the breast.

## Risks

Breast reduction surgery is not recommended for women whose breasts are not fully developed or who plan to breast-feed.

Risks common to any operation include bleeding, infection, anesthesia reactions, or unexpected scarring. Breast reduction may result in decreased feeling in the breasts or nipples and/or impaired ability to breast-feed. When healing is complete, the breasts may be slightly uneven, or the nipples may be asymmetric. This is consistent with normal breast tissue.

## Normal results

Smaller breast size should be achieved and, with that, the accompanying pain and discomfort should be alleviated. Self-esteem should be improved for both females and males having breast reduction surgery.

## Morbidity and mortality rates

Deaths associated with breast reduction surgery are extremely rare. Most post-surgical mortality has been attributed to anesthesia errors, overdoses of pain medications, or postoperative infections.

In very rare cases, the skin of the breast or nipple does not heal properly and additional surgery is necessary to graft skin. Approximately 10% of women experience some loss of sensation in their nipples.

Permanent scars are left after breast reduction surgery. At first, the scars usually appear red and raised but will become less obvious over time. Women who smoke often experience more prominent scars. This is because smoking interferes with the healing process.

## Alternatives

There are no alternatives to surgery as a way to reduce breast tissue, although significant weight loss can decrease the size of the breast.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Breast reduction surgery is normally performed by a surgeon with advanced training in plastic and reconstructive procedures. It is commonly, but not exclusively, performed as an inpatient procedure in a hospital.

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## QUESTIONS TO ASK THE DOCTOR

- What will be the resulting appearance?
- Is the surgeon board certified in plastic and reconstructive surgery?
- How many breast reduction procedures has the surgeon performed?
- What is the surgeon's complication rate?

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Breast x ray see **Mammography**

## Bronchoscopy

### Definition

Bronchoscopy is a procedure in which a hollow, flexible tube called a bronchoscope is inserted into the airways through the nose or mouth to provide a view of the tracheobronchial tree. It can also be used to

collect bronchial and/or lung secretions and to perform tissue biopsy.

### Purpose

During a bronchoscopy, the physician can visually examine the lower airways, including the larynx, trachea, bronchi, and bronchioles. The procedure is used to examine the mucosal surface of the airways for abnormalities that might be associated with a variety of lung diseases. Its use may be diagnostic or therapeutic.

Bronchoscopy may be used to examine and help diagnose all of the following:

- diseases of the lung, such as cancer or tuberculosis
- congenital deformity of the lungs
- suspected tumor, obstruction, secretion, bleeding, or foreign body in the airways
- airway abnormalities, such as tracheal stenoses
- persistent cough, or hemoptysis, that includes blood in the sputum

Bronchoscopy may also be used for the following therapeutic purposes:

- remove a foreign body in the lungs
- remove excessive secretions
- remove tumors in the airway
- treat stenosis (narrowing) of the airways, by using balloon dilatation or placing a stent

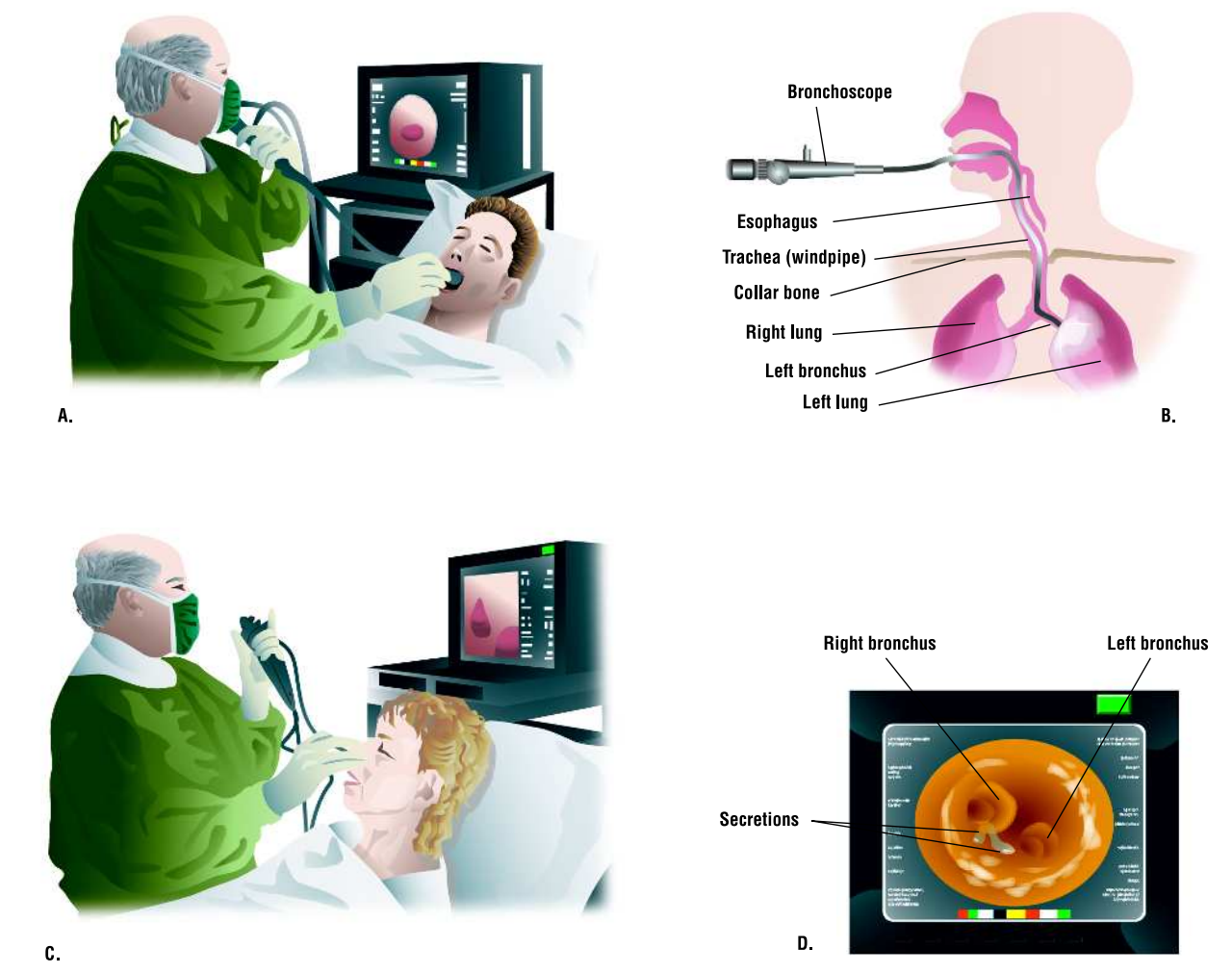
Bronchoscopy can also be used to collect the following biopsy specimens:

- sputum
- tissue samples from the bronchi or bronchioles
- cells collected from washing the lining of the bronchi or bronchioles

If the purpose of the bronchoscopy is to take tissue samples, or biopsy, a forceps or bronchial brush are used to obtain cells. Alternatively, if the purpose is to identify an infectious agent, a bronchoalveolar lavage can be performed to gather fluid for culture purposes. If any foreign matter is found in the airways, it can be removed as well. Tumors can be debulked (made smaller) through the use of laser, electrocautery, or **cryotherapy** during the bronchoscopy. A balloon can be passed into a narrowed area of the airway and inflated in order to treat stenosis. A stent (tiny artificial tube) can be placed during bronchoscopy, in order to keep a portion of the airway open.

The instrument used in bronchoscopy, a bronchoscope, is a slender, flexible tube less than 0.5 in (2.5 cm)

## Bronchoscopy

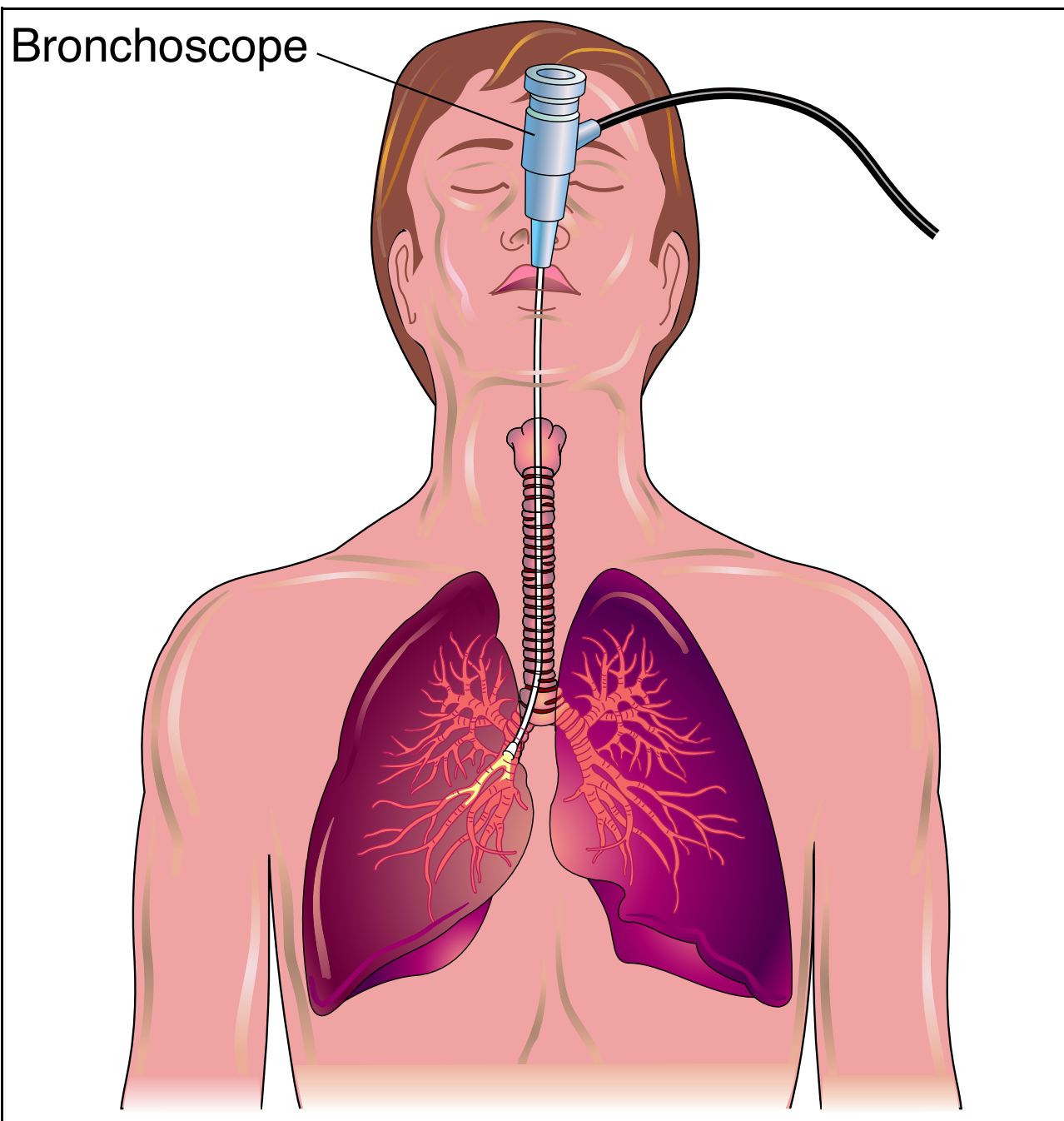


**Bronchoscopy can be performed via the patient's mouth (A) or through the nose (C). During the procedure, the scope is fed down the trachea and into the bronchus leading to the lungs (B), providing the physician with a view of internal structures (D).** (Illustration by GGS Information Services. Cengage Learning, Gale.)

wide and approximately 2 ft (0.3 m) long that uses fiber-optic technology (very fine filaments that can bend and carry light). There are two types of bronchoscopes: a standard tube that is more rigid and a fiber-optic tube that is more flexible. The rigid instrument does not bend, does not see as far down into the lungs as the flexible one, and may carry a greater risk of causing injury to nearby structures. Because a standard tube can cause more discomfort than the flexible bronchoscope, it usually requires **general anesthesia**. However, it is useful for taking large samples of tissue and for removing foreign bodies from the airways. During the procedure, the airway is not blocked since oxygen can be supplied through the bronchoscope.

## Demographics

Nearly 500,000 bronchoscopies are performed annually in the United States. According to the National Cancer Institute, cancer of the lung and bronchi is the second most common cancer among both men and women and is the leading cause of cancer **death** in both sexes in the United States. Among men, lung cancer incidence rates per 100,000 people range from a low of approximately 14 among American Indians to a high of 117 among African Americans. Between these two extremes, rates fall into two groups ranging from 42 to 53 for Hispanics, Japanese, Chinese, Filipinos, and Koreans, and from



**Bronchoscopy** is a procedure in which a hollow, flexible tube is inserted into the airways, allowing the physician to visually examine the lower airways, including the larynx, trachea, bronchi, and bronchioles. It can also be used to collect specimens for bacteriological culture to diagnose infectious diseases such as tuberculosis. (Illustration by Electronic Illustrators Group. Cengage Learning, Gale.)

71 to 89 for Vietnamese, Caucasians, Alaska Natives, and Hawaiians. The range among women is much narrower, from a rate of about 15 among Japanese to nearly 51 among Alaska Natives, only a three-fold difference. Rates for the remaining female populations fall roughly into two groups with low rates of 16–25

for Korean, Filipino, Hispanic, and Chinese women, and rates of 31–44 among Vietnamese, Caucasian, Hawaiian, and African American women. The rates among men are about two to three times greater than the rates among women in each of the racial/ethnic groups.



## KEY TERMS

**Anesthetic**—A drug that causes loss of sensation. It is used to lessen the pain of surgery and medical procedures.

**Biopsy**—Procedure that involves obtaining a tissue specimen for microscopic analysis to establish a precise diagnosis.

**Bronchi**—The network of tubular passages that carry air to the lungs and allow air to be expelled from the lungs.

**Bronchioles**—Small airways extending from the bronchi into the lobes of the lungs.

**Bronchoalveolar lavage**—Washing cells from the air sacs at the end of the bronchioles.

**Computed tomography (CT)**—A special radiographic imaging technique that uses a computer to acquire multiple x rays into a two-dimensional sectional image.

**Emesis basin**—A basin used to collect sputum or vomit.

**Endoscope**—A highly flexible viewing instrument.

**Endoscopy**—The visual inspection of any cavity of the body using an endoscope.

**Hemoptysis**—The expectoration of blood or of blood containing sputum.

**Larynx**—The voice box.

**Lavage**—Washing out.

**Neoplasm**—A new growth or tumor.

**Sputum**—Matter ejected from the lungs, bronchi, and trachea through the mouth.

**Stenosis**—Narrowing of a duct or canal.

**Trachea**—The windpipe.

**Tracheobronchial**—Pertaining both to the tracheal and bronchial tubes or to their junction.

## Description

Bronchoscopy is usually performed in an endoscopy room, but may also be performed at the bedside. The patient is placed on the back or sits upright. A pulmonologist, a specialist trained to perform the procedure, sprays an anesthetic into the patient's mouth or throat. When anesthesia has taken effect and the area is numb, the bronchoscope is inserted into the mouth and passed into the throat. If the bronchoscope is passed through the nose, an anesthetic jelly is inserted into one nostril. While the bronchoscope is

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The test is usually performed in a hospital or clinic by a pulmonologist, a physician specializing in diseases of the lungs. Nursing staff assist by providing education, monitoring the patient, and conducting tests, including checking blood pressure, pulse, and respiratory rate prior to the patient's discharge.

moving down the throat, additional anesthetic is put into the bronchoscope to anesthetize the lower airways. The physician observes the trachea, bronchi, and the mucosal lining of these passageways looking for any abnormalities that may be present. If samples are needed, a bronchial lavage may be performed, meaning that a saline solution is used to flush the area prior to collecting cells for laboratory analysis. Very small brushes, needles, or forceps may also be introduced through the bronchoscope to collect tissue samples from the lungs. If the procedure is therapeutic in nature, laser, electrocautery, cryotherapeutic, or balloon dilatation instruments may be passed through the bronchoscope, as well as a stent may be placed.

## Preparation

The patient should fast for six to 12 hours prior to the procedure and refrain from drinking any liquids the day of the procedure. Smoking should be avoided for 24 hours prior to the procedure, and patients should also avoid taking any **aspirin** or ibuprofen-type medications. The bronchoscopy itself takes about 45–60 minutes. Prior to the bronchoscopy, several tests are usually done, including a **chest x ray** and blood work. Sometimes a bronchoscopy is done under general anesthesia, in which case the patient will have an intravenous (IV) line in the arm. More commonly, the procedure is performed under **local anesthesia**, which is sprayed into the nose or mouth. This is necessary to inhibit the gag reflex. A sedative may also be given. A signed consent form is necessary for this procedure.

## Aftercare

After the bronchoscopy, the **vital signs** (heart rate, blood pressure, and breathing) are monitored. Sometimes patients have an abnormal reaction to anesthesia. Any sputum should be collected in an emesis basin

## QUESTIONS TO ASK THE DOCTOR

- What will happen during the procedure?
- Will it hurt?
- How long will the test take to perform?
- How many bronchoscopies do you perform each year?
- Are there any risks associated with the procedure?

so that it can be examined for the presence of blood. If a biopsy was taken, the patient should not cough or clear the throat as this might dislodge any blood clot that has formed and cause bleeding. No food or drink should be consumed for about two hours after the procedure or until the anesthesia wears off. There is a significant risk for choking if anything (including water) is ingested before the anesthetic wears off, and the gag reflex has returned. To test if the gag reflex has returned, a spoon is placed on the back of the tongue for a few seconds with light pressure. If there is no gagging, the process is repeated after 15 minutes. The gag reflex should return in one or two hours. Ice chips or clear liquids should be taken before the patient attempts to eat solid food. Patients should be informed that the throat may be irritated for several days.

Patients should notify their healthcare provider if they develop any of these symptoms:

- hemoptysis (coughing up blood)
- shortness of breath, wheezing, or any trouble breathing
- chest pain
- fever, with or without breathing problems

### Risks

Use of the bronchoscope mildly irritates the lining of the airways, resulting in some swelling and inflammation, as well as hoarseness caused from abrading the vocal cords. If this abrasion is more serious, it can lead to respiratory difficulty or bleeding of the lining of the airways.

The bronchoscopy procedure is also associated with a small risk of disordered heart rhythm (arrhythmia), heart attacks, low blood oxygen (hypoxemia), and pneumothorax (a puncture of the lungs that allows air to escape into the space between the lung and the chest wall). These risks are greater with the use of a rigid bronchoscope than with a fiberoptic

bronchoscope. If a rigid tube is used, there is also a risk of chipped teeth. The risk of transmitting infectious disease from one patient to another by the bronchoscope is also present. The Centers for Disease Control (CDC) reported cases of patient-to-patient transmission of infections following bronchoscopic procedures using bronchoscopes that were inadequately reprocessed by the automated endoscope reprocessing (AER) system. Investigation of the incidents revealed inconsistencies between the reprocessing instructions provided by the manufacturer of the bronchoscope and the manufacturer of the AER; or that the bronchoscopes were inadequately reprocessed.

### Normal results

If the results of the bronchoscopy are normal, the windpipe (trachea) appears as smooth muscle with C-shaped rings of cartilage at regular intervals. There are no abnormalities either in the trachea or in the bronchi of the lungs.

Bronchoscopy results may also confirm a suspected diagnosis. This may include swelling, ulceration, or deformity in the bronchial wall, such as inflammation, stenosis, or compression of the trachea, neoplasm, and foreign bodies. The bronchoscopy may also reveal the presence of atypical substances in the trachea and bronchi. If samples are taken, the results could indicate cancer, disease-causing agents, or other lung diseases. Other findings may include constriction or narrowing (stenosis), compression, dilation of vessels, or abnormal branching of the bronchi. Abnormal substances that might be found in the airways include blood, secretions, or mucous plugs.

### Morbidity and mortality rates

Bronchoscopy belongs to the group of procedures associated with highest inpatient mortality with a 12.7% mortality rate.

### Alternatives

Depending upon the purpose of the bronchoscopy, alternatives may include a chest x ray or a computed tomography (CT) scan. If the purpose is to obtain biopsy specimens, one option is to perform surgery, which carries greater risks. Another option is percutaneous biopsy guided by CT.

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- American College of Chest Physicians. 3300 Dundee Road, Northbrook, IL 60062. (800) 343-2227.
- The Association of Perioperative Registered Nurses, Inc. (AORN). 2170 South Parker Rd, Suite 300, Denver, CO 80231-5711. (800) 755-2676. <http://www.aorn.org> (accessed March 8, 2008).

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## BUN-creatinine ratio

### Definition

Blood Urea Nitrogen (BUN) and creatinine are both waste products of normal metabolism in the human body. BUN represents the amount of nitrogen produced from the metabolism of proteins. Creatinine is a normal waste product of muscle. The ratio of BUN to creatinine is a relationship between these two end products found in blood, and paints a clinical picture for physicians describing kidney functionality.

### Why BUN-creatinine is measured

The BUN-creatinine ratio provides specific clinical information about the kidney that can be used for multiple purposes. The BUN-creatinine ratio is obtained to assess normal kidney function, help identify possible kidney diseases, to monitor the progression of kidney disease, or to monitor the effectiveness of medications in treating kidney disease.

### Demographics

BUN-creatinine ratio is obtained whenever medically appropriate regardless of age, gender, or race. It is commonly measured in patients before a surgical procedure to assess general function, after some types of surgical procedures, and in patients with kidney disease or failure. The BUN-creatinine ratio is also obtained to assess the degree and effectiveness of kidney filtration prior to some radiology studies.

### Description

The BUN-creatinine ratio is a value measured in the blood to help assess the health of the kidney.

### BUN

As a normal part of protein metabolism in the liver, protein is broken down into a compound called urea. Urea can be measured by nitrogen in the blood. Once in the blood, urea nitrogen is carried to the kidneys to be filtered out of the blood into the urine. Some of the urea nitrogen is reabsorbed back into the body for further use, but most is left in the urine. Hence, products of protein breakdown are excreted from the body. Females have lower normal BUN values than males. Women in the second or third trimester of pregnancy may present with a lower BUN value as normal. Normal BUN values in the elderly may be elevated.

### Abnormal BUN Values

If the BUN value not within the normal range, it is a sign that either there is an excess of protein

breakdown products in the blood, or some part of the system of BUN filtration is not functioning normally. A BUN value higher or lower than normal demonstrates a potential problem in urea removal from the blood.

The BUN filtration system relies on both kidney filtration function and on a sufficient amount of blood traveling to the kidney to be filtered. An abnormal BUN value may indicate a breakdown somewhere in this system. The kidney may not be filtering properly due to disease or injury, or blood flow may be decreased to the kidney and so not available for filtration. Either of these scenarios may cause an increased BUN value. Kidney damage can be caused by diabetes, high blood pressure, and pathologies that block the urinary tract such as kidney stones. Decreased blood flow to the kidneys may be caused by multiple disease states or physiological disorders, including congestive heart failure, dehydration, shock, or gastrointestinal bleeding.

Diets that involve consuming large amounts of protein, such as the Atkins diet, may cause an excess of protein breakdown products to be present in the blood. The more protein is ingested, the greater the amount of urea and nitrogen will be present in the blood for the kidneys to filter. Even with a healthy pair of kidneys, an excess amount of protein to be filtered can stress the kidney filtration system and result in higher than normal BUN levels. Lower than normal BUN values may occur due to a state of malnutrition where not enough protein is ingested, over hydration where the amount of BUN is diluted, or liver damage where protein breakdown is defective.

### *Creatinine*

Creatinine is a waste product formed when the amino acid creatine in muscle tissue is metabolized. Creatinine is released into the blood, where it is carried to the kidneys for filtration into the urine. When creatinine levels are measured in the blood it is known as serum creatinine (used to help calculate the BUN-creatinine ratio). When creatinine levels are measured in the urine it is known as urine creatinine. Once creatinine is filtered by the kidney, it is not reabsorbed into the body. All the creatinine that is filtered is excreted in the urine. This is an important trait of creatinine, and makes it useful as a monitor of kidney filtration capability. Since creatinine originates from muscle breakdown, females may have lower normal serum creatinine values than males due to lower muscle mass. Pregnancy may cause low normal serum creatinine.

### *Abnormal Creatinine Values*

Some types of kidney disease affect the ability of the kidney to filter waste products such as creatinine from the blood. The kidney diseases acute tubular necrosis, diabetic nephropathy, and glomerulonephritis may all increase serum creatinine values. Diseases that decrease the amount of blood that reaches the kidney for filtration may also increase serum creatinine values. The muscle disease rhabdomyolysis and any other disease that causes excessive breakdown of muscle tissue can cause abnormally high serum creatinine levels. Pathologies that block the urinary tract such as kidney stones will increase serum creatinine. Lower than normal serum creatinine values may be caused by decreased muscle mass due to age or diseases such as muscular dystrophy. Very low protein diets may also cause decreased serum creatinine levels.

### *BUN-creatinine ratio*

The BUN-creatinine ratio is determined by measuring the concentrations of BUN and creatinine in the blood. A change in either component will influence the value of the ratio. A normal BUN-creatinine ratio is based on the normal values for BUN and serum creatinine. A normal BUN value is 10–20 mg/dl. A normal serum creatinine value is 0.5–1.2 mg/dl. Hence, a normal BUN-creatinine ratio lies between 10:1 and 20:1. The normal value of the BUN-creatinine ratio is different in infants less than 12 months old, where it may be as high as 30:1 and still be normal.

### *Abnormal BUN-creatinine ratio values*

Abnormal BUN-creatinine ratios may be caused by many different types diseases, disorders, or injury to the kidney. The ratio may be abnormally high with any pathology that increases BUN or decreases creatinine. The ratio may be abnormally low with any pathology that decreases BUN or increases creatinine.

### **BUN-creatinine ratio and acute renal failure**

Acute Renal Failure (ARF), or kidney failure, may be caused by kidney disease or injury. The cause of ARF may be due to a pathology that occurs outside of the kidney before the blood reaches the kidney filtration apparatus, or within the actual kidney. Depending on where the cause for kidney failure lies, ARF is categorized as being “prerenal” or “renal or intrinsic.” The BUN-creatinine ratio is a useful tool for identifying which category of ARF is present in a patient. Prerenal causes of ARF create extremely high BUN-creatinine ratios. Renal or intrinsic causes of ARF create BUN-creatinine ratios that are higher than normal but less than those created by prerenal ARF.



## How to prepare for a BUN-creatinine ratio test

BUN-creatinine ratios are measured using blood samples. Having blood drawn from a vein with a syringe, usually in the arm, is necessary. Since some medications may affect the results, it is critical that the physician take into account all prescription medications, non-prescription medications, herbal, and nutritional supplements that the patient is taking before running the BUN-creatinine ratio test. Age and gender may also affect the results in predictable patterns. To prepare for the BUN-creatinine test patients should not do any strenuous **exercise** for 2 days (48 hours) prior; not eat meat, especially beef, or other protein for 24 hours prior; drink a normal amount of fluids.

### Drugs that affect BUN

- Allopurinol;
- Aminoglycosides;
- Amphotericin B;
- Bacitracin;
- Carbamazepine;
- Cephalosporins;
- Chloramphenicol;
- Cimetidine;
- Cisplatin;
- Corticosteroids;
- Furosemide;
- Gentamicin;
- Guanethidine;
- High-Dose Aspirin;
- Indomethacin;
- Methicillin;
- Methotrexate;
- Methyldopa;
- Neomycin;
- Penicillamine;
- Polymixin B;
- Probenecid;
- Propranolol;
- Rifampin;
- Spironolactone;
- Tetracyclines;
- Thiazide Diuretics;
- Triamterene; and
- Vancomycin.

## QUESTIONS TO ASK YOUR DOCTOR

- Why do I need the BUN-creatinine ratio measured?
- What results are anticipated from my test?
- When can I expect the results?
- Are there any risks associated with the test?
- What do I need to do to prepare for the test?
- Will any of my medications, nutritional, or herbal supplements affect the test?

### Drugs that affect creatinine

- Aminoglycosides;
- Bactrim;
- Cimetidine;
- Cisplatin;
- Cephalosporins;
- Methyldopa;
- Trimethoprim; and
- Any drug toxic to kidneys.

## Risks associated with testing the BUN-creatinine ratio

There is very little risk associated with having blood drawn for a BUN-creatinine ratio test. Most people have no side effects or a small bruise; however, with any blood draw there is a small chance that the area around the punctured vein may develop phlebitis, the inflammation of a vein. Phlebitis may also involve a bacterial infection if the site of the blood draw was not appropriately cleaned before the needle was inserted. Phlebitis can be locally painful but usually resolves in a short period of time. Additionally, patients with disorders involving the inability of the blood to form normal blood clots should discuss their condition and their medications with the physician before the blood draw and BUN-creatinine ratio test is done.

Risks associated with the test result include a deceptively normal value for the BUN-creatinine ratio. It is important that the physician note both the value of the BUN-creatinine ratio and the values of BUN and serum creatinine individually. Kidney damage may present with abnormal values for BUN and creatinine, but a normal value for their ratio. If the individual values are not noted, this scenario may present a seemingly normal picture of health that is not accurate. For example, in patients with chronic kidney failure, the BUN-creatinine ratio may be 10:1

## KEY TERMS

**Acute Renal Failure (a.k.a. Acute Kidney Failure)**—The rapid loss of the kidney’s ability to function due to kidney damage. Acute renal failure decreases the kidney’s ability to filter waste products from the blood for excretion in the urine.

**Acute Tubular Necrosis**—A kidney disease involving damage to the portion of the kidney known as the tubules that causes kidney failure.

**Atkins Diet**—A diet that involves eating a high amount of protein and fat with a low amounts of carbohydrates.

**Blood Serum**—The fluid portion of the blood.

**Congestive Heart Failure**—A serious condition caused by disease or damage to the heart that weakens the heart’s ability to pump a sufficient amount of blood to the body tissues.

**Diabetic Nephropathy**—A progressive kidney disease associated with diabetes that interferes with the kidney’s ability to function in filtering waste products from the blood.

**Gastrointestinal Tract**—The path in the body from the mouth, through the stomach, intestines, rectum, and the anus.

**Glomerulonephritis**—A disease of the kidneys mediated by the immune system that causes inflammation of the part of the kidney known as the glomerulus.

**Muscular Dystrophy**—A genetic muscle disease that causes progressive muscle weakness along with the breakdown and death of muscle tissue.

**Phlebitis**—Inflammation of a vein.

**Rhabdomyolysis**—A condition causing the rapid breakdown of muscle tissue that may be caused by severe injuries or toxic chemicals. It causes the release of muscle tissue breakdown products into the blood in such excess that it may lead to acute renal failure.

with a BUN level of 60mg/dl and a **serum creatinine level** of 2mg/dl. In conclusion, a normal looking BUN-creatinine ratio does not always mean that the kidneys are functioning normally.

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BUN test see **Kidney function tests**

## Bunionectomy

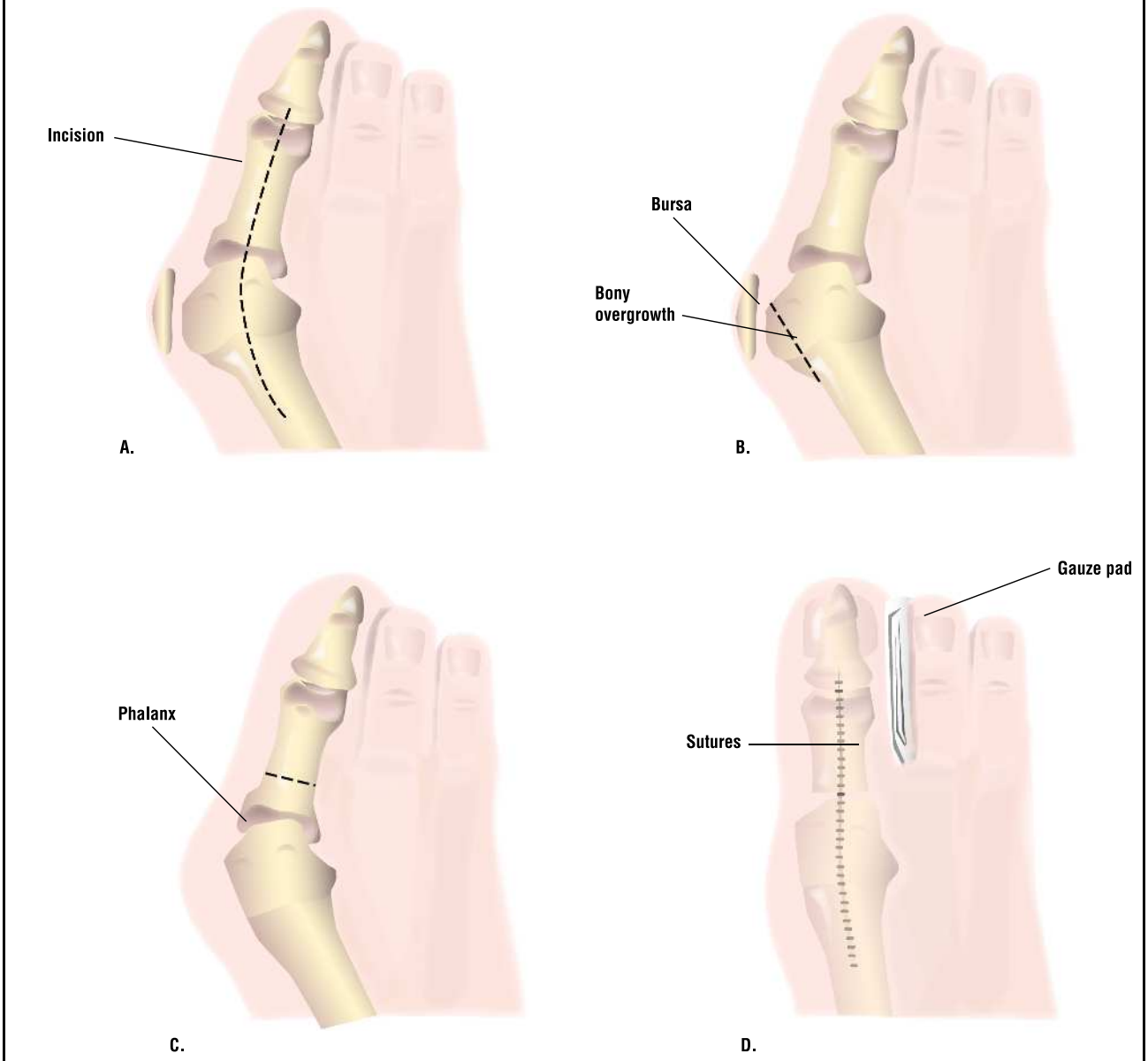
### Definition

A bunionectomy is a surgical procedure to excise, or remove, a bunion. A bunion is an enlargement of the joint at the base of the big toe and is comprised of bone and soft tissue. It is usually a result of inflammation and irritation from poorly fitting (narrow and tight) shoes in conjunction with an overly mobile first metatarsal joint and over-pronation of the foot. Over time, a painful lump appears at the side of the joint, while the big toe appears to buckle and move sideways towards the second toe. New bone growth can occur in response to the inflammatory process, and a bone spur may develop. Therefore, the development of a bunion may involve soft tissue as well as a hard bone spur. The intense pain makes walking and other activities extremely difficult. Since the involved joint is a significant structure in providing weight-bearing stability, walking on the foot while trying to avoid putting pressure on the painful area can create an unstable gait.

### Purpose

A bunionectomy is performed when conservative means of addressing the problem, including properly fitting, wide-toed shoes, a padded cushion against the joint, orthotics, and anti-inflammatory medication, are unsuccessful. As the big toe moves sideways, it can push the second toe sideways as well. This can result in extreme deformity of the foot, and the patient may complain not only of significant pain, but of an inability to find shoes that fit.

## Bunionectomy



A bunion results in a bony overgrowth in the foot, causing the big toe to curve outward. To repair this, an incision is made in the top of the foot (A). The overgrowth and fluid-filled sac called a bursa are removed (B). The phalanx bone of the big toe is shortened to straighten it (C). The foot is realigned, and incision is closed (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

### Demographics

Bunion formation can be hereditary, which means that if the individual's mother or father had the condition, he or she is at an increased risk of developing one as well. Bunions can also be a result of a congenital

deformity, which means that the individual was born with an anatomical condition that made the development of a bunion more likely. Women are nine to 10 times more likely to develop bunions than men. The American Orthopaedic Foot & Ankle Society reports a study estimating that about 88% of women wear

## KEY TERMS

**Excision**—The surgical removal of a damaged or diseased part of the body.

**Incision**—A surgical incision is a cut into the body or an organ of the body to create an opening such as to remove a lump.

**Metatarsal joint**—Having to do with the bones of the foot.

**Orthotic**—A device designed to be inserted into a shoe to help keep the foot in proper alignment, stabilize the heel, support the arch, and distribute body weight more evenly over the foot.

**Pronation**—The foot leans toward the inside of the foot, towards the center of the body.

shoes that are too small and that 55% have developed bunions. The condition may begin to form in adolescence. Other conditions that contribute to bunion formation include flat-footedness, a tight Achilles tendon, and rheumatoid arthritis. The earlier the diagnosis, the better the chance that significant deformity will be avoided.

## Description

Bunions become more common later in life. One reason is that with age the foot spreads and proper alignment is not maintained. In addition, the constant friction of poorly fitting shoes against the big toe joint creates a greater problem over time. Ignoring the problem in its early stages leads to a shifting gait that further aggravates the situation.

Once surgery has been decided on, the extent of the procedure will depend on the degree of deformity that has taken place. There are several different surgical techniques, mostly named after the surgeons who developed them, such as McBride, Chevron, and Keller. The degree and angle of deformity as well as the patient's age and physical condition play a significant role in the surgeon's choice of technique, which will determine how much tissue is removed and whether or not bone repositioning will occur. If bone repositioning is done, that part of the surgery is referred to as an osteotomy (*osteo* means bone). The type of anesthesia, whether ankle block (the most common, in which the foot is numb but the patient is awake), general, or spinal, will depend on the patient's condition and the anticipated extent of the surgery. For surgery done on an ambulatory basis, the patient will usually be asked to arrive one to two hours before the surgery and stay

for about two to three hours after the procedure. The procedure itself may take about an hour.

The surgeon will make an incision over the swollen area at the first joint of the big toe. The enlarged lump will be removed. The surgeon may need to reposition the alignment of the bones of the big toe. This may require more than one incision. The bone itself may need to be cut. If the joint surfaces have been damaged, the surgeon may hold the bones together with screws, wires, or metal plates. In severe cases, the entire joint may need to be removed and a joint replacement inserted. If pins were used to hold the bones in place during recovery, they will be removed a few weeks later. In some mild cases, it may be sufficient to repair the tendons and ligaments that are pulling the big toe out of alignment. When finished, the surgeon will close the incision with sutures and may apply steri-strips as an added reinforcement. A compression dressing will be wrapped around the surgical wound. This helps to keep the foot in alignment as well as help reduce postoperative swelling.

## Diagnosis/Preparation

Intense pain at the first joint of the big toe is what most commonly brings the patient to the doctor. Loss of toe mobility may also have occurred. Severe deformity of the foot may also make it almost impossible for the patient to fit the affected foot into a shoe. The condition may be in either foot or in both. In addition, there may be a crackling sound in the joint when it moves. Diagnosis of a bunion is based on a **physical examination**, a detailed history of the patient's symptoms and their development over time, and x rays to determine the degree of deformity. Other foot disorders such as gout must be ruled out. The patient history should include factors that increase the pain, the patient's level of physical activity, occupation, amount of time spent on his or her feet, the type of shoe most frequently worn, other health conditions such as diabetes that can affect the body's ability to heal, a thorough medication history, including home remedies, and any allergies to food, medications, or environmental aspects. The physical exam should include an assessment while standing and walking to judge the degree to which stability and gait have been affected, as well as an assessment while seated or lying down to measure range of motion and anatomical integrity. An examination of the foot itself will check for the presence of unusual calluses, which indicate abnormal patterns of friction. Circulation in the affected foot will be noted by checking the skin color and temperature. A neurological assessment will also be conducted.



Conservative measures are usually the first line of treatment and target dealing with the acute phase of the condition, as well as attempting to stop the progression of the condition to a more serious form. Measures may include:

- rest and elevation of the affected foot
- eliminating any additional pressure on the tender area, perhaps by using soft slippers instead of shoes
- soaking the foot in warm water to improve blood flow
- use of anti-inflammatory oral medication
- an injection of a steroidal medication into the area surrounding the joint
- systematic use of an orthotic, either an over-the-counter product or one specifically molded to the foot
- the use of a cushioned padding against the joint when wearing a shoe

If these measures prove unsuccessful, or if the condition has worsened to significant foot deformity and altered gait, then a bunionectomy is considered. The doctor may use the term *hallux valgus* when referring to the bunion. *Hallux* means big toe and *valgus* means bent outward. In discussing the surgical option, it is important for the patient to clearly understand the degree of improvement that is realistic following surgery.

X rays to determine the exact angle of displacement of the big toe and potential involvement of the second toe will be taken. The angles of the two toes in relation to each other will be noted to determine the severity of the condition. Studies in both a standing as well as a seated or lying down position will be considered. These will guide the surgeon at the time of the surgery as well. In addition, blood tests, an EKG, and a **chest x ray** will most likely be ordered to be sure that no other medical condition has gone undiagnosed that could affect the success of the surgery and the patient's recovery.

### Aftercare

Recovery from a bunionectomy takes place both at the surgical center as well as in the patient's home. Immediate post-surgical care is provided in the surgical recovery area. The patient's foot will be monitored for bleeding and excessive swelling; some swelling is considered normal. The patient will need to stay for a few hours in the recovery area before being discharged. This allows time for the anesthesia to wear off. The patient will be monitored for nausea and vomiting, potential aftereffects of the anesthesia, and will be given something light to eat, such as crackers

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Bunionectomies are performed by orthopedic surgeons, podiatric surgeons, and general surgeons. In selecting a surgeon, it is best to consider those who perform at least 20 bunionectomies each year. Most bunionectomies are performed as same-day, or ambulatory, surgery, in which the patient goes home the same day of the procedure. Sometimes a patient's condition may warrant staying overnight in the hospital.

and juice or ginger ale, to see how the food is tolerated. Hospital policy usually requires that the patient have someone drive them home, as there is a safety concern after having undergone anesthesia. In addition, the patient will most likely be on pain medication that could cause drowsiness and impaired thinking.

It is important to contact the surgeon if any of the following occur after discharge from the surgical center:

- fever
- chills
- constant or increased pain at the surgical site
- redness and a warmth to the touch in the area around the dressing
- swelling in the calf above the operated foot
- dressing that has become wet or that has fallen off
- dressing that has become bloody

While the patient can expect to return to normal activities within six to eight weeks after the surgery, the foot is at increased risk for swelling for several months. When the patient can expect to bear weight on the operated foot will depend on the extent of the surgery. The milder the deformity, the less tissue is removed and the sooner the return to normal activity level. During the six-to-eight-week recovery period, a special shoe, boot, or cast may be worn to accommodate the surgical bandage and to help provide stability to the foot.

### Risks

All surgical procedures involve some degree of risk. The most likely problems to occur in a bunionectomy are infection, pain, nerve damage to the operated foot, and the possibility that the bunion will recur. Sharing all pertinent past and present medical

## QUESTIONS TO ASK THE DOCTOR

- How many bunionectomies do you perform each year?
- Are there any clinical trials for new medications or new types of procedures available?
- What complications have you seen with this procedure?
- What choices do I have for anesthesia?
- What can I expect during the recovery period?
- When can I return to my work and other regular activities?
- How soon after the surgery can I drive?
- How much improvement can I expect after surgery?

history with the **surgical team** helps to lower the chance of a complication. In addition to the risk of the surgery itself, anesthesia also has risks. It is important to share with the anesthesia team the list of all the vitamins, herbs, and supplements, over-the-counter medications, and prescription medications that the patient is taking.

### Normal results

The expected result will depend on the degree of deformity that has occurred prior to surgery, the patient's medical condition and age, and the adherence to the recovery regimen prescribed. Some degree of swelling in the foot is normal for up to six months after the surgery. Once wound healing has taken place, the surgeon may recommend exercises or physical therapy to improve foot strength and range of motion. It is important to be realistic about the possible results before consenting to the surgery. Since over-pronation of the foot is not corrected with the surgery, orthotics to help keep the foot/feet in alignment are usually prescribed.

### Morbidity and mortality rates

According to the American Orthopaedic Foot & Ankle Society, less than 10% of patients undergoing

bunionectomy experience complications, and 85–90% of patients feel the surgery was successful.

### Alternatives

It may be possible to avoid surgery by preventing bunion growth from worsening. Wearing shoes that are the right size and shape is a key factor. Try on new shoes in the afternoon when the foot is more tired and perhaps has some fluid buildup. Rather than going by size alone, make sure the shoe fits well, and that there is proper arch support. Additionally, there should be enough space in the toe box for the toes to wiggle around.

If diagnosed early, an injection of a steroidal anti-inflammatory medication around the joint may be enough to decrease the irritation in the area and allow the joint to recuperate. This, along with proper shoes, may halt progression of the condition. If there is no pain accompanying the bunion, surgery is not necessary. Some people find that a cream containing the same ingredient as found in chili peppers, capsaicin, applied locally to the joint can decrease the pain. However, once deformity and its accompanying severe pain has occurred, it is unlikely that surgery can be avoided.

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Burch procedure see **Retropubic suspension**

Bypass surgery see **Coronary artery bypass graft surgery**



# C

C-reactive protein tests see **Cardiac marker tests**

C-section see **Cesarean section**

CABG surgery see **Coronary artery bypass graft surgery**

Cancer surgery see **Surgical oncology**

Carcinoembryonic antigen test see **Tumor marker tests**

Cardiac blood pool scan see **Multiple-gated acquisition (MUGA) scan**

## Cardiac catheterization

### Definition

Cardiac catheterization, also called heart catheterization, is a diagnostic and occasionally therapeutic procedure that allows a comprehensive examination of the heart and surrounding blood vessels. It enables the physician to take angiograms; record blood flow; calculate cardiac output and vascular resistance; perform an endomyocardial biopsy; and evaluate the heart's electrical activity. Cardiac catheterization is performed by inserting one or more catheters (thin flexible tubes) through a peripheral blood vessel in the arm (antecubital artery or vein) or leg (femoral artery or vein) under x-ray guidance.

### Purpose

Cardiac catheterization is most commonly performed to examine the coronary arteries, because heart attacks, angina, sudden **death**, and heart failure most often originate from disease in these arteries. Cardiac catheterization may reveal the presence of other conditions, including enlargement of the left

ventricle; ventricular aneurysms (abnormal dilation of a blood vessel); narrowing of the aortic valve; insufficiency of the aortic or mitral valve; and septal defects that allow an abnormal flow of blood from one side of the heart to the other.

Symptoms and diagnoses that may be associated with the above conditions and may lead to cardiac catheterization include:

- chest pain characterized by prolonged heavy pressure or a squeezing pain
- abnormal results from a treadmill stress test
- myocardial infarction (heart attack)
- congenital heart defects
- valvular disease

Cardiac catheterization with coronary **angiography** is recommended in patients with angina (especially unstable angina); suspected coronary artery disease; suspected silent ischemia and a family history of heart attack; congestive heart failure; congenital heart disease; and pericardial disease. (The pericardium is the layer of thin tissue covering the heart.) Catheterization is also recommended for patients with suspected heart valve disease, including aortic valve stenosis (narrowing) or regurgitation, and mitral valve stenosis or regurgitation.

Patients with congenital cardiac defects are also evaluated with cardiac catheterization to visualize the abnormal direction of blood flow associated with these diseases. In addition, the procedure may be performed after acute myocardial infarction (heart attack); before major noncardiac surgery in patients at high risk for cardiac problems; before cardiac surgery in patients at risk for coronary artery disease; and before such interventional technologies and procedures as stents and percutaneous transluminal coronary **angioplasty** (PTCA) or closure of small openings between the atria (upper chambers of the heart), called atrial septal defects.



## KEY TERMS

**Aneurysm**—An abnormal dilatation of a blood vessel, usually an artery. It may be caused by a congenital defect or weakness in the vessel's wall.

**Angiography**—A procedure that allows x-ray examination of the heart and coronary arteries following injection of a radiopaque substance (often referred to as a dye or contrast agent).

**Angioplasty**—A procedure in which a balloon catheter is used to mechanically dilate the affected area of a diseased artery and enlarge the constricted or narrowed segment; it is an alternative to vascular surgery.

**Aortic valve**—The valve between the heart's left ventricle and ascending aorta that prevents regurgitation of blood back into the left ventricle.

**Arrhythmia**—A variation in the normal rhythm of the heartbeat.

**Catheter**—A flexible or pre-shaped curved tube, usually made of plastic, used to evacuate fluids from or inject fluids into the body.

**Computed tomography (CT)**—A diagnostic imaging procedure that uses x rays to produce cross-sectional images of the anatomy.

**Coronary bypass surgery**—A surgical procedure that places a shunt to allow blood to travel from the aorta to a branch of the coronary artery at a point below an obstruction.

**Echocardiography**—An ultrasound examination of the heart.

**Fluoroscopy**—A diagnostic imaging procedure that uses x rays and contrast agents to visualize anatomy and motion in real time.

**Hematoma**—An accumulation of clotted blood that may occur in the tissue around a catheter insertion site.

**Ischemia**—A localized deficiency in the blood supply, usually caused either by vasoconstriction or by obstacles to the arterial blood flow.

**Magnetic resonance imaging (MRI)**—A diagnostic imaging procedure that uses a magnetic field to produce anatomical images.

**Mitral valve**—The bicuspid valve that lies between the left atrium and left ventricle of the heart.

**Percutaneous transluminal coronary angioplasty (PTCA)**—A cardiac intervention in which an artery blocked by plaque is dilated, using a balloon catheter to flatten the plaque and open the vessel; it is also called balloon angioplasty.

**Pericardial tamponade**—The collection of blood in the sac surrounding the heart that causes compression.

**Pseudoaneurysm**—A dilation of a blood vessel that resembles an aneurysm.

**Pulmonary valve**—The heart valve that separates the right ventricle and the opening into the pulmonary artery.

**Septum**—The muscular wall that separates the two sides of the heart; an opening in the septum that allows blood to flow from one side to the other is called a septal defect.

**Shunt**—A passageway (or an artificially created passageway) that diverts blood flow from one main route to another.

**Stent**—A small tube-like device made of stainless steel or other material, used to hold open a blocked artery.

**Tricuspid valve**—The right atrioventricular valve of the heart; it has three flaps, whereas the mitral valve has only two.

### *Left- and right-side catheterization*

Cardiac catheterization can be performed on either side of the heart to evaluate different functions. Testing the right side of the heart allows the physician to evaluate tricuspid and pulmonary valve function, in addition to measuring blood pressures and collecting blood samples from the right atrium, right ventricle (lower chamber), and pulmonary artery. Catheterization of the left side of the heart is performed to test the blood flow in the coronary arteries, as well as the level of function of the mitral and aortic valves and left ventricle.

### *Coronary angiography*

Coronary angiography, also known as coronary arteriography, is an imaging technique that involves injecting a dye into the vascular system to outline the heart and coronary vessels. Angiography allows the visualization of any blockages, narrowing, or abnormalities in the coronary arteries. If these signs are visible, the cardiologist may assess the patient's readiness for coronary bypass surgery, or a less invasive approach such as dilation of a narrowed blood vessel by surgery or the use of a balloon (angioplasty). Because some interventions may be performed during

cardiac catheterization, the procedure is considered therapeutic as well as diagnostic.

## Demographics

Coronary artery disease is the first-ranked cause of death for both men and women in the United States. More than 1.5 million cardiac catheterizations are performed every year in the United States, primarily to diagnose or monitor heart disease. There is an expected growth to more than 3 million procedures by 2010.

## Description

### *Cardiac anatomy*

The heart consists of four chambers separated by valves. The right side of the heart, which consists of the right atrium (upper chamber, sometimes called the right auricle) and the right ventricle (lower chamber), pumps blood to the lungs. The left side of the heart, which consists of the left atrium and the left ventricle, simultaneously pumps blood to the rest of the body. The right and left coronary arteries, which are the first vessels to branch off from the aorta, supply blood to the heart. The left anterior descending coronary artery supplies the front of the heart; the left circumflex coronary artery wraps around and supplies the left side and the back of the heart; and the right coronary artery supplies the back of the heart. There is, however, a considerable amount of variation in the anatomy of the coronary arteries.

### *Catheterization procedure*

The patient lies face up on a table during the catheterization procedure, and is connected to a **cardiac monitor**. The insertion site is numbed with a local anesthetic, and access to the vein or artery is obtained using a needle. A sheath, a rigid plastic tube that facilitates insertion of catheters and infusion of drugs, is placed in the puncture site. Under fluoroscopic guidance, a guide-wire (a thin wire that guides the catheter insertion) is threaded through a brachial or femoral artery to the heart. The catheter, a flexible or pre-shaped tube approximately 32–43 inches (80–110 cm) long, is then inserted over the wire and threaded to the arterial side of the heart. The patient may experience pressure as the catheter is threaded into the heart. The contrast agent, or dye, used for imaging is then injected so that the physician can view the heart and surrounding vessels. The patient may experience a hot, flushed feeling or slight nausea following injection of the contrast medium. Depending on the type of catheterization (left or right heart) and

the area being imaged, different catheters with various shapes and ends are used.

The radiographic/fluoroscopic system has an x-ray subsystem and video system with viewing monitors that allow the physician to observe the procedure in real time using fluoroscopy as well as taking still x rays for documentation purposes. Most newer systems use a digital angiography system that allows images to be recorded, manipulated, and stored digitally on a computer.

The procedure usually lasts two or three hours. If further intervention is necessary, an angioplasty, stent implantation, or other procedure can be performed. At the end of the catheterization, the catheter and sheath are removed, and the puncture site is closed using a sealing device or manual compression to stop the bleeding. One commonly used sealing device is called Perclose, which allows the doctor to sew up the hole in the groin. Other devices use collagen seals to close the hole in the femoral artery.

## Diagnosis/Preparation

Before undergoing cardiac catheterization, the patient may have had other noninvasive diagnostic tests, including an **electrocardiogram (ECG)**, **echocardiography**, computed tomography (CT), **magnetic resonance imaging (MRI)**, laboratory studies (e.g., blood work), and/or nuclear medicine cardiac imaging. The results of these noninvasive tests may have indicated a need for cardiac catheterization to confirm a suspected cardiac condition, further define the severity of a previously diagnosed condition, or establish the need for an interventional procedure (e.g., cardiac surgery).

Patients should give the physician or nurse a complete list of their regular medications, including **aspirin** and **nonsteroidal anti-inflammatory drugs (NSAIDs)**, because they can affect blood clotting. Diabetics who are taking either metformin or insulin to control their diabetes should inform the physician, as these drugs may need to have their dosages changed before the procedure. Patients should also notify staff members of any allergies to shellfish containing iodine, iodine itself, or the dyes commonly used as contrast agents before cardiac catheterization.

Because cardiac catheterization is considered surgery, the patient will be instructed to fast for at least six hours prior to the procedure. A mild sedative may be administered about an hour before the procedure to help the patient relax. If the catheter is to be inserted through the groin, the area around the patient's groin will be shaved and cleansed with an antiseptic solution.

## Aftercare

While cardiac catheterization may be performed on an outpatient basis, the patient requires close monitoring following the procedure; the patient may have to remain in the hospital for up to 24 hours. The patient will be instructed to rest in bed for at least eight hours immediately after the test. If the catheter was inserted into a vein or artery in the leg or groin area, the leg will be kept extended for four to six hours. If a vein or artery in the arm was used to insert the catheter, the arm will need to remain extended for a minimum of three hours.

Most doctors advise patients to avoid heavy lifting or vigorous **exercise** for several days after cardiac catheterization. Those whose occupation involves a high level of physical activity should ask the doctor when they could safely return to work. In most cases, a hard ridge will form over the incision site that diminishes as the site heals. A bluish discoloration under the skin often occurs at the point of insertion but usually fades within two weeks. The incision site may bleed during the first 24 hours following surgery. The patient may apply pressure to the site with a clean tissue or cloth for 10–15 minutes to stop the bleeding.

The patient should be instructed to call the doctor at once if tenderness, fever, shaking, or chills develop, which may indicate an infection. Other symptoms requiring medical attention include severe pain or discoloration in the leg, which may indicate that a blood vessel was damaged.

## Risks

Cardiac catheterization is categorized as an invasive procedure that involves the heart, its valves, and coronary arteries, in addition to a large artery in the arm or leg. Cardiac catheterization is contraindicated (not advised) for patients with the following conditions:

- a bleeding disorder, or anticoagulation treatment with Coumadin (sodium warfarin), which may adversely affect bleeding and clotting during the catheterization procedure
- renal insufficiency or poor kidney functioning (especially in diabetic patients), which may worsen following angiography
- severe uncontrolled hypertension
- severe peripheral vascular disease that limits access to the arteries

- untreated active infections, severe anemia, electrolyte imbalances, or coexisting illnesses that may affect recovery or survival
- endocarditis (an inflammatory infection of the heart's lining that often affects the valves)

## Radiation hazards

Cardiac catheterization involves radiation exposure for staff members as well as the patient. The patient's dose of radiation is minimized by using lead shielding in the form of blankets or pads over certain body parts and by choosing the appropriate dose during fluoroscopy. To monitor staff members' exposure to radiation, they wear radiation badges that detect exposure and lead aprons that shield the body. The radiographic/fluoroscopic system may be equipped with movable lead shields that do not interfere with access to the patient and are placed between staff members and the source of radiation during the procedure.

## Morbidity and mortality rates

As with all invasive procedures, cardiac catheterization involves some risks. The most serious complications include stroke and myocardial infarction. Other complications include cardiac arrhythmias, pericardial tamponade, vessel injury, and renal failure. One study demonstrated a total risk of major complications under 2% for all patients. The risk of death from cardiac catheterization has been demonstrated at 0.11%. The most common complications resulting from cardiac catheterization are vascular related, including external bleeding at the arterial puncture site, hematomas, and pseudoaneurysms.

The patient may be given anticoagulant medications to lower the risk of developing an arterial blood clot (thrombosis) or of blood clots forming and traveling through the body (embolization).

The risk of complications from cardiac catheterization is higher in patients over the age of 60, those who have severe heart failure, or those with advanced valvular disease.

Allergic reactions related to the contrast agent (dye) and anesthetics may occur in some patients during cardiac catheterization. Allergic reactions may range from minor hives and swelling to severe shock. Patients with allergies to seafood or penicillin are at a higher risk of allergic reaction; giving antihistamines prior to the procedure may reduce the occurrence of allergic reactions to contrast agents.

## Normal results

Normal findings from a cardiac catheterization will indicate no abnormalities in the size or configuration of the heart chamber, the motion or thickness of its walls, the direction of blood flow, or motion of the valves. Smooth and regular outlines indicate normal structure of the coronary arteries.

The measurement of intracardiac pressures, or the pressure in the heart's chambers and vessels, is an essential part of the catheterization procedure. Pressure readings that are higher than normal are significant for a patient's overall diagnosis. Pressure readings that are lower, other than those resulting from shock, are usually not significant.

The ejection fraction is also determined by performing a cardiac catheterization. The ejection fraction is a comparison of the quantity of blood ejected from the heart's left ventricle during its contraction phase with the quantity of blood remaining at the end of the left ventricle's relaxation phase. The cardiologist will look for a normal ejection fraction reading of 60–70%.

Abnormal results are obtained by viewing the still and live motion x rays during cardiac catheterization for evidence of coronary artery disease, poor heart function, disease of the heart valves, and septal defects.

The most prominent sign of coronary artery disease is narrowing or blockage (stenosis) in the coronary arteries, with narrowing greater than 50% considered significant. A clear indication for intervention by angioplasty or surgery is a finding of significant narrowing of the left main coronary artery and/or blockage or severe narrowing in the high left anterior descending coronary artery.

A finding of impaired wall motion is an additional indicator of coronary artery disease, an aneurysm, an enlarged heart, or a congenital heart problem. Using an ejection fraction test that measures wall motion, cardiologists regard an ejection fraction reading under 35% as increasing the risk of complications while also decreasing the possibility of a successful long- or short-term outcome from surgery.

Detecting the difference in pressure above and below the heart valve can verify the presence of valvular disease. The greater the narrowing, the higher the difference in pressure.

To confirm the presence of septal defects, measurements are taken of the oxygen content on both the left and right sides of the heart. The right heart pumps unoxygenated blood to the lungs, and the left heart pumps blood containing oxygen from the lungs to the rest of the body. Elevated oxygen levels on the right

side indicate the presence of a left-to-right atrial or **ventricular shunt**. Low oxygen levels on the left side indicate the presence of a right-to-left shunt.

## Alternatives

Other methods of visualization are available that limit radiation exposure, by using **ultrasound** imaging to observe the coronary arteries. Imaging of general cardiac architecture and valvular function can be visualized by noninvasive cardiac ultrasound. Cardiac ultrasound and Doppler ultrasound can be used together to observe valvular insufficiency and stenosis. Areas of poor myocardial function can also be evaluated by ultrasound.

Nuclear medicine scans of the heart can show the perfusion of blood to a region of the myocardium. If blockages of the coronary artery exist, blood flow will be reduced. By adding a radioactive marker to the blood, images are generated to show areas of poor perfusion. Combined with exercise, these tests can accurately demonstrate cardiovascular disease. However, the imaging process can take several hours, and the patient is still internally exposed to high levels of radiation.

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## Cardiac event monitor

### Definition

A cardiac event monitor is an electronic device that attaches to the body and records the rhythm of the heart while the patient is experiencing pathological symptoms. The cardiac event monitor allows recording of the heart without the inconvenience of staying in the hospital or undergoing invasive procedures.

### Purpose

Patients who have symptoms of heart disease such as angina (pain from a lack of oxygen flow to the heart) or arrhythmias (irregular heartbeats) use the cardiac event monitor to record the rhythm of their heart while they are experiencing the symptoms. The cardiac event monitor was designed to record pathological events in real time, allowing for continuous heart monitoring over long periods of time. The heart is thus effectively monitored without necessity for invasive procedures or staying in the hospital. The longer the cardiac event monitor is worn by the patient, the greater the chances of catching and recording the abnormal heart rhythm of a spontaneous cardiac event. Cardiac event monitors were designed as a useful tool for patients who experience symptoms that do not occur regularly, or involve fainting, and so are difficult to analyze.

### Demographics

Cardiac event monitors are used to aid in the diagnosis of heart conditions that cause irregular rhythms. They are designed for a demographic of patients that do not experience symptoms on a predictable, daily basis. Cardiac event monitors can be used for patients with abnormal heart rhythms regardless of age, race, or gender.

### Description

Cardiac event monitors allow the recording of heart rhythms over long periods of time. When used properly, the monitor is able to record information about heart rhythms that assists cardiologists in diagnosing different types of heart disease. There are multiple types and designs of cardiac event monitors. Each type offers unique features.

### *Heart Rhythm*

The heart is a contracting muscle that pumps blood to the body tissues. Oxygenated blood leaves the heart and supplies tissues with the oxygen necessary for life. Deoxygenated blood carrying carbon dioxide waste travels from the tissues back to the heart. The heart sends the deoxygenated blood carrying carbon dioxide to the lungs to be oxygenated. The oxygenated blood from the lungs returns to the heart and the cycle begins again. During this cycle of pumping blood, valves in the heart create the sound of the heartbeat as they close.

The heart rhythm should be a regular pattern of heartbeats occurring at a regular rate that is considered normal. Many types of disease may cause an irregularity in this pattern. A cardiac arrhythmia is an irregular rhythm of heartbeats that does not allow the heart to pump blood properly. Cardiac arrhythmias may cause symptoms of palpitations (pounding heart), syncope (fainting), chest pain, dizziness, light-headedness, shortness of breath, weakness, or fatigue. When a cardiac arrhythmia does not occur regularly and so is difficult to diagnose with an **electrocardiogram** (ECG) reading in a hospital setting, cardiac event monitors may be utilized to help elucidate the relationship between a patient's symptoms and the heart rhythms recorded. Cardiac event monitors may be used on patients with different types of heart conditions, including arrhythmias, myocardial infarctions (heart attacks), stroke, or during recovery from **coronary artery bypass graft surgery** (CABG).

### *Holter Cardiac Event Monitors*

A Holter monitor is a general type of **cardiac monitor** which records heart rhythm continuously for 24 to 48 hours. Holter monitors are useful when a patient experiences symptoms on a daily basis. Holter monitors record each heartbeat, using electrodes attached to the chest. Patients using Holter monitors go through their normal daily activities (except bathing) and keep a diary of how they feel physically during the monitoring time period. When the monitoring time period is over, the Holter monitor and the accompanying diary are turned in to the diagnostic center for evaluation of the recorded results. While Holter monitors are effective, patients whose symptoms occur less frequently require the cardiac event monitor.

### *Looping Memory Cardiac Event Monitors*

Cardiac event monitors are small black boxes attached to several wires with electrodes. The cardiac event monitor is monitoring heart rhythm as the

patient goes through their daily activities. Cardiac event monitors do not record heart rhythm for more than a few minutes at a time in a cycling stream of memory. When the patient experiences symptoms it is known as a cardiac event. The patient immediately presses a button on the event monitor that records the activity of the heart while the symptom is occurring. Many cardiac events are fleeting experiences and it may take the patient a moment to press the event button, therefore, cardiac event monitors have been designed with a continuous memory “loop” that allows the recording to backtrack about 30 seconds to a minute before the event button was pressed, and obtain a complete picture of the cardiac event. If the event button is not pressed, no permanent record will be kept of the event within the basic monitor design. Some types of cardiac event monitors have been preset to record cardiac events if the heart goes into an arrhythmia and circumvent the need for the event button; however, these monitors may be less specific in the data they gather.

Cardiac event monitors are often used for 30 days. For this reason, cardiac events need to be transmitted to the diagnostic center frequently during the monitoring time frame, rather than at the end of the monitoring period. Cardiac event monitors can have their data transmitted via a telephone line to a computer system that turns the transmitted data into an ECG reading. Essentially, the cardiac event monitor provides the ability to obtain an ECG of an irregularly occurring symptom that would likely otherwise be missed in an office visit. Since transmission of data is done approximately every other time a symptom is experienced, the cardiologist is able to keep track of the patient’s condition in real time over the duration of the cardiac event monitoring. Event monitors notify physicians in a timely manner if intervention is needed for a serious cardiac arrhythmia that might have otherwise have been missed.

### ***Implantable Cardiac Event Monitors***

Implantable cardiac event monitors were designed for use in patients with unexplained syncope that may have a heart-related cause. The implantable monitors are surgically placed just under the skin of the chest within a one-inch incision. The implantation procedure involves only **local anesthesia**. Implantable cardiac event monitors are set to specific heart rhythm limits in order to obtain a record of heart events during syncope episodes. The implantable design that does not require pressing an event button is critical to record events that involve a patient losing

## **QUESTIONS TO ASK YOUR DOCTOR**

- Why do I need a cardiac event monitor?
- Which type of cardiac event monitor will I be using?
- What are the advantages and disadvantages of this type of monitor over other types?
- How should I prepare for the cardiac event monitor?
- Are there any restrictions on my daily activity with the cardiac event monitor?
- How do I use the cardiac event monitor?
- How long will I use the cardiac event monitor?
- When can I expect to go over the results of my cardiac event monitor?
- Could any of my prescription or nonprescription medications, nutritional, or herbal supplements be causing my symptoms or affect the results?

consciousness. After a period of time, the monitor is removed and its data is analyzed by a diagnostic center.

### ***Mobile Cardiovascular Telemetry***

Cardiac event monitors have been designed for use with a wireless cell phone system that transmits data from the monitor without the need of calling in a transmission to a diagnostic center. These devices act as both a monitor and an alarm system for patients with potentially life threatening cardiac arrhythmias. The remote diagnostic center and patient’s physician automatically receive daily reports of the patient’s heart activity. In addition to daily reports, any urgent, life-threatening data gathered by the device is immediately transmitted. In this way, the remote diagnostic center and physician are notified relatively quickly in urgent circumstances and intervention can be made in a timely manner.

### **Results Obtained with Cardiac Event Monitors**

The recordings obtained by cardiac event monitors are sent to cardiac event monitor diagnostic centers and converted into ECG readings. Trained health care professionals interpret the ECG readings. Cardiologists are heart doctors that specialize in diagnosing heart disease, and use ECGs as tools to assist in a patient’s diagnosis. Cardiac event monitors alone

## KEY TERMS

**Angina**—Condition causing chest discomfort or pain due to a decreased oxygen supply to the heart.

**Arrhythmia**—An irregular pattern of heartbeats that affects how well the heart pumps blood and can be life threatening.

**Coronary Artery Bypass Graft Surgery (CABG)**—A surgical procedure where arteries or veins from elsewhere in the patient's body grafted into the arteries of the heart as a way to bypass damaged or narrowed heart blood vessels. Heart blood vessels may have been damaged or narrowed from fat deposition and need to be bypassed to increase the blood supply and oxygen delivered to the heart.

**Electrocardiogram (ECG)**—A medical tool used to monitor the electrical impulses released by the beating heart. The results are drawn out in graphical fashion to visualize the function of the heart.

**Palpitations**—Forcible pulsation or pounding of the heart that is perceptible to the patient.

**Syncope**—A fainting episode.

cannot diagnose heart conditions, but only display the heart rhythm a patient is experiencing at the time of symptom onset. Cardiologists may use ECGs to help narrow down the diagnosis whether or not the condition is caused by an arrhythmia.

### Risks Associated with Cardiac Event Monitors

Cardiac event monitors are useful tools, but may not be sensitive enough to catch every cardiac event or specific enough to detail it well. Different designs have different levels of sensitivity in picking up events and give different levels of detail about the events they record. Even with designs in which event recording is automatic, some data may be missed.

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Maria Basile, Ph.D.

Cardiac exercise stress testing see **Stress test**  
Cardiac mapping see **Electrophysiology study of the heart**

## Cardiac marker tests

### Definition

Cardiac marker tests identify blood chemicals associated with myocardial infarction (MI), commonly known as a heart attack. The myocardium is the middle layer of the heart wall composed of heart muscle. Infarction is tissue **death** caused by an interruption in the blood supply to an area.

### Purpose

Cardiac markers are types of blood-lab tests that help physicians assess acute coronary syndromes and identify and manage high-risk patients. Creatine kinase-MB (CK-MB), myoglobin, homocysteine, C-reactive protein (CRP), troponin T (cTnT), and troponin I (cTnI) are all types of cardiac markers used for assessment of the suspected acute myocardial infarction. CK-MB, cTnT, and cTnI may also be used to identify and manage high-risk patients.

### Precautions

C-reactive protein results may be affected by the use of oral contraceptives, **nonsteroidal anti-inflammatory drugs** (NSAIDs), steroids, salicylates, and intrauterine

devices (IUDs). Homocysteine levels may be affected by smoking, diabetes, and coffee.

## Description

### *Creatine kinase (CK)*

Creatine kinase is an enzyme responsible for transferring a phosphate group from ATP (adenosine triphosphate) to creatine. It is composed of M and/or B subunits that form CK-MM, CK-MB, and CK-BB isoenzymes. Total CK (the activity of the MM, MB, and BB isoenzymes) is not myocardial-specific. However, the MB isoenzyme (also called CK-2) comprises about 40% of the CK activity in cardiac muscle and 2% or less of the activity in most muscle groups and other tissues. In the proper clinical setting, MB is both a sensitive and specific marker for heart attack. MB usually becomes abnormal three to four hours after a heart attack, peaks in 10–24 hours, and returns to normal within 72 hours; however, an elevated serum MB may occur in people with severe skeletal muscle damage (such as in muscular dystrophy or a crush injury) and renal (kidney) failure. In such cases, the CK index (MB divided by total CK) is very helpful. If the index is under 4%, a nonmyocardial cause of a high MB should be suspected. CK-MB is considered the benchmark for cardiac markers of myocardial injury.

CK-MB forms can be used to determine whether **thrombolytic therapy** (such as treatment with tissue plasminogen activator to dissolve a blood clot in the coronary artery) has succeeded. MB forms are different molecular forms of MB found in the circulation. When MB is released into the blood, part of the M subunit is removed by an enzyme in the plasma. This results in a molecule called CK-2<sub>1</sub>. This is the prevalent form of MB in the blood. CK-2<sub>2</sub> is the unmodified cardiac form of MB. After successful thrombolytic therapy, the unmodified form of MB is rapidly flushed into the blood, causing it to become the dominant form.

### *Myoglobin*

Myoglobin is a protein found in both skeletal and myocardial muscle. It is released rapidly after tissue injury and may be elevated as early as one hour after myocardial injury, though it may also be elevated due to skeletal muscle trauma. However, if myoglobin values do not rise within three to four hours after a person shows acute symptoms, it is highly unlikely that he or she had a heart attack.

### *Troponin T and troponin I*

Troponin C, I, and T are proteins that form the thin filaments of muscle fibers and regulate the

## KEY TERMS

**Cardiac marker**—A substance in the blood that rises following a myocardial infarction.

**Diagnostic window**—A cardiac marker's timeline for rising, peaking, and returning to normal after a heart attack.

**Isoenzymes**—Structurally related forms of an enzyme.

**Myocardial**—Referring to the heart muscle.

**Myocardial infarction (MI)**—Commonly known as a heart attack, a myocardial infarction is an episode in which some of the heart's blood supply is severely cut off or restricted, causing the heart muscle to suffer and die from lack of oxygen.

**Myoglobin**—A protein that holds oxygen in heart and skeletal muscle. It rises after damage to either of these muscle types.

movement of contractile proteins in muscle tissue. Skeletal and cardiac forms are structurally distinct, and antibodies can be produced that react only with the cardiac forms of troponin I and troponin T.

Cardiac troponin T (cTnT) and cardiac troponin I (cTnI) are the newest additions to the list of cardiac markers. Cardiac troponins are specific to heart muscle. They have enabled the development of laboratory tests that can detect heart muscle injury with great sensitivity and specificity. While these markers have been used mainly to aid in the diagnosis of chest-pain patients with nondiagnostic electrocardiograms, they also help doctors determine a prognosis for patients who have had a heart attack. According to the American Heart Association, "... it's possible that the results of a troponin test could be used to identify people at either low risk or high risk for later, serious heart problems."

### *C-reactive protein (CRP)*

CRP is a protein found at elevated levels in serum or plasma during inflammatory processes. CRP binds to part of the capsule of *Streptococcus pneumoniae*. It is a sensitive marker of acute and chronic inflammation and infection, and in such cases is increased several hundred-fold. Several studies have demonstrated that CRP levels are useful in predicting the risk for a thrombotic event (such as a blood clot causing heart attack). These studies suggest that a high-sensitivity



assay for CRP be used that is capable of measuring the very low level normally found in serum (0.1–2.5 mg/L). Heart patients who have persistent CRP levels between 4 and 10 mg/L, with clinical evidence of low-grade inflammation, should be considered to be at increased risk for thrombosis (blood clots). People can be stratified into four groups of increased risk based on their CRP levels.

### Homocysteine

Homocysteine is an amino acid. According to the American Heart Association, studies have shown that too much homocysteine in the blood is related to a higher risk of coronary heart disease, stroke, and peripheral vascular disease; and that it may also have an effect on atherosclerosis. High levels of homocysteine are the result of a lack of certain B vitamins, inheritance, or dietary excess and have been implicated in vascular-wall injury. It is believed that laboratory testing for plasma homocysteine levels can improve the assessment of risk, particularly in patients with a personal or family history of cardiovascular disease, but in whom the well-established risk factors (smoking, high blood cholesterol, high blood pressure, physical inactivity, obesity, and diabetes) do not exist.

### Preparation

These tests require a sample of blood, which is typically obtained via a standard vein puncture procedure. Homocysteine tests require the patient to fast before the test.

### Aftercare

Discomfort or bruising may occur at the puncture site, or the person may feel dizzy or faint. Applying pressure to the puncture site until the bleeding stops reduces bruising. Warm packs to the puncture site can relieve discomfort.

### Risks

There are no complications associated with these tests.

### Results

Normal results vary, based on the laboratory and method used. Unless otherwise specified, the following information is from the American College of Cardiology and the American Heart Association.

- **Total CK:** Reference value is 38–174 units/L for men and 96–140 units/L for women. The values begin to rise within four to six hours and peak at 24 hours. Values return to normal within three to four days.
- **CK-MB:** Reference value is 10–13 units/L. The values begin to rise within three to four hours and peak at 10–24 hours. Values return to normal within two to four days.
- **Troponin T:** Reference value is less than 0.1 ng/mL. The values begin to rise within two to four hours and peak at 10–24 hours. Values return to normal within five to 14 days.
- **Troponin I:** Reference value is less than 1.5 ng/mL. The values begin to rise within two to four hours and peak at 10–24 hours. Values return to normal within five to 10 days.
- **CK-MB forms:** Reference value is a ratio of 1.5 or greater. The values begin to rise within two to four hours and peak at six to 12 hours. Values return to normal within 12–24 hours.
- **Myoglobin:** Reference value is less than 110 ng/mL. The values begin to rise within one to two hours and peak at four to eight hours. Values return to normal within 12–24 hours.
- **Homocysteine:** The normal fasting level for plasma is 5–15 micromol/L. Moderate, intermediate, and severe hyperhomocysteinemia refer to concentrations between 16 and 30, between 31 and 100, and less than 100 micromol/L, respectively.
- **C-reactive protein:** According to the U.S. Food and Drug Administration, in healthy people, reference values are below 5 mg/dL; in various diseases, this threshold is often exceeded within four to eight hours after an acute inflammatory event, with CRP values reaching approximately 20–500 mg/dL.

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**ORGANIZATIONS**

American Heart Association, 7272 Greenville Avenue,  
Dallas, TX, 75231, (800) 242 8721, <http://www.americanheart.org>.

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## Cardiac monitor

### Definition

The cardiac monitor is a device that shows the electrical and pressure waveforms of the cardiovascular system for measurement and treatment. Parameters specific to respiratory function can also be measured. Because electrical connections are made between the cardiac monitor and the patient, it is kept at the patient's bedside.

### Purpose

The cardiac monitor continuously displays the cardiac **electrocardiogram** (EKG) tracing. Additional monitoring components allow cardiovascular pressures and cardiac output to be monitored and displayed as required for patient diagnosis and treatment. Oxygen saturation of the arterial blood can also be monitored continuously. Most commonly used in emergency rooms and critical care areas, bedside monitors can be interconnected to allow for continual observation of several patients from a central display. Continuous cardiovascular and pulmonary monitoring allows for prompt identification and initiation of treatment.

### Description

The monitor provides a visual display of many patient parameters. It can be set to sound an alarm if any parameter changes outside of an expected range determined by the physician. Parameters to be monitored may include, but are not limited to, electrocardiogram, noninvasive blood pressure, intravascular pressures, cardiac output, arterial blood oxygen saturation, and blood temperature.

Equipment required for continuous cardiac monitoring includes the cardiac monitor, cables, and disposable supplies such as electrode patches, pressure transducers, a pulmonary artery catheter (Swan-Ganz catheter), and an arterial blood saturation probe.

## KEY TERMS

**Artifact**—Extra electrical activity typically caused by interference.

**Cardiomyopathies**—Diseases of the heart muscle; usually refers to a disease of obscure etiology.

**Electrodes**—Adhesive pads that are placed on the skin and attached to the leads.

**Lead**—Color-coded wires that connect the electrode to the monitor cable.

**QRST complex**—The combined waves of an electrocardiogram for monitoring the heart.

### Preparation

As the cardiac monitor is most commonly used to monitor electrical activity of the heart, the patient can expect the following preparations. The sites selected for electrode placement on the skin will be shaved and cleaned causing surface abrasion for better contact between the skin and electrode. The electrode will have a layer of gel protected by a film, which is removed prior to placing the electrode to the skin. Electrode patches will be placed near or on the right arm, right leg, left arm, left leg, and the center left side of the chest. The cable will be connected to the electrode patches for the measurement of a five-lead electrocardiogram. Additional configurations are referred to as three-lead and 12-lead electrocardiograms. If noninvasive blood pressure is being measured, a blood pressure cuff will be placed around the patient's arm or leg. The blood pressure cuff will be set to inflate manually or automatically. If manual inflation is chosen, the cuff will only inflate at the prompting of the health care provider, after which a blood pressure will be displayed. During automatic operation, the blood pressure cuff will inflate at timed intervals and the display will update at the end of each measurement.

Disposable pressure transducers require a reference to atmosphere, called zeroing, which is completed before monitoring patient pressures. This measurement will occur once the patient is comfortably positioned since the transducer must be level with the measurement point. The pressure transducer will then be connected to the indwelling catheter. It may be necessary for as many as four or five pressure transducers to be connected to the patient.

The arterial blood saturation probe will be placed on the finger, toe, ear, or nasal septum of the patient,

providing as little discomfort as possible, while achieving a satisfactory measurement.

### Aftercare

After connecting all equipment, the health care provider will observe the monitor and evaluate the quality of the tracings, while making size and position adjustments as needed. The provider will confirm that the monitor is detecting each heartbeat by taking an apical pulse and comparing the pulse to the digital display. The upper and lower alarm limits should be set according to physician orders, and the alarm activated. A printout may be recorded for the medical record, and labeled with patient name, room number, date, time, and interpretation of the strip.

Maintenance and replacement of the disposable components may be necessary as frequently as every eight hours, or as required to maintain proper operation. The arterial saturation probe can be repositioned to suit patient comfort and to obtain a tracing. All connections will be treated in a gentle manner to avoid disruption of the signal and to avoid injury to the patient.

### Normal results

The monitor will provide waveforms and/or numeric values associated with the patient status. These may include, but are not limited to, heart rate, arterial blood pressure, central venous pressure, pulmonary artery pressure, pulmonary capillary wedge pressure, left atrial pressure, cardiac output, arterial blood saturation, and blood temperature. Furthermore, these values can be used to calculate other values, or parameters, or used to diagnose and treat the patient's condition.

Patient movement may cause measurement errors; the patient will be requested to remain motionless. Depending on the mobility of the patient, assistance should be provided by the health care provider prior to changing from a laying down position to sitting or standing.

As the patient's condition improves, the amount of monitoring equipment may be decreased. The electrocardiogram and arterial blood saturation probe should be expected to remain attached until discharge is imminent.

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### ORGANIZATIONS

American Association of Critical Care Nurses, 101 Columbia, Aliso Viejo, CA, 92656 4109, (800) 899 2226, <http://www.aacn.org/>.

The American College of Cardiology, Heart House, 2400 N. Street NW, Washington, DC, 20037, (800) 253 4636, <http://www.acc.org>.

American Heart Association, 7272 Greenville Ave., Dallas, TX, 75231, (800) 242 8721, <http://www.americanheart.org>.

Applied Biometrics, 501 East Highway Thirteen, Suite 108, Burnsville, MN, 55337, (952) 890 1123

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Cardiopulmonary bypass machine see  
**Heart-lung machines**

## Cardiopulmonary resuscitation

### Definition

Cardiopulmonary resuscitation, commonly called CPR, combines rescue breathing (one person breathing into another person) and chest compression in a life-saving procedure performed when a person has stopped breathing or a person's heart has stopped beating.

## Purpose

When performed quickly enough, CPR can save lives in such emergencies as loss of consciousness, heart attacks or heart “arrests,” electric shock, drowning, excessive bleeding, drug overdose, and other conditions in which there is no breathing or no pulse. The purpose of CPR is to bring oxygen to the victim’s lungs and to keep blood circulating so oxygen gets to every part of the body. When a person is deprived of oxygen, permanent brain damage can begin in as little as four minutes and **death** can follow only minutes later.

## Description

There are three physical symptoms that indicate a need for CPR to be performed immediately and for emergency medical support to be called: unconsciousness, not breathing, and no pulse detected.

### *Unconsciousness*

Unconsciousness is when the victim seems to be asleep but has lost all awareness and is not able to respond to questions, touch, or gentle shaking. A sleeping person will usually respond to a loud noise, shouting, or gentle shaking. An unconscious person will not respond to noise or shaking. When unconscious, a person can not cough or clear the throat, which may allow the windpipe to become blocked, causing suffocation and death. People with a major illness or injury or who have had recent surgery are at risk for losing consciousness. If a person has fainted, which is brief unconsciousness, the cause may be dehydration (lack of body fluids), low blood pressure, or low blood sugar. This is a temporary condition. If the victim is known to have diabetes, a bit of fruit juice may revive the person once they have regained consciousness.

Just before a person loses consciousness, symptoms may include:

- lack of response to voice or touch
- disorientation or stupor
- light-headedness
- headache
- sleepiness

### *Not breathing*

Not breathing, which is also called apnea, is the lack of spontaneous breathing. It requires immediate medical attention. The victim may become limp and lifeless, have a seizure, or turn blue. Prolonged apnea is called respiratory arrest. In children, this can lead quickly to cardiac arrest in which the heart stops beating. In adults, cardiac arrest usually happens first and

## KEY TERMS

**Apnea**—A period of no breathing, sometimes sudden, sometimes prolonged.

**Arrest**—A sudden stopping of the function of a body organ, such as no breathing (respiratory arrest) or no beating of the heart (cardiac arrest).

**Cardiopulmonary**—Involving both heart and lungs.

**Circulation**—The passage of blood and delivery of oxygen through the veins and arteries of the body.

**Respiratory**—Referring to breathing in and breathing out, and the function of the lungs.

**Resuscitation**—Reviving an unconscious person or restoring breathing.

**Shock**—A sudden reducing of function in major body systems such as circulation and respiration.

then respiratory arrest. In adults, the common causes of apnea are obstructive sleep apnea (something blocks the airway during sleep), choking, drug overdose, near-drowning, head injury, heart irregularities (arrhythmia, fibrillation) or cardiac arrest, nervous system disorders, or metabolic disorders. In children the causes may be different, such as prematurity, bronchial disturbances or pneumonia, airway blockage or choking on a foreign object, holding the breath, seizures, meningitis, regurgitating food, or asthma attacks.

### *No pulse detected*

If the rescuer is unable to detect a pulse or has difficulty feeling a pulse, it can be an indication of the use of improper technique by the rescuer, or it may be due to shock or cardiac arrest in the victim. If a sudden, severe decrease occurs in pulse quality (such as pulse weakness) or pulse rate (how many beats in a minute) when other symptoms are also present, life-threatening shock is suspected. The rescuer may need to explain to a doctor or medical professional where on the victim’s body the pulse was measured, whether or not the pulse is weak or absent, and what other symptoms are present.

Medical help and CPR are needed immediately if any of these symptoms are found. Time is critical. A local emergency number should be called immediately. If more than one person is available to help, one person can call 911 or a local emergency medical service, while the other person begins CPR. If needed, the emergency dispatcher (the person who picks up emergency 911 calls) can give step-by-step CPR



instructions over the telephone. Local medical personnel, staff at hospitals and fire departments, and members of the American Heart Association teach CPR courses. If a critically ill patient or postoperative patient is being cared for at home, it is a good idea for a family member to take a CPR course to be better prepared to help in the event of an emergency.

The steps usually followed in *adult* CPR by a layperson are as follows:

1. If the victim appears to be unconscious with either no breathing or no pulse, the person should be shaken or tapped gently to check for any movement. The victim should be spoken to loudly, asking if he or she is OK. If there is no response, the rescuer should leave to call 911 immediately, send someone to call for help, or call from a cell phone. If the rescuer is alone, they should call 911 before beginning CPR. If an automated external defibrillator (AED) is found close by, the rescuer should bring the AED back with them to the victim's side.
2. The victim should be placed on his or her back on a level surface such as the ground or the floor. The rescuer should kneel next to the victim and tilt the victim's head back. The rescuer should then put their ear to the victim's open mouth and look for chest movement, listen for air flowing through the mouth or nose, and feel for air on his or her cheek. If there is no breathing, they should pinch the victim's nose, make a seal over the victim's mouth with theirs, and give the victim a breath big enough to make the chest rise. The rescuer should use a CPR mask if there is one available. The rescuer should let the chest fall, then repeat the rescue breath once more. If the chest does not rise, the victim's head should be repositioned to help ensure the tongue is kept away from the windpipe, then the rescuer should try again to give a breath.
3. If the victim is found to be breathing and has perhaps fainted, he or she can be placed in the recovery position until medical assistance arrives. This is done by straightening the victim's legs and pulling the closest arm out away from the body with the elbow at a right angle (or three o'clock position), and the other arm across the chest. The far leg should be pulled up over the victim's body with the hip and knee bent. This allows the victim's body to be rolled onto its side. The head should be tilted back slightly to keep the windpipe open. The head should not be propped up.
4. If the victim is not breathing, the rescuer should begin chest compressions. Chest compressions are needed to restore circulation (the victim has

no pulse). The rescuer should push down one and a half to two inches on the chest, placing the heel of one hand in the middle of the chest, putting the other hand on top of the first, and interlacing the fingers. When performing compressions, the rescuer should keep the elbows straight, center his or her shoulders over the victim, develop an up-and-down rhythm, and keep their hands firmly on the victim's chest. Compressions should be done on the center of the chest midway between the nipples. Compressions should be hard and fast, at a rate of 100 times per minute. The rescuer should perform 30 compressions at this rate, then give 2 breaths and the again, 30 compressions (this ratio is the same whether it is performed by one or by two people at the scene). The rescuer should allow the chest to completely recoil before the next compression. The sequence of 30 compressions and two breaths should continue to be repeated until professional medical help arrives. Note: If an AED is immediately available, deliver one shock if advised by the device, then begin CPR. If an AED is not available initially, but later becomes available and the person is still unresponsive, stop doing CPR and quickly follow the directions for using the AED.

### Precautions

There are certain important precautions for rescuers to remember in order to protect the victim and get the best result from CPR. These include:

- Do not leave the victim alone.
- Do not give the victim anything to eat or drink.
- Avoid moving the victim's head or neck if spinal injury is a possibility. The person should be left as found if breathing freely. To check for breathing when spinal injury is suspected, the rescuer should only listen for breath by the victim's mouth and watch the chest for movement.
- Do not slap the victim's face, or throw water on the face to try and revive the person.
- Do not place a pillow under the victim's head.

The description above is not a substitute for CPR training and is not intended to be followed as a procedure.

### Normal results

Successful CPR will restore breathing and circulation in the victim. Medical attention is required immediately even if successful CPR has been performed and the victim is breathing freely.

## Prevention

Loss of consciousness is an emergency that is potentially life threatening. To avoid loss of consciousness and protect themselves from emergency situations, people at risk can follow these general guidelines:

- People with such conditions as diabetes or epilepsy should wear a medical alert tag or bracelet.
- People with diabetes should avoid situations that will lower their blood sugar level.
- People who feel weak, become dizzy or light-headed, or have ever fainted, should avoid standing in one place too long without moving.
- People who feel faint can lie down or sit with their heads lowered between their knees.
- Risk factors that contribute to heart disease should be reduced or eliminated. People can reduce risks if they stop smoking, lower blood pressure and cholesterol, lose excess weight, and reduce stress.
- Illegal recreational drugs should be avoided.
- Seeing a doctor regularly and being aware of any disease conditions or risk factors can help prevent or complicate illness, as can seeking and following the doctor's advice about diet and exercise.
- Using seat belts and driving carefully can help avoid accidental injury.
- People with poor eyesight or those who have difficulty walking because of disability, injury, or recovery from illness, can use a cane or other assistive device to help them avoid falls and injury.

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### ORGANIZATIONS

American CPR Training, 444 Sante Fe Drive #127, Encinitas, CA, 92024 5134, (760) 944 1048, <http://www.cprtrainingclasses.com>.

American Heart Association, National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242 8721, <http://www.americanheart.org>.

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## Cardioversion

### Definition

Cardioversion refers to the process of restoring the heart's normal rhythm either by applying a controlled electric shock to the exterior of the chest or by giving certain medications. The first type is called synchronized electrical cardioversion; the second is called pharmacologic or chemical cardioversion. Abnormal heart rhythms are called arrhythmias or dysrhythmias.

### Purpose

When the heart beats too fast, blood no longer circulates effectively in the body. Cardioversion is used to stop this abnormal beating so that the heart can begin its normal rhythm and pump more efficiently.

### Demographics

Cardioversion is used to treat many types of fast and/or irregular heart rhythms. Most often, cardioversion is used to treat atrial fibrillation or atrial flutter. Life-saving cardioversion can be used to treat ventricular tachycardia and ventricular fibrillation; implantable cardioverter-defibrillators (ICDs) are designed to treat these two conditions.

Abnormal heart rhythms are slightly more common in men than in women and the prevalence of abnormal heart rhythms, especially atrial fibrillation, increases with age. Atrial fibrillation is relatively uncommon in people under age 20 but affects 5% of the American population over 65, and 8% of the population over 80. It is responsible for 15–25% of all strokes.

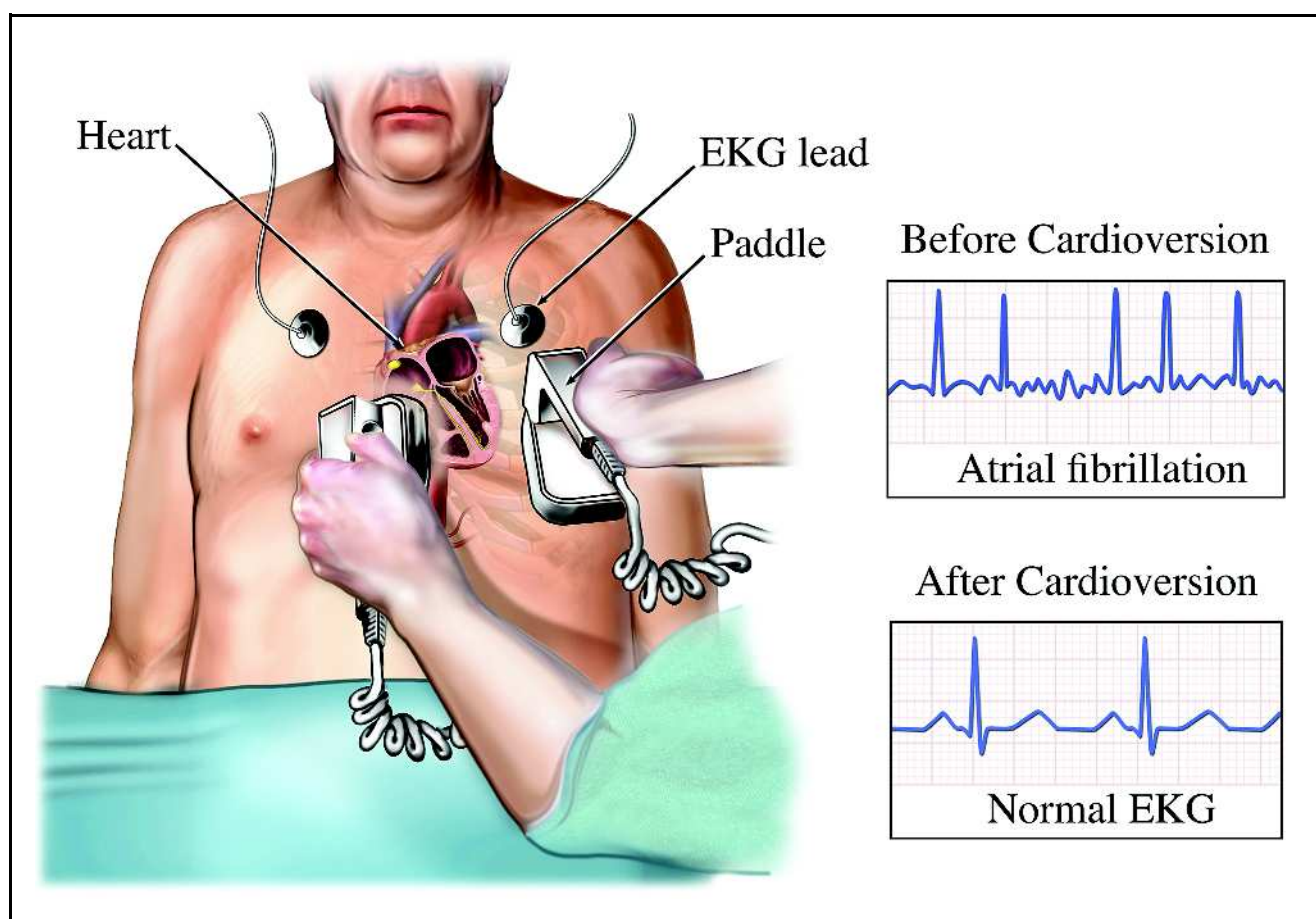
### Description

#### *Synchronized electrical cardioversion*

Elective synchronized electrical cardioversion is usually scheduled ahead of time. After arriving at the hospital, the patient will have an intravenous (IV) catheter placed in the arm to deliver medications and fluids. Oxygen may be given through a face mask.

In some people, a test called a transesophageal echocardiogram (TEE) may need to be performed before the cardioversion to make sure there are no blood clots in the heart.

A short-acting general anesthetic will be given through the IV to put the patient to sleep. During the



**Cardioversion.** (Nucleus Medical Art, Inc./Phototake. Reproduced by permission.)

five or 10 minutes of anesthesia, an electric shock is delivered through paddles or patches placed on the exterior of the chest and sometimes on the back. It may be necessary for the doctor to administer the shock two or three times to stop the abnormal heartbeat and allow the heart to resume a normal rhythm. During the procedure, the patient's breathing, blood pressure, and heart rhythm are continuously monitored.

#### ***Pharmacologic cardioversion***

Pharmacologic, or chemical, cardioversion is a less immediate method of restoring normal heart rhythm, and is somewhat less effective than electrical cardioversion, having a success rate between 60% and 80%. It has the advantage of being simpler and more convenient, particularly for patients who are afraid of electrical devices. The patient does not need to undergo anesthesia and can receive the drugs immediately after eating; there is no need to fast for several hours.

There are two basic groups of drugs given in pharmacologic cardioversion: those given to control

the heart rate and those given to normalize the heart rhythm. The first group includes such medications as digoxin (Lanoxin), diltiazem (Cardizem), verapamil (Calan), esmolol (Brevibloc), metoprolol (Lopressor), and propranolol (Inderal). These drugs may be given either intravenously or orally. With the exception of digoxin, which takes about 30 minutes to take effect, these drugs begin to work in 5–7 minutes.

Drugs given to normalize the heart rhythm are called antiarrhythmics. Quinidine (Quinaglute), the oldest drug in this group, is given by mouth, while procainamide, propafenone (Rythmol), flecainide (Tambocor), amiodarone (Cordarone), sotalol (Betapace), dofetilide (Tikosyn) and ibutilide (Corvert) may be given intravenously or orally. Unlike the drugs given to control the heart rate, these medications take longer to work, one hour for procainamide and ibutilide, and 3–8 hours for the others. These drugs should be administered in a hospital setting where the patient can be monitored. Dofetilide can be prescribed only by physicians who

have had special training in the risks and side effects of the drug.

## Diagnosis/Preparation

### *Diagnosis of abnormal heart rhythms*

A doctor may be able to detect an irregular heart beat during a physical exam by taking the patient's pulse. In addition, the diagnosis may be based upon the presence of certain symptoms, including:

- palpitations (feeling of skipped heart beats or fluttering in the chest)
- pounding in the chest
- shortness of breath
- chest discomfort
- fainting
- dizziness or feeling light-headed
- weakness or fatigue

Not everyone with abnormal heart rhythms will experience symptoms, so the condition may be discovered upon examination for another medical condition.

**DIAGNOSTIC TESTS.** Tests used to diagnose an abnormal heart rhythm or determine its cause include:

- blood tests
- chest x rays
- electrocardiogram
- ambulatory monitors such as the Holter monitor, loop recorder, and transtelephonic transmitter
- stress test
- echocardiogram
- cardiac catheterization
- electrophysiology study (EPS)
- head-upright tilt table test
- nuclear medicine test, such as a MUGA scan (multiple-gated acquisition)

### *Preparation for synchronized electrical cardioversion*

Medication to thin the blood (blood thinner or anticoagulant) is usually given for at least three weeks before elective cardioversion. The patient should take all usual medications as prescribed, unless other instructions have been given. Patients who take diabetes medications or anticoagulants should ask their doctor for specific instructions.

The patient should not eat or drink anything for six to eight hours before the procedure.

It is advisable to arrange for transportation home, because drowsiness may last several hours and driving

is not permitted after the procedure. The patient is also advised not to apply any lotion or ointments to the chest or back before the procedure.

## Aftercare

The patient generally wakes quickly after the procedure. Medical personnel will monitor the patient's heart rhythm for a few hours, after which the patient is usually sent home. The patient should not drive home; driving is not permitted for 24 hours after the procedure.

## Medications

The doctor may prescribe anti-arrhythmic medications (such as beta-blockers, digitalis, or calcium channel blockers) to prevent the abnormal heart rhythm from returning.

Some patients may be prescribed anticoagulant medication, such as warfarin and **aspirin**, to reduce the risk of blood clots.

The medications prescribed may be adjusted over time to determine the best dosage and type of medication so the abnormal heart rhythm is adequately controlled.

## Discomfort

Some chest wall discomfort may be present for a few days after the procedure. The doctor may recommend that the patient take an over-the-counter pain reliever such as ibuprofen to relieve discomfort. Skin irritation may also be present after the procedure. Skin lotion or ointment can be used to relieve irritation.

## Risks

Cardioverters have been in use for many years and the risks are few. The unlikely risks that remain include those instances when the device delivers greater or lesser power than expected or when the power setting and control knobs are not set correctly. Unfortunately, in about 50% of cases, the heart prefers its abnormal rhythm and reverts to it within one year, despite cardioversion. Cardioversion can be repeated for some patients whose abnormal heart rhythm returns.

## Normal results

About 90% of cardioversions are successful and, at least for a time, restore the normal heart rhythm safely and prevent further symptoms.



## KEY TERMS

**Ablation**—The removal or destruction of tissue.

**Ablation therapy**—A procedure used to treat arrhythmias, especially atrial fibrillation. During the procedure, a catheter (small flexible tube) is inserted in a vein and threaded to the heart. High-frequency electrical energy is delivered through the catheter to disconnect the pathway causing the abnormal heart rhythm in the heart.

**Ambulatory monitors**—Small portable electrocardiograph machines that record the heart's rhythm. Ambulatory monitors include the Holter monitor, loop recorder, and transtelephonic transmitter. Each type of monitor has specific features related to the length of recording time and the ability to send the recordings over the phone.

**Antiarrhythmic**—Medication used to treat abnormal heart rhythms.

**Anticoagulant**—A medication, also called a “blood thinner,” that prevents blood from clotting. This type of medication is used for people at risk of stroke or blood clots.

**Arrhythmia**—An irregular heart rhythm.

**Atria (singular, atrium)**—The right and left upper chambers of the heart.

**Atrial fibrillation**—A condition in which the upper chamber of the heart quivers instead of pumping in an organized way.

**Atrial flutter**—A rapid pulsation of the upper chambers of the heart that interferes with normal heart function. Atrial flutter is usually more organized and regular than atrial fibrillation, although it often converts to atrial fibrillation. Atrial flutter occurs

most often in people with heart disease and in the first week after heart surgery.

**Cardiac catheterization**—An invasive procedure used to create x-ray images of the coronary arteries, heart chambers and valves. During the procedure, a catheter is inserted into an artery in the groin or arm and is guided to the heart. Contrast material (dye) is injected into the catheter to produce the x ray images.

**Echocardiogram**—An imaging procedure used to create a picture of the heart's movement, valves and chambers. The test uses high-frequency sound waves that come from a hand wand placed on the chest. Echocardiogram may be used in combination with Doppler ultrasound to evaluate the blood flow across the heart's valves.

**Electrocardiogram (ECG, EKG)**—A test that records the electrical activity of the heart using small electrode patches attached to the skin on the chest.

**Electrophysiology study (EPS)**—A test that evaluates the electrical activity within the heart. The test is used to help determine the cause of the abnormal heart rhythm and find the best treatment. During the test, the doctor may safely reproduce the abnormal heart rhythm and give the patient medications to determine which medication works best to control the abnormal heart rhythm.

**Head-upright tilt table test**—A test used to determine the cause of fainting spells. During the test, the patient is tilted at different angles on special table for a period time. During the test, the patient's heart rhythm, blood pressure and other measurements are evaluated with changes in position.

## Morbidity and mortality rates

Controlling a patient's heart rate is as important as controlling the patient's heart rhythm to prevent **death** and complications from cardiovascular causes. Anticoagulant therapy is important to reduce the risk of stroke and is appropriate therapy for patients who have recurring, persistent atrial fibrillation even after they were treated with cardioversion. In patients who did not receive anticoagulant therapy after cardioversion, there was a reported 2.4% increase of embolic events (such as stroke or blood clots), even though there were no signs of these events prior to the procedure.

## Alternatives

Atrial fibrillation and atrial flutter often revert to normal rhythms without the need for cardioversion. Healthcare providers usually try to correct the heart rhythm with medication or recommend lifestyle changes before recommending electrical cardioversion.

Lifestyle changes often recommended to treat abnormal heart rhythms include:

- quitting smoking
- avoiding activities that prompt the symptoms of abnormal heart rhythms
- limiting alcohol intake

**Implantable cardioverter-defibrillator (ICD)**—An electronic device that is surgically placed to constantly monitor the patient's heart rate and rhythm. If a very fast abnormal heart rate is detected, the device delivers electrical energy to the heart to beat in a normal rhythm again.

**Maze procedure**—A surgical procedure used to treat atrial fibrillation. During the procedure, precise incisions are made in the right and left atria to interrupt the conduction of abnormal impulses. When the heart heals, scar tissue forms and the abnormal electrical impulses are blocked from traveling through the heart.

**Nuclear imaging**—Method of producing images by detecting radiation from different parts of the body after a radioactive tracer material is administered.

**Pacemaker**—A small electronic device implanted under the skin. This device sends electrical impulses to the heart to maintain a suitable heart rate and prevent slow heart rates.

**Pharmacologic cardioversion**—The use of medications to restore normal heart rhythm. It is also called chemical cardioversion.

**Pulmonary vein isolation**—A surgical procedure used to treat atrial fibrillation. During the procedure, a radio frequency probe, microwave probe, or cryoprobe is inserted and, under direct vision, used to create lesion lines in the heart to interrupt the conduction of abnormal impulses.

**Stress test**—A test used to determine how the heart responds to stress. It usually involves walking on a treadmill or riding a stationary bike at increasing levels of difficulty, while the electrocardiogram, heart rate and blood pressure are monitored. If the

patient is unable to walk on a treadmill or ride a stationary bike, medications may be used to produce similar results.

**Synchronized electrical cardioversion**—The term used to describe cardioversion by the application of a controlled electric shock to the patient's chest.

**Transesophageal echocardiogram (TEE)**—An invasive imaging procedure used to create a picture of the heart's movement, valves, and chambers. The test uses high-frequency sound waves that come from a small transducer passed down the patient's throat. TEE may be used in combination with Doppler ultrasound to evaluate the blood flow across the heart's valves.

**Ventricles**—The lower, pumping chambers of the heart. The heart has two ventricles: the right and the left ventricle.

**Ventricular fibrillation**—An erratic, disorganized firing of impulses from the ventricles, the lower chambers of the heart. The ventricles quiver instead of pumping in an organized way, preventing blood from pumping through the body. Ventricular fibrillation is a medical emergency that must be treated with cardiopulmonary resuscitation (CPR) and defibrillation as soon as possible.

**Ventricular tachycardia**—A rapid heart beat, usually over 100 beats per minute. Ventricular tachycardia originates from the lower chambers of the heart (ventricles). The rapid rate prevents the heart from filling adequately with blood, so less blood is able to pump through the body. Ventricular tachycardia can be a serious type of arrhythmia and may be associated with more symptoms.

- limiting or not using caffeine (caffeine products may produce more symptoms in some people with abnormal heart rhythms)
- avoiding medications containing stimulants, such as some cough and cold remedies (these medications contain ingredients that may cause abnormal heart rhythms)

If cardioversion is not successful in restoring the normal heart rhythm, other treatments for abnormal heart rhythms are considered. These include an **implantable cardioverter-defibrillator (ICD)**. Since first approved by the Food and Drug Administration (FDA) in 1985, ICDs have been continually improved.

Current models are much smaller and easier to implant than the early ICDs, can be programmed to deliver low-energy or high-energy shocks, and have batteries that last as long as six years. Originally considered a treatment of last resort, ICDs are now considered first-line therapy for some abnormal heart rhythms. The chief drawback of ICDs is the anxiety some patients feel about the possibility of the device's firing (emitting a shock).

Other treatments for abnormal heart rhythms include permanent **pacemakers**, ablation therapy, and heart surgery, including the Maze procedure and the pulmonary vein isolation procedure.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Heart doctors (cardiologists) specially trained in cardioversion (called electrophysiologists) should perform this procedure. To find a heart rhythm specialist or an electrophysiologist, patients can contact the Heart Rhythm Society (formerly the North American Society of Pacing and Electrophysiology). Cardioversion usually takes place in the hospital setting in a special lab called the electrophysiology (EP) laboratory. It may also be performed in an intensive care unit, recovery room or other special procedure room.

### Resources

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- London, B. "Amiodarone and Atrial Fibrillation." *Journal of Cardiovascular Electrophysiology* 18 (December 2007): 1321-1322.

## QUESTIONS TO ASK THE DOCTOR

- Why is this procedure being performed?
- What are the potential benefits of the procedure?
- What are the risks of the procedure?
- Can I take my medications the day of the procedure?
- Can I eat or drink the day of the procedure? If not, how long before the procedure should I stop eating or drinking?
- When can I drive after the procedure?
- What should I wear the day of the procedure?
- Will I be awake during the procedure?
- What kinds of monitors are used during the procedure to evaluate my condition?
- Will I have to stay in the hospital after the procedure?
- When can I resume my normal activities?
- When will I find out the results?
- What if the procedure was not successful?
- If I have had the cardioversion procedure once, can I have it again to correct an abnormal heart rhythm, if necessary?
- Will I have any pain or discomfort after the procedure? If so, how can I relieve this pain or discomfort?
- Are there any medications, foods or activities I should avoid to prevent my symptoms from recurring?
- Is an ICD suitable for my condition?

Miller, Karl E. "Amiodarone for Cardioversion on Recent Onset Atrial Fibrillation." *American Family Physician* 68 (July 15, 2003): 355.

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- American College of Cardiology. Heart House, 2400 N Street, NW, Washington, DC 20037. (202) 375 6000. <http://www.acc.org> (accessed March 8, 2008).
- American Heart Association (AHA). 7272 Greenville Ave. Dallas, TX 75231. (800) 242 8721 or (214) 373 6300. <http://www.americanheart.org> (accessed March 8, 2008).
- Cleveland Clinic Heart and Vascular Institute, The Cleveland Clinic Foundation. 9500 Euclid Avenue, F25, Cleveland, Ohio, 44195. (216) 445 9288. <http://www.clevelandclinic.org/heartcenter> (accessed March 8, 2008).
- HeartCenterOnline. <http://www.heartcenteronline.com> (accessed March 8, 2008).

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Carotid artery stenting see **Endovascular stent surgery**

## Carotid endarterectomy

### Definition

Carotid endarterectomy (CEA) is a surgical procedure that is performed to remove deposits of fat, called plaque, from the carotid arteries in the neck. These two main arteries, one on each side of the neck, deliver blood and oxygen to the brain. Plaque builds up in large- and medium-sized arteries as people get older, more in some people than others depending on lifestyle and hereditary factors. This buildup is a vascular disease called atherosclerosis, or hardening of the arteries. When this happens in either one or both of the carotid arteries, they can become narrowed, a condition called stenosis. During a carotid endarterectomy, a surgeon removes the fatty deposits to correct the narrowing and to allow blood and oxygen to flow freely to the brain.

### Purpose

Carotid endarterectomy is a protective procedure intended to reduce the risk of stroke, a vascular condition also known as a cardiovascular accident (CVA). In studies conducted by the National Institute of Neurological Disorders and Stroke (NINDS), endarterectomy has proven to be especially protective for people who have already had a stroke, and for people who are

at high risk for stroke or who have already been diagnosed with significant stenosis (between 50% and 70% blockage).

### Demographics

The National Stroke Association reports that two-thirds of stroke victims are over age 65. Risk is shown to double with each 10 years over age 55. Men are more at risk than women, although most stroke survivors over age 65 are women, which may be partly because there are more women than men in this age group. African Americans have been shown to be at greater risk for stroke than other racial groups in the United States. Risk is also higher in people who have a family history of stroke, as well as people with diabetes because of the circulatory problems associated with diabetes. People with high blood pressure, called hypertension, have four to six times the risk of stroke.

Nearly 750,000 strokes occur in the United States each year, with about 160,000 deaths, making stroke the third leading cause of **death** behind heart disease and cancer. Stroke is also responsible for the high number of disabled adults in the United States; two million stroke survivors have some permanent disability. The annual cost to the country for treating stroke and disabilities caused by stroke is about \$40 billion.

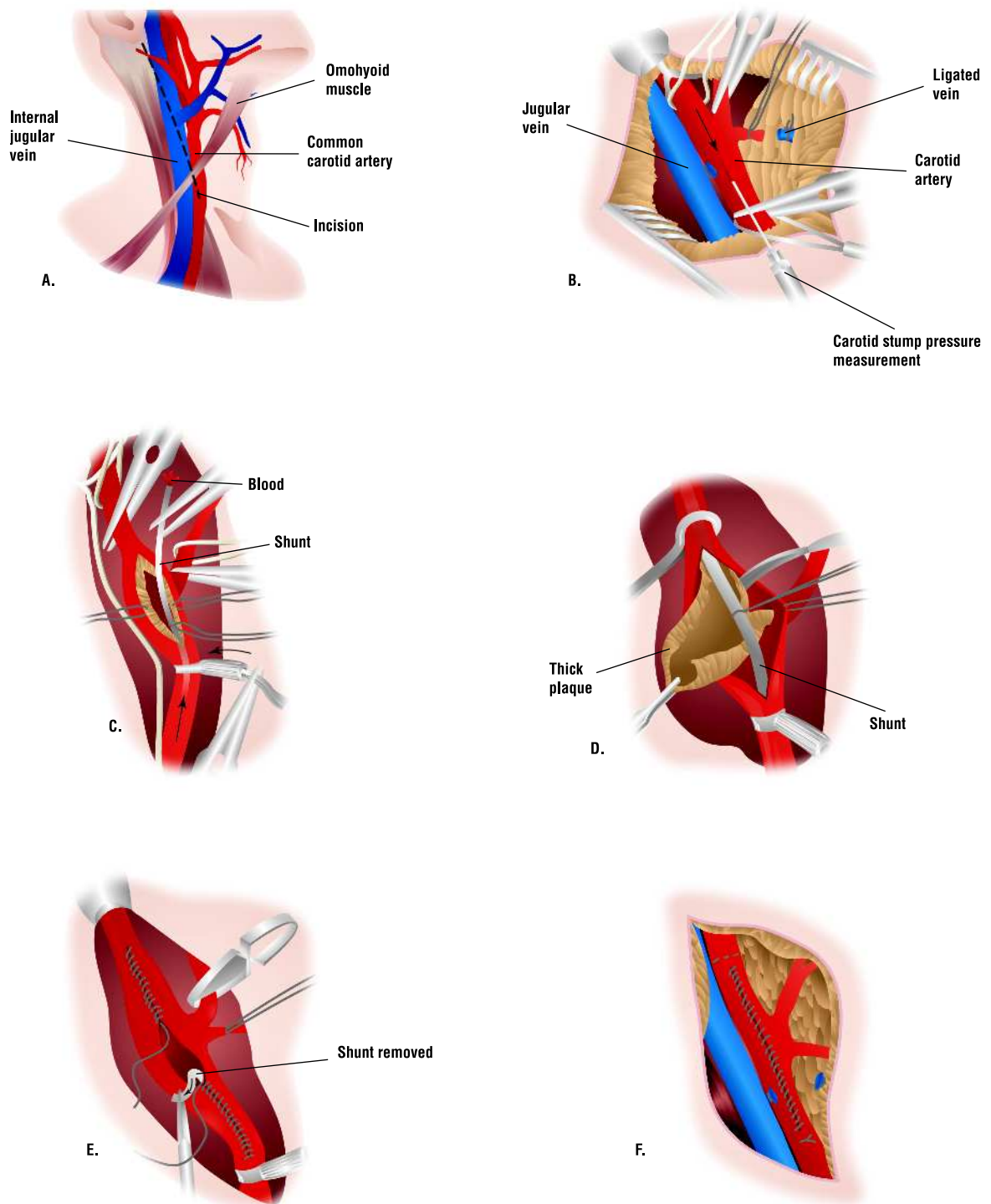
### Description

The presence of fatty deposits in the carotid arteries of the neck is the most significant risk factor for ischemic stroke, which represents 80% of all strokes. A stroke can be either ischemic, which is an interruption of blood flow in a narrowed carotid artery, or hemorrhagic, which involves bleeding in the brain. Carotid endarterectomy is performed as prevention of ischemic strokes.

Some people at high risk for ischemic stroke have disturbing symptoms that can occur periodically and last from minutes to up to 24 hours, and then disappear. These episodes are called transient ischemic attacks (TIA). The symptoms are the same as actual stroke symptoms. The symptoms of TIA and ischemic stroke may include:

- numbness, muscle weakness, or paralysis of the face, arm, or leg, usually on one side of the body, and usually occurring suddenly
- speech or vision difficulties
- sudden loss of understanding, confusion
- lightheadedness or fainting spells



**Carotid endarterectomy**

In a carotid endarterectomy, the carotid artery is accessed through an incision in the neck (A). A measure of the pressure inside the vessel is taken to assess the degree of blockage (B). The carotid is clamped above and below the incision, and a shunt is inserted to maintain blood flow (C). Plaque lining the artery is removed (D). The shunt is taken out (E), and the incision is repaired (F). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Atherosclerosis**—A disease characterized by the buildup of fatty deposits on the insides of artery walls, which results in thickening and hardening of the arteries and the narrowing of space for the passage of blood; also known as arteriosclerosis and hardening of the arteries, it can lead to high blood pressure, stroke, and heart attack.

**Neurosurgeon**—A surgeon who specializes in surgery of the nervous system, including the brain and nerves.

**Plaque**—A collection of wax-like fatty deposits on the insides of artery walls.

**Restenosis**—The repeated narrowing of blood vessels.

**Stenosis**—The narrowing of blood vessels in the body as a result of blockage.

**Vascular**—Pertaining to the veins, arteries, and organs in the body's circulatory system.

- loss of balance with difficulty walking and moving; poor coordination
- severe headache with no obvious cause, either sudden or persistent

About 35% of people who have TIAs will have a stroke within five years. The risk of stroke goes up with age and is greatest in people whose blood pressure is higher than normal. High blood pressure stresses the walls of blood vessels, particularly when the vessels are blocked with plaque and space for blood to pass is reduced.

Carotid endarterectomy has been performed since the 1950s as a stroke-prevention method. Because the surgery itself presents a high risk of complications, surgeons will look at the possible benefits and risks for each patient and compare them with medical treatment such as drug therapy to reduce plaque, cholesterol, and blood pressure. Carotid endarterectomy is typically performed on those who will benefit most from the surgery and who have the lowest risk for postoperative complications. Good candidates include:

- people who have already had one or more TIA episodes in a six-month period, with 70% narrowing of the carotid arteries supplying the part of the brain affected by the TIA.
- people who have had a mild stroke in the past six months but who are not significantly disabled and whose carotid arteries are at least 70% narrowed.

- people who have not had a stroke or TIA, but their carotid arteries are narrowed 60% or more and they have low risk of complication from having the surgery.

Carotid endarterectomy is not recommended for:

- people whose risk of complications from the surgery (such those with heart disease) is greater than the intended benefits.
- people who have had a TIA but their carotid arteries are less than 50% narrowed.
- people who have had a stroke or TIA because arteries other than the carotid arteries are blocked.
- people whose carotid arteries are blocked above a point on the neck where they can be reached easily during surgery.

The endarterectomy procedure takes about an hour to perform. **General anesthesia** is usually administered. A vascular surgeon or neurosurgeon will usually perform the surgery. During the procedure, a small incision is made in the neck below the jaw to expose the carotid artery. Blood that normally flows through the artery must be diverted in order to perform the surgery. This is accomplished by rerouting the blood through a tube (shunt) connecting the vessels below and above the surgical site. The carotid artery is opened and the waxy fat deposit is removed, sometimes in one piece. If the carotid artery is observed to be too narrow or too damaged to perform the critical job of delivering blood to the brain, a graft using a vein from the patient's leg may be created and stitched (grafted) onto the artery to enlarge or repair it. The shunt is then removed, and incisions in the blood vessels, the carotid artery, and the skin are closed.

## Diagnosis/Preparation

### Diagnosis

The presence and degree of stenosis in the carotid artery must be determined before a doctor decides that carotid endarterectomy is necessary. Carotid stenosis can sometimes be detected in a routine checkup, especially when a detailed history reveals that the patient has experienced symptoms of TIA or stroke. The doctor will use a **stethoscope** to listen to blood flow in the carotid artery and may hear an abnormal rushing sound called a "bruit" that will indicate narrowing in the artery. The absence of sound, however, does not mean there is no risk. More extensive testing will most likely have to be done to determine the degree of stenosis and the potential of risk for the patient. These tests may include:

- Ultrasound imaging with Doppler. A painless, non-invasive imaging test that measures sound waves directed into the body and returned to the ultrasound machine as echoes. Usually these echoes are visualized as an image on a screen; Doppler captures the sound as the echoes bounce off of moving blood in the carotid artery, giving some indication of the amount of blockage as the ultrasound probe moves up and down the arteries on each side of the neck.
- Computed tomography (CT) or computer-assisted tomography (CAT) scan. A series of cross-sectional x rays of the head and brain that can rule out other causes for the symptoms but cannot detect carotid artery stenosis.
- Oculoplethysmography (OPG). A procedure that measures the pulsing of arteries behind the eye, which can show carotid artery blockage.
- Arteriography and digital subtraction angiography (DSA). Special x-ray procedures using dye in the patient's vascular system. These tests are invasive and can actually cause a stroke, but they do indicate more exactly what degree of stenosis is present. The doctor will have to weigh the extent of risk and how much the patient will benefit from the tests.
- Magnetic resonance angiography (MRA). An imaging test that does not use dyes or x rays and relies on special computer software and powerful magnetic fields to create a highly detailed image of the inside of the brain's arteries.

### Preparation

If carotid ultrasonography or arteriography procedures were not performed earlier to diagnose carotid stenosis, these tests will be performed before surgery to evaluate the amount of plaque and the extent and location of narrowing in the patient's carotid arteries. Other blood vessels in the body are also evaluated. If other arteries show significant signs of atherosclerosis or damage, the patient's risk for surgery may be too great, and the procedure will not be performed. **Aspirin** therapy or other clot-prevention medication may be prescribed before surgery. Any underlying medical condition such as high blood pressure or heart disease will be treated prior to carotid endarterectomy to help achieve the best result from the surgery. Upon **admission to the hospital**, routine blood and urine tests will be performed.

### Aftercare

A person who has had carotid endarterectomy will be monitored in a hospital **recovery room** immediately after the surgery and will then go to an **intensive care**

**unit** at least overnight to be observed for any sign of complications. The total hospital stay may be two to three days. When the patient returns home, activities can be resumed gradually, as long as they are not strenuous. During recuperation, the patient's neck may ache slightly. The doctor may recommend against turning the head often or too quickly during recovery. The most important thing people can do after endarterectomy is to follow their doctor's guidelines for stroke prevention, which will reduce the progression of atherosclerosis and avoid repeat narrowing of the carotid artery. Repeat stenosis (restenosis) has been shown to occur frequently in people who do not make the necessary changes in lifestyle such as in diet, **exercise**, and quitting smoking, or excessive use of alcohol. The benefits of the surgery may only be temporary if underlying disease such as atherosclerosis, high blood pressure, or diabetes is not also treated.

### Risks

Serious risks are associated with carotid endarterectomy. They involve complications that can arise during or following the surgery, as well as underlying conditions that led to blockage of the patient's arteries in the first place. Stroke is the most serious postoperative risk. If it occurs within 12–24 hours after surgery, the cause is usually an embolism, which is a clot or tissue from the endarterectomy site. Other major complications that can occur are:

- heart attack or other heart problems
- death
- breathing difficulties
- high blood pressure
- nerve injury, which can cause problems with vocal cords, saliva management, and tongue movement
- bleeding within the brain
- restenosis, the continuing buildup of plaque, which can occur from five months to 13 years after surgery

The risks of carotid endarterectomy surgery depend upon age, overall health, and the skill and experience levels of the surgeons treating the patient. The likelihood of complications is lower when the surgeon performing the procedure has acknowledged skills and experience. According to the Stroke Council of the American Heart Association, surgery is best performed by a surgeon who has only had complications occur in less than 3% of patients. Hospitals, too, should be able to show that fewer than 3% of their patients undergoing endarterectomy have had complications. These recommendations are based not only on skill levels, but also on the ability to accurately weigh the stroke risks for each patient against the

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Carotid endarterectomy is performed in a hospital or medical center operating room by a vascular surgeon or neurosurgeon.

potential risk of complication because of age, hereditary factors, and the presence of underlying conditions or diseases.

### Normal results

The desired outcome of carotid endarterectomy is improved blood flow to the brain and a reduced risk of stroke. The National Stroke Association has reported that successful carotid endarterectomy surgery reduces risk of stroke by as much as 80% in people who have had either transient ischemic attacks or symptoms of stroke, or who have been diagnosed with 70% or more arterial blockage. Studies show that for people who have no symptoms but have been found to have stenosis from 60–99%, endarterectomy surgery also reduces the risk of stroke by more than 50%. These groups of people at higher risk for stroke will benefit most from having carotid endarterectomy. The benefit for people who have lesser degrees of blockage is shown to be much lower than that of high-risk stroke candidates. Surgery is not indicated for people with artery narrowing less than 50%.

### Morbidity and mortality rates

Death and disabling stroke occur more often in symptomatic and asymptomatic patients at high risk for stroke who have not been treated with carotid endarterectomy surgery. A well-respected study, the North American Symptomatic Carotid Endarterectomy Trial (NASCET), along with a corresponding European study (ECST), showed that death or disabling stroke are reduced by 48% among those with severe stenosis (greater than 70%) when they undergo carotid endarterectomy surgery. In patients with less severe stenosis (50–69%), endarterectomy was shown to reduce risk by 27%. Patients with less than 50% stenosis were actually harmed by surgery, increasing the risk of death or disability by 20%. The conclusion of the study was that death and disability could be reduced overall if carotid endarterectomy was performed only on patients with the more severe stenosis

## QUESTIONS TO ASK THE DOCTOR

- Why do I need this surgery?
- How will the surgery improve my condition?
- What kind of anesthesia will I be given?
- What are the risks of having this surgery?
- Is there anything I can do to get in shape for the surgery and to improve my chances of successful surgery?
- How many of these procedures have you performed? How many of the surgery patients had complications after surgery?
- How can I expect to feel after surgery? How long will it take me to recover?
- What are my chances of developing this problem again after the surgery?
- If the surgery is not successful, what will my options be?

who are also surgically fit, and that the procedure should be performed only by surgeons whose complication rates are less than 6%.

### Alternatives

The carotid endarterectomy removes plaque directly from blocked arteries and there is no alternative way to mechanically remove plaque. However, there are alternative ways to prevent the buildup of plaque and thus help to prevent stroke or heart attack. Certain vitamin deficiencies in older people are known to promote high levels of homocysteine, an amino acid that contributes to atherosclerosis, putting people at greater risk for stroke or heart attack. Certain nutritional supplements have been shown to reduce homocysteine levels.

Nutritional supplements and alternative therapies that are sometimes recommended to help reduce risks and promote good vascular health include:

- Folic acid helps lower homocysteine levels and increases the oxygen-carrying capacity of red blood cells.
- Vitamins B<sub>6</sub> and B<sub>12</sub> help lower homocysteine levels; B<sub>6</sub> is also a mild diuretic and helps to balance fluids in the body.
- Antioxidant vitamins C and E work together to promote healthy blood vessels and improve circulation.



- Angelica, an herb that contains Coumadin, a recognized anticoagulant, may help to prevent clot formation in the blood (blood thinner).
- Essential fatty acids help reduce blood pressure and cholesterol, and maintain elasticity of blood vessels.
- Chelation therapy can be used to break up plaque and improve circulation.

## Resources

### BOOKS

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### ORGANIZATIONS

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## Purpose

Carpal tunnel syndrome is a relatively common problem affecting the wrist and hand. Individuals afflicted with carpal tunnel syndrome complain of numbness, tingling, and pain in the hand, with pain radiating up into the arm, shoulder, and even the neck. Some patients may experience an aching or burning sensation in the affected hand. The fingers may feel swollen, although they are no larger in size. If the condition is left unattended, symptoms may begin to awaken the individuals during sleep. If left unattended medically, muscle weakness can develop, leading to an inability to grasp objects or engage in any action requiring the opposition of the thumb and the other fingers in the affected hand. It is known as a repetitive stress injury, as it most commonly occurs in individuals who engage in motions that require the hands to repeat the same movements over and over again, especially with strong, forceful hand movements or ones that involve vibrating tools. Many individuals develop carpal tunnel syndrome in both hands. For some, the condition is worse in the dominant hand.

## Demographics

Individuals who perform repetitive wrist movements, either at work or play, are at risk of developing carpal tunnel syndrome. Repetitive movements include computer work, typing, computer games; sports such as tennis; scanning items at the supermarket checkout; playing musical instruments for extended periods of time on a daily basis; assembly-line work, especially that requiring heavy gripping or the use of vibrating machinery; and the use of power tools such as for lawn care. It is more common in women, perhaps as much as three to seven times more than in men, especially during pregnancy, and also in individuals who are obese, or have diabetes or rheumatoid arthritis. It is also more common with advancing age. Carpal tunnel release is one of the most common hand surgeries performed in the United States.

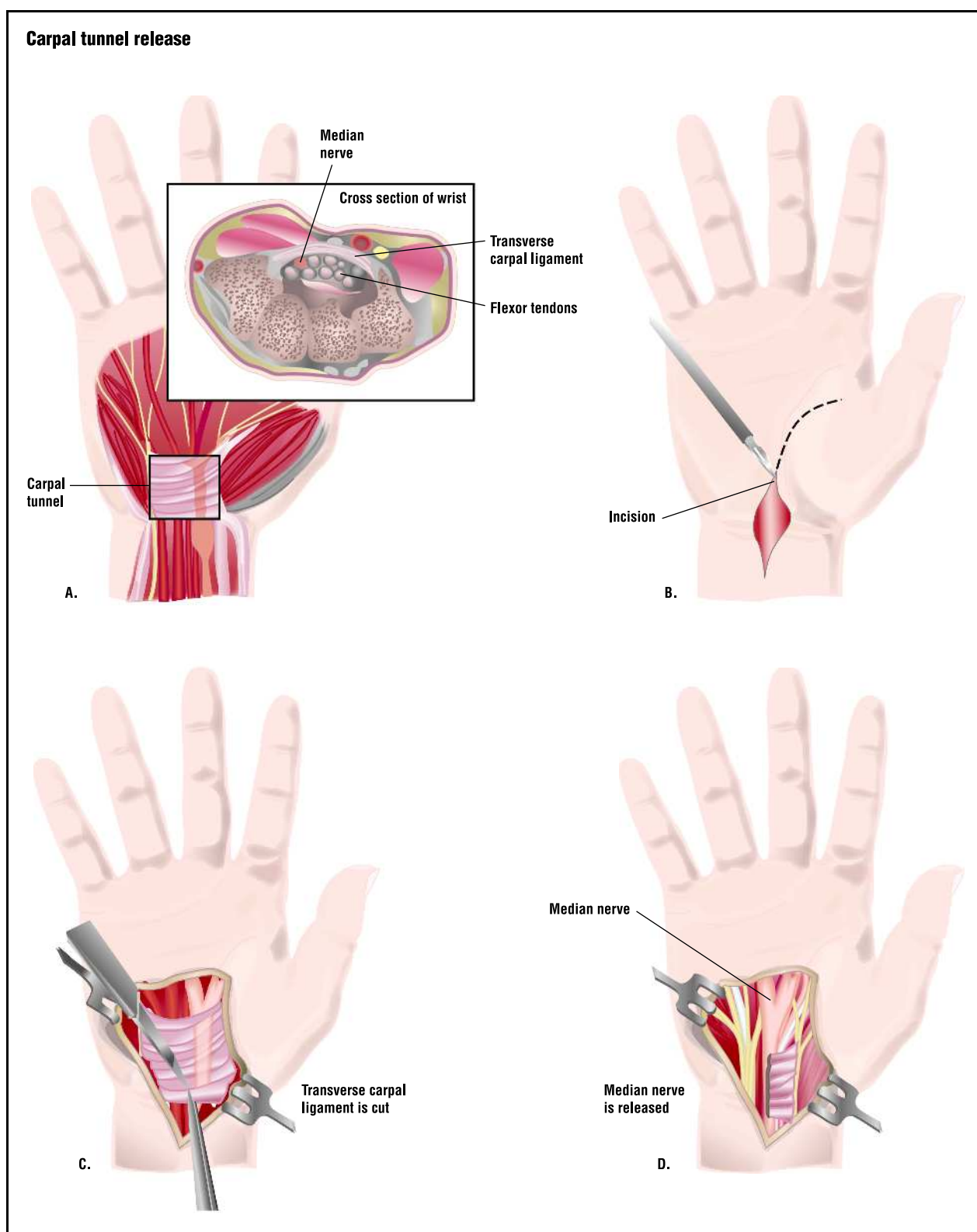
## Description

The carpal tunnel is a channel inside the hand, on the palm side, that surrounds and protects the main nerve and the tendons that help bend the fingers. This nerve is called the median nerve. The symptoms start gradually and continue to increase if the problem is not addressed. Numbness and tingling in the fingers are usually the first signs of the condition. It may come on while driving, sleeping, holding a telephone, or reading a book. It may also occur after a long bicycle ride, which involves gripping the handlebars. The pain

## Carpal tunnel release

### Definition

A carpal tunnel release is a surgical procedure performed to relieve pressure on the nerve located inside the carpal tunnel, an area in the wrist that supplies nerve function to the fingers. The condition for which the release is performed is called carpal tunnel syndrome.



To perform a carpal tunnel release, the surgeon makes an incision in the palm of the hand, above the area of the carpal tunnel (B). The carpal ligament going across the hand is severed (C), releasing pressure on the median nerve (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Dominant hand**—The hand that the individual prefers to use for most activities, especially writing.

**Edema**—The abnormal accumulation of fluid in the body tissues.

**Endoscopic**—Surgery done making a few small incisions and inserting specialized instruments, one of which is a camera, that function as extended hands of the surgeon.

**Innervate**—To carry nerve impulses to a particular body part.

**Neurosurgeon**—A surgeon who specializes in dealing with nerve-related conditions.

or tingling might begin to travel up the arm to the shoulder. The individual may appear clumsy, drop objects, or have difficulty holding on to a glass. There may be a decrease in the ability to feel sensations in the hand. Once the problem interferes with daily activity, including sleep, or persists for longer than two weeks, it is important to seek medical advice. This is because the symptoms, even if they are not terribly disabling, can become permanent, as the damage to the tissues themselves becomes permanent.

Because of the nerve innervation routes, the one finger that is not involved in carpal tunnel syndrome is the pinkie.

Conditions associated with carpal tunnel syndrome, or that appear to put the individual at higher risk for developing the condition, include:

- obesity
- pregnancy
- certain thyroid conditions
- arthritis, especially rheumatoid
- diabetes
- menopause
- taking oral contraceptives
- conditions involving hormonal changes
- gout
- cigarette smoking

Conditions such as carpal tunnel syndrome are sometimes referred to as cumulative trauma disorders. In these disorders, the injury is not related to one major incident that causes damage, such as a fall that results in a fractured limb, but is the buildup of small micro-traumas, in which the affected area is repeatedly

damaged. Each small injury causes the area to become irritated or inflamed, and there is not enough time in between injuries for complete healing to occur. Treatment focuses on relieving the compression of the nerve and decreasing or eliminating the irritation and inflammation of the area. A term often associated with micro-traumas or repetitive stress injuries is ergonomics, which means the way in which the body is set up to perform a certain function. If the function is typing, an ergonomic assessment would include looking at the height of the desk, the height of the chair in which one is sitting to work at the desk, the height of the hands in relation to the work area, such as the keyboard, and the angle of the wrist, elbow, hips, and knees. An ergonomically designed work station would have all components at the right height and angle for work so that there is no strain put on any joint as it performs its necessary function, and therefore no injury can take place. For those who use vibrating tools at work, special gloves exist that are padded and designed to decrease the effect of the vibration.

## Diagnosis/Preparation

The diagnosis of carpal tunnel syndrome most commonly occurs because the individual seeks medical advice for numbness and tingling in the hand, especially while holding a telephone, newspaper, or holding onto the steering wheel in a car, or has experienced dropping objects. A thorough medical and medication history and a **physical examination**, especially for checking the nerve pathway functioning in the arms and hands, are essential components of a full diagnostic workup for carpal tunnel syndrome. It is important to be able to rule out other medical conditions such as a pinched nerve in the neck, which may present with similar symptoms. A complete account of symptoms, including which fingers are involved, is important because the median nerve, the nerve involved in carpal tunnel syndrome, does not innervate the little finger. The timing of the symptoms is also important because it indicates what activities set off the symptoms, such as while reading a book or having the hands placed on the steering wheel. Symptoms often occur at night because the hand gets set in a certain position for extended periods of time. Many people find that their hand is numb when they wake up in the morning, or that they wake up during the night with pain in the affected hand. To get relief, the individual may hang the hand off the bed, rub the hand, or shake it until the tingling goes away. Since, for many sufferers, the symptoms are worse at night than during the day, it may take time to associate the symptoms with the problem causing them. For some people, the symptoms come on, especially at first, only

at work, because that is where the hand has to exert more than usual force in an awkward position. For others, the symptoms may come on when engaging in a hobby such as painting, gardening, knitting, wood-working, lifting weights, or playing a musical instrument. What begins as periodic symptoms may progress to constant symptoms, and mundane tasks such as unscrewing a bottle top or turning a key in a lock become extremely painful, or even impossible to perform. The doctor will want to try to elicit the symptoms by placing the hands in the same position as when the symptoms come on naturally.

Carpal tunnel syndrome is sometimes referred to as entrapment neuropathy, which means that a nerve, in this case the median nerve, is entrapped or compressed. In carpal tunnel syndrome, the median nerve is compressed, usually by swelling and inflammation, as it passes from the forearm into the hand through the carpal tunnel. The compression puts pressure on the nerve, which is what elicits the tingling and numbness felt by the patient. Compression can arise from a condition that causes the carpal tunnel to become smaller or narrower, or by something such as fluid retention, which would increase the volume inside the tunnel. In addition to trying to assess what nerve is involved in the problem, the doctor will want to see if strength in the hand has been affected. As part of the neurological exam, the doctor may tap at the base of the crease of the wrist. If this tapping brings on tingling in all the fingers except the pinkie, it is said that the Tinel's sign was positive. A positive Phalen test occurs when the two hands are placed back-to-back and held in that position for 60 seconds, bringing on symptoms. By extending the hands out of that position, symptoms are relieved. If these tests are positive, the doctor may want to order nerve conduction studies, although it is possible for conduction tests to be normal when the individual suffers from carpal tunnel syndrome.

## Treatment

Once diagnosed, the first line of treatment for carpal tunnel syndrome is usually conservative in nature. This means that surgery is reserved as a last resort. Initial treatment may include taking frequent rest breaks from aggravating activity (if the activity cannot be completely avoided), anti-inflammatory medication, physical therapy, and using a splint or brace to keep the wrist in a neutral position; the splint is usually worn at night. Activities that bring on the symptoms are eliminated, avoided, or altered in some way to change the stress on the nerve. Tests to rule out conditions such as hypothyroidism may be conducted. If the problem is work related, an assessment of the

work environment from an ergonomic standpoint will be important. Work positions and tools used may need to be modified or changed completely.

If symptoms persist after conservative treatment, the injection of a corticosteroid medication may be the next line of treatment suggested. This is an anti-inflammatory medication, but because it is injected directly into the area affected, it has a greater impact than medication that is taken orally. If injections are being considered, it is important that the doctor have considerable skill and experience in administering these injections, with a thorough understanding of the anatomy of the wrist and hand. After the injection, a restriction on any wrist movement will be imposed for several days, usually followed by the wearing of a wrist splint for about one month. Finally, hand and wrist exercises to stretch the tendons as well as increase hand strength may be recommended. While the injection tends to give good short-term results, long-term results are less promising. When symptoms are not relieved by these more conservative measures, then surgery may be the next step. It is estimated that about one third of patients will not respond to conservative treatment and will require surgery.

Surgery may be performed in the more traditional fashion, or endoscopically. In traditional surgical treatment, an incision is made in the palm of the hand to openly expose the underlying structures. In endoscopic surgery, a smaller incision is made in the palm or wrist into which endoscopic instruments are inserted. In both techniques, entry into the carpal tunnel is made and the tissue called the transverse carpal ligament is cut, which stops the compression on the median nerve from continuing. Extreme caution is taken to avoid cutting additional anatomical structures or damaging the surrounding nerves.

## Aftercare

Initial **postoperative care** while the individual is still in the surgical center involves making sure that circulation in the hands and fingers has not been compromised. There should be a strong radial (wrist) pulse, and the fingers should be their normal skin color and warm to the touch. The individual should be able to move all fingers equally, and there should be no edema.

Once discharged, it will be important for the patient to be aware of signs of complications, including:

- fever
- pale or bluish color to the operated hand
- if the operated hand feels significantly colder than the non-operated hand



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The carpal tunnel release surgery is done by an orthopedic, plastic, or neurosurgeon. Patients considering carpal tunnel release should find a surgeon who performs this and other hand surgeries on a regular basis. The surgery is done on an outpatient or ambulatory basis.

- inability or difficulty moving the fingers in the operated hand
- numbness in the operated hand
- bleeding from the bandaged hand
- swelling of the operated arm

A splint may be worn for about a month to help keep the wrist in a neutral position. This may be followed by exercises to both stretch and strengthen the hand, fingers, and wrist. Any accommodations in the work or home environment will need to be made to prevent further problems.

### Risks

All surgical procedures involve some risk of infection through the operated site. Sharing all pertinent past and present medical history with the **surgical team** helps to lower the chance of a complication. In addition to the risk of the surgery itself, there are the risks associated with anesthesia. In carpal tunnel release surgery, anesthesia is more localized, which lowers the chance of complications. Nonetheless, it is important to share with the anesthesia team the list of all the vitamins, herbs, and supplements, over-the-counter medications, and prescription medications that the patient is taking. Drug interactions can be significant, especially if the anesthesia team does not have all the necessary information to make the best anesthesia choices for a particular patient. Complications such as nerve damage are linked with poor surgical technique.

### Normal results

Whether or not a full recovery is achieved depends on several factors. The most important factor is if there has been permanent damage to the nerve or tissue fibers. If muscle atrophy occurred because the condition went untreated for a significant period of time, full recovery is unlikely. If no permanent damage resulted,

## QUESTIONS TO ASK THE DOCTOR

- Can I expect a full recovery?
- Will I be able to return to my regular work?
- Can both wrists be done at the same time?
- Is this a work-related condition?
- How soon will I be able to drive?
- When can I return to playing sports?
- How many of these surgeries have you performed?
- What complications have you seen in the surgeries you performed?
- What other complications might I encounter?

then full recovery would be expected. Recovery is expected to take about six to eight weeks. Occupational rehabilitation may take an additional month. Those for whom the condition was work related will need to address the causative factors before returning to work.

### Morbidity and mortality rates

The research literature does not indicate a significant mortality risk with carpal tunnel release. Morbidity complications are small, and it is a safe enough procedure to be done during pregnancy. Nerve block anesthesia decreases morbidity and offers pain relief from the wrist to the fingertips. According to a study, recurrent scar formation was the most common complication. Individuals considering surgery should investigate the complication rates with the surgeon, as well as the surgeon's and the facility's record.

### Alternatives

Conservative treatment is the main alternative to surgery. A "wait and see" method is not a realistic form of treatment, as symptoms worsen over time, and the risk of permanent damage exists. Some acupuncturists treat carpal tunnel syndrome with success, though research studies have not been done in this area. A 2002 British study looked at the use of the homeopathic medicine, Arnica, for postoperative pain following carpal tunnel release. In the 37 patients tested, researchers found a significant decrease in pain reported by those taking the Arnica. A July 1998 study reported that about 70% of patients who undertook a specific **exercise** program for their carpal tunnel condition reported good results and were able to avoid surgery.

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Castration see **Orchiectomy**

CAT scan see **CT scans**

Cataract cryotherapy see **Cryotherapy for cataracts**

Catheterization, cardiac see **Cardiac catheterization**

## Catheterization, female

### Definition

Urinary catheterization is the insertion of a catheter through the urethra into the urinary bladder for withdrawal of urine. Straight catheters are used for intermittent withdrawals, while indwelling (Foley) catheters are inserted and retained in the bladder for continuous drainage of urine into a closed system.

### Purpose

Intermittent catheterization is used for the following reasons:

- Obtaining a sterile urine specimen for diagnostic evaluation.

- Emptying bladder contents when an individual is unable to void (urinate) due to urinary retention, bladder distention, or obstruction.
- Measuring residual urine after urinating.
- Instilling medication for a localized therapeutic effect in the bladder.
- Instilling contrast material (dye) into the bladder for cystourethralgraphy (x-ray study of the bladder and urethra).
- Emptying the bladder for increased space in the pelvic cavity to protect the bladder during labor and delivery or during pelvic and abdominal surgery.
- Monitoring accurately the urinary output and fluid balance of critically ill patients.

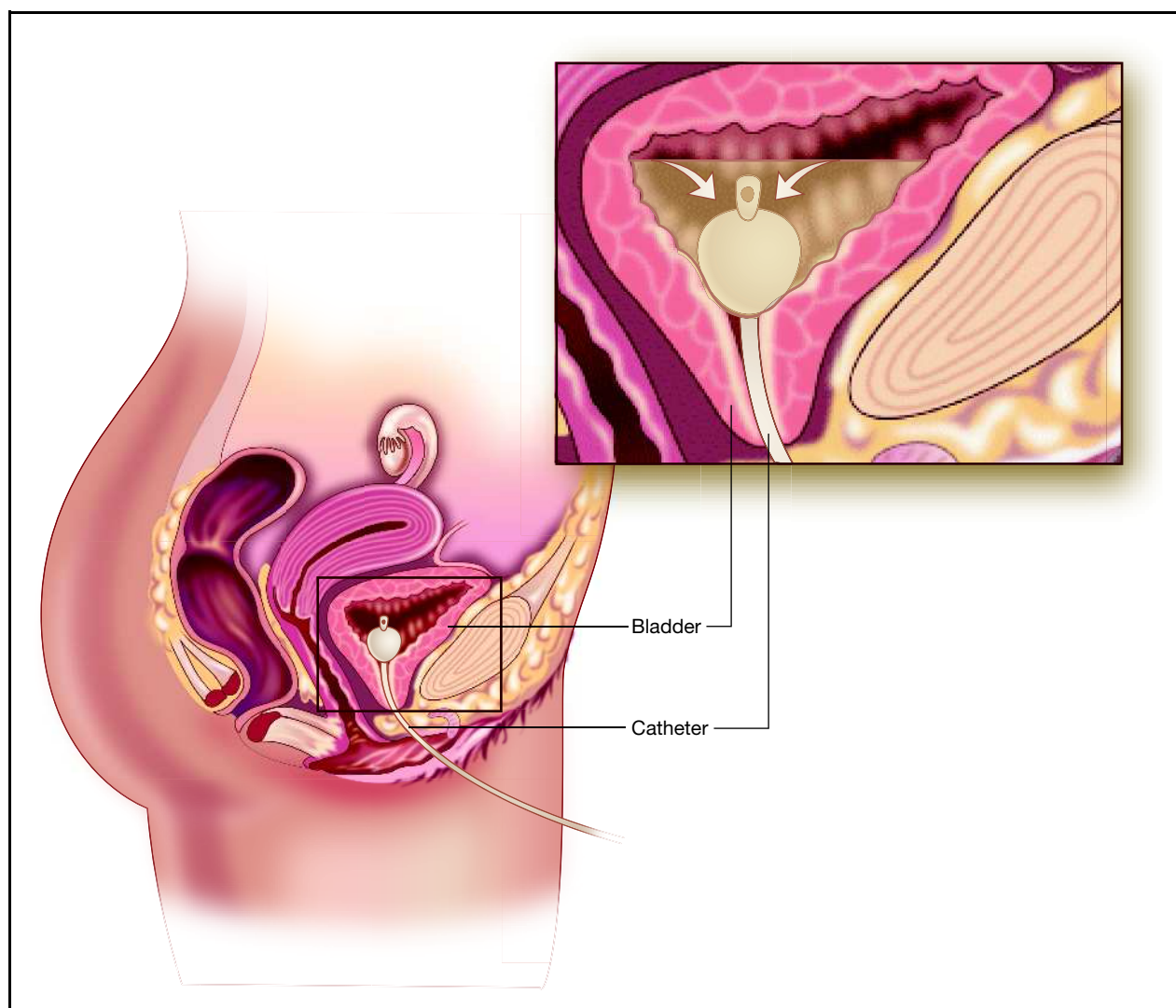
Indwelling catheterization is used for the following reasons:

- Providing palliative care for incontinent persons who are terminally ill or severely impaired, and for whom bed and clothing changes are uncomfortable.
- Managing skin ulceration caused or exacerbated by incontinence.
- Maintaining a continuous outflow of urine for persons undergoing surgical procedures that cause a delay in bladder sensation, or for individuals with chronic neurological disorders that cause paralysis or loss of sensation in the perineal area.
- Keeping with standard preoperative preparation for urologic surgery and procedures for bladder outlet obstruction.
- Providing relief for persons with an initial episode of acute urinary retention, allowing the bladder to regain its normal muscle tone.

### Description

The female urethral orifice is a vertical, slit-like, or irregularly ovoid (egg-shaped) opening, 0.16–0.2 in (4–5 mm) in diameter, located between the clitoris and the vagina. The urinary meatus (opening) is concealed between the labia minora, which are the small folds of tissue that need to be separated to view the opening and insert a catheter. With proper positioning, good lighting, and gloved hands, these anatomical landmarks can be identified. Perineal care or cleansing may be required to ensure a clean procedural environment.

Catheterization of the female patient is traditionally performed without the use of local anesthetic gel to facilitate catheter insertion. But since there are no lubricating glands in the female urethra (as are found in the male urethra), the risk of trauma from a simple catheter insertion is increased. Therefore, an ample



(Illustration by Electronic Illustrators Group.)

supply of an anesthetic or antibacterial lubricant should be used.

Once the catheter is inserted, it is secured as appropriate for the catheter type. A straight catheter is typically secured with adhesive tape. An indwelling catheter is secured by inflating a bulb-like device inside of the bladder.

### Diagnosis/Preparation

Healthcare practitioners performing the catheterization should have a good understanding of the anatomy and physiology of the urinary system, be trained in antiseptic techniques, and have proficiency in catheter insertion and catheter care.

After determining the primary purpose for the catheterization, practitioners should give the woman

to be catheterized and her caregiver a detailed explanation. Women requiring self-catheterization should be instructed and trained in the technique by a qualified health professional.

Sterile disposable catheterization sets are available in clinical settings and for home use. These sets contain most of the items needed for the procedure, such as antiseptic agent, perineal drapes, gloves, lubricant, specimen container, label, and tape. Anesthetic or antibacterial lubricant, catheter, and a drainage system may need to be added.

### Catheter choices

**TYPES.** Silastic catheters have been recommended for short-term catheterization after surgery because they are known to decrease incidence of urethritis

## KEY TERMS

**Catheter**—A tube for evacuating or injecting fluid.

**Contaminate**—To make an item unsterile or unclean by direct contact.

**Foley catheter**—A double-channel retention catheter; one channel provides for the inflow and outflow of bladder fluid, the second (smaller) channel is used to fill a balloon that holds the catheter in the bladder.

**Incontinence**—The inability to retain urine or control one's urine flow.

**Intermittent catheterization**—Periodic catheterization to facilitate urine flow.

**Perineal area**—The genital area between the vulva and anus in a woman.

**Urethra**—The tube that allows passage of urine out of the urinary bladder.

**Urethritis**—Inflammation of the urinary bladder.

**Urinary retention**—The inability to void (urinate) or discharge urine.

**Septicemia**—An infection in the blood.

(inflammation of the urethra). However, due to lower cost and acceptable outcomes, latex is the catheter of choice for long-term catheterization. Silastic catheters should be reserved for individuals who are allergic to latex products.

Additional types of catheters include:

- PTFE (plastic)-coated latex indwelling (Foley) catheters
- hydrogel-coated latex indwelling catheters
- pure silicone indwelling catheters
- silicone-coated latex indwelling catheters

**SIZE.** The diameter of a catheter is measured in millimeters. Authorities recommend using the narrowest and softest tube that will serve the purpose. Rarely is a catheter larger than size 18 F(rench) required, and sizes 14 or 16 F are used more often. Catheters greater than size 16 F have been associated with patient discomfort and urine bypassing. A size 12 catheter has been successfully used in children and in female patients with urinary restriction.

**DRAINAGE SYSTEM.** The healthcare provider should discuss the design, capacity, and emptying mechanism of several urine drainage bags with the patient. For women with normal bladder sensation, a

catheter valve for intermittent drainage may be an acceptable option.

**PROCEDURE.** When inserting a urinary catheter, the healthcare provider will first wash the hands and put on gloves and clean the skin of the area around the urethra. An anesthetic lubricating gel may be used. The catheter is threaded up the urethra and into the bladder until the urine starts to flow. The catheter is taped to the upper thigh and attached to a drainage system.

## Aftercare

Women using intermittent catheterization to manage incontinence may require a period of adjustment as they try to establish a catheterization schedule that is adequate for their normal fluid intake.

**Antibiotics** should not be prescribed as a preventative measure for women at risk for urinary tract infection (UTI). Prophylactic use of antibacterial agents may lead to the development of drug-resistant bacteria. Women who practice intermittent self-catheterization can reduce their risk for UTI by using antiseptic techniques for insertion and catheter care.

The extended portion of the catheter should be washed with a mild soap and warm water to keep it free of accumulated debris.

## Risks

Complications that may occur include:

- Trauma or introduction of bacteria into the urinary system, leading to infection and, rarely, septicemia.
- Trauma to the urethra or bladder from incorrect insertion or attempting to remove the catheter with the balloon inflated; repeated trauma may cause scarring or stricture (narrowing) of the urethra.
- Passage of urine around the catheter; inserting a different catheter size can minimize this problem.

Sexual activity and menopause can also compromise the sterility of the urinary tract. Irritation of the urethra during intercourse promotes the migration of perineal bacteria into the urethra and bladder, causing UTIs. Postmenopausal women may experience more UTIs than younger women. The presence of residual urine in the bladder due to incomplete voiding provides an ideal environment for bacterial growth.

Urinary catheterization should be avoided whenever possible. Clean intermittent catheterization, when practical, is preferable to long-term catheterization.

Catheters should not be routinely changed. Before the catheter is changed, each woman should be monitored for indication of obstruction, infection, or



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Urinary catheterization can be performed by health-care practitioners, by home caregivers, or by women themselves in hospitals, long-term care facilities, or personal homes.

complications. Some women require weekly catheter changes, while others may need one change in several weeks. Fewer catheter changes will reduce trauma to the urethra and reduce the incidence of UTI.

Because the urinary tract is normally a sterile system, catheterization presents the risk of causing a UTI. The catheterization procedure must be sterile, and the catheter must be free from bacteria.

Frequent intermittent catheterization and long-term use of indwelling catheterization predisposes a woman to UTI. Care should be taken to avoid trauma to the urinary meatus or urothelium (urinary lining) with catheters that are too large or inserted with insufficient use of lubricant. Women with an indwelling catheter must be reassessed periodically to determine if alternative treatment will be more effective in treating the problem.

### Normal results

A catheterization program that includes correctly inserted catheters and is appropriately maintained will usually control urinary incontinence.

The woman and her caregiver should be taught to use **aseptic technique** for catheter care. Nursing interventions and patient education can make a difference in the incidence of urinary tract infections in hospitals, **nursing homes**, and **home care** settings.

The sexuality of a woman with an indwelling catheter for continuous urinary drainage is seldom considered. If the patient is sexually active, the practitioner must explain that intercourse can take place with the catheter in place. The woman and her partner can be taught to remove the catheter before intercourse and replace it with a new one afterwards.

### Morbidity and mortality rates

Injuries resulting from catheterization are infrequent. Deaths are extremely rare. Both complications are usually due to infections that result from improper catheter care.

## QUESTIONS TO ASK THE DOCTOR

- Will the catheterization be intermittent or indwelling?
- Who will change the catheter and how long will it remain in place?
- Who will teach me or my caregiver how to insert and remove the catheter, monitor it, and perform routine care?

### Alternatives

An alternative to catheterization is to use a pad to absorb voided urine.

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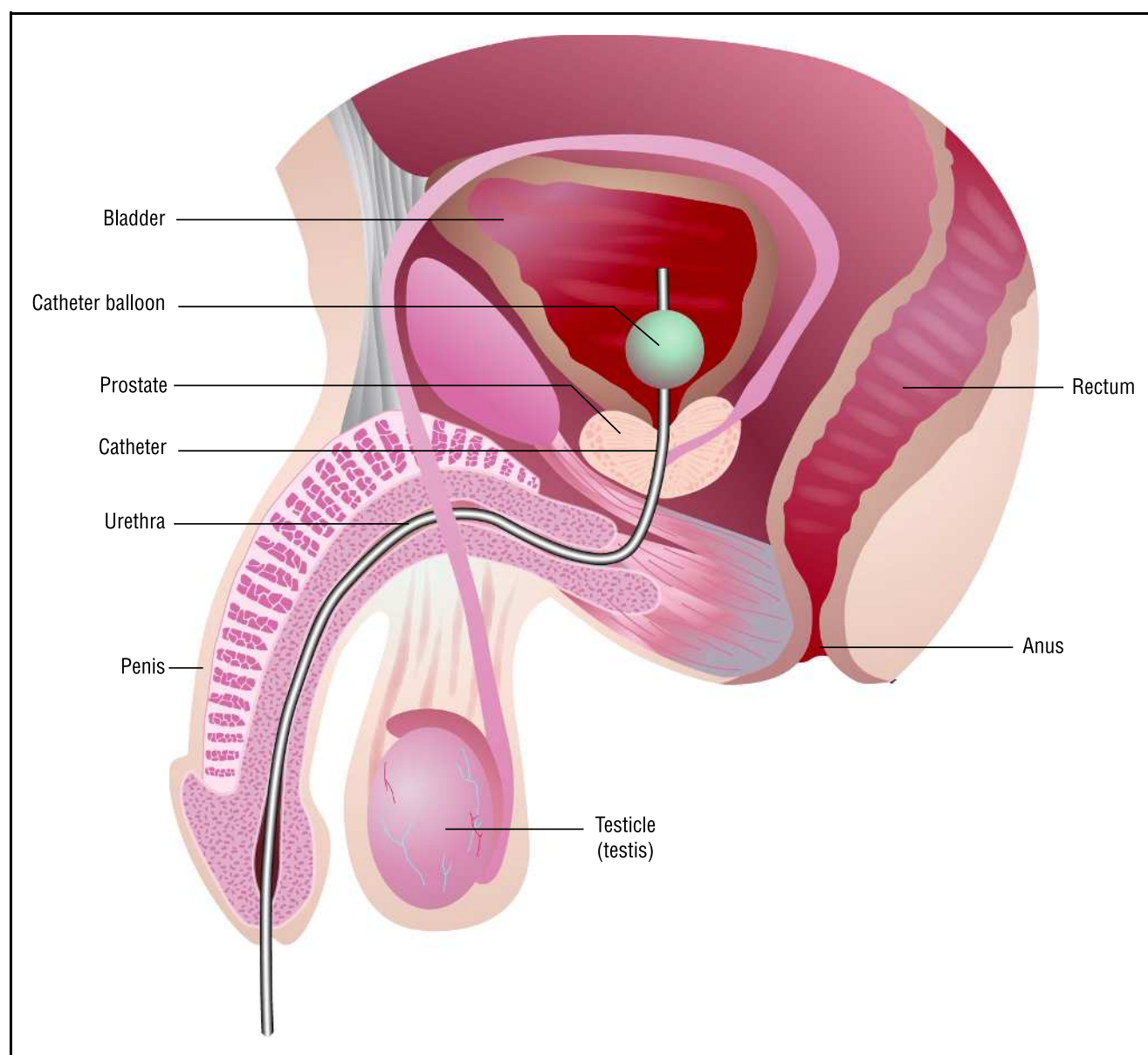
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## Catheterization, male

### Definition

Urinary catheterization is the insertion of a catheter through the urethra into the urinary bladder for withdrawal of urine. Straight catheters are used for intermittent withdrawals, while indwelling (Foley) catheters are inserted and retained in the bladder for continuous drainage of urine into a closed system.



(Illustration by GGS Information Services. Cengage Learning, Gale.)

## Purpose

Intermittent catheterization is used for the following reasons:

- Obtaining a sterile urine specimen for diagnostic evaluation.
- Emptying bladder contents when an individual is unable to void (urinate) due to urinary retention, bladder distention, or obstruction.
- Measuring residual urine after urinating.
- Instilling medication for a localized therapeutic effect in the bladder.
- Instilling contrast material (dye) into the bladder for cystourethralgraphy (x-ray study of the bladder and urethra).
- Emptying the bladder for increased space in the pelvic cavity to protect the bladder during labor and delivery or during pelvic and abdominal surgery.
- Monitoring accurately the urinary output and fluid balance of critically ill patients.

Indwelling catheterization is used for the following reasons:

- Providing palliative care for incontinent persons who are terminally ill or severely impaired, and for whom bed and clothing changes are uncomfortable.
- Managing skin ulceration caused or exacerbated by incontinence.
- Maintaining a continuous outflow of urine for persons undergoing surgical procedures that cause a delay in bladder sensation, or for individuals with chronic neurological disorders that cause paralysis or loss of sensation in the perineal area.
- Included in standard preoperative preparation for urologic surgery and procedures for bladder outlet obstruction.
- Providing relief for persons with an initial episode of acute urinary retention, allowing their bladder to regain its normal muscle tone.

## Demographics

Men are less likely than women to use urinary catheters.

## Description

The male urethral orifice (urinary meatus) is a vertical, slit-like opening, 0.15–0.2 in (4–5 mm) long, located at the tip of the penis. The foreskin of the penis may conceal the opening. This must be retracted to view the opening to be able to insert a catheter. With proper positioning, good lighting, and gloved hands,

## KEY TERMS

**Catheter**—A tube for evacuating or injecting fluid.

**Contaminate**—To make an item unsterile or unclean by direct contact.

**Foley catheter**—A double-channel retention catheter. One channel provides for the inflow and outflow of bladder fluid, the second (smaller) channel is used to fill a balloon that holds the catheter in the bladder.

**Incontinence**—The inability to retain urine or control one's urine flow.

**Intermittent catheterization**—Periodic catheterization to facilitate urine flow. The catheter is removed when the bladder is sufficiently empty.

**Urethra**—The tube that allows passage of urine out of the urinary bladder.

**Urethritis**—Inflammation of the urinary bladder.

**Urinary retention**—The inability to void (urinate) or discharge urine.

**Septicemia**—An infection in the blood.

these anatomical landmarks can be identified. Perineal care or cleansing may be required to ensure a clean procedural environment.

The male urethra is longer than the female urethra and has two curves in it as it passes through the penis to the bladder. Catheterization of the male patient is traditionally performed without the use of local anesthetic gel to facilitate catheter insertion. Glands along the urethra provide some natural lubrication. Older men may require lubrication; in such an instance, an anesthetic or antibacterial lubricant should be used.

Once the catheter is inserted, it is secured as appropriate for the catheter type. A straight catheter is typically secured with adhesive tape. An indwelling catheter is secured by inflating a bulb-like device inside of the bladder.

## Diagnosis/Preparation

Healthcare practitioners performing the catheterization should have a good understanding of the anatomy and physiology of the urinary system, be trained in aseptic techniques, and have proficiency in catheter insertion and catheter care.

After determining the primary purpose for the catheterization, practitioners should give the male patient and his caregiver a detailed explanation. Men requiring

self-catheterization should be instructed and trained in the technique by a qualified health professional.

Sterile disposable catheterization sets are available in clinical settings and for home use. These sets contain most of the items needed for the procedure, including antiseptic agent, gloves, lubricant, specimen container, label, and tape. Anesthetic or antibacterial lubricant, catheter, and a drainage system may need to be added.

### *Catheter choices*

**TYPES.** Silastic catheters have been recommended for short-term catheterization after surgery because they are known to decrease incidence of urethritis (inflammation of the urethra). However, due to lower cost and acceptable outcomes, latex is the catheter of choice for long-term catheterization. Silastic catheters should be reserved for individuals who are allergic to latex products.

There are additional types of catheters:

- PTFE (plastic)-coated latex indwelling (Foley) catheters
- hydrogel-coated latex indwelling catheters
- pure silicone indwelling catheters
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**SIZE.** The diameter of a catheter is measured in millimeters. Authorities recommend using the narrowest and softest tube that will serve the purpose. Rarely is a catheter larger than size 18 F(rench) required, and sizes 14 or 16 F are used more often. Catheters greater than size 16 F have been associated with patient discomfort and urine bypassing. A size 12 F catheter has been successfully used in children and in male patients with urinary restriction.

**DRAINAGE SYSTEM.** The healthcare provider should discuss the design, capacity, and emptying mechanism of several urine drainage bags with the patient. For men with normal bladder sensation, a catheter valve for intermittent drainage may be an acceptable option.

**PROCEDURE.** When inserting a urinary catheter, the healthcare provider will first wash the hands and put on gloves and clean the tip of the penis. An anesthetic lubricating gel may be used. The catheter is threaded up the urethra and into the bladder until the urine starts to flow. The catheter is taped to the upper thigh and attached to a drainage system.

### **Aftercare**

Men using intermittent catheterization to manage incontinence may require a period of adjustment as

## **WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?**

Urinary catheterization can be performed by health-care practitioners, by home caregivers, or by men themselves in hospitals, long-term care facilities, or personal homes.

they try to establish a catheterization schedule that is adequate for their normal fluid intake.

**Antibiotics** should not be prescribed as a preventative measure for men at risk for urinary tract infection (UTI). Prophylactic use of antibacterial agents may lead to the development of drug-resistant bacteria. Men who practice intermittent self-catheterization can reduce their risk for UTI by using antiseptic techniques for insertion and catheter care.

The extended portion of the catheter should be washed with a mild soap and warm water to keep it free of accumulated debris.

### **Risks**

Phimosis is constriction of the prepuce (foreskin) so that it cannot be drawn back over the glans penis. This may make it difficult to identify the external urethral meatus. Care should be taken when catheterizing men with phimosis to avoid trauma from forced retraction of the prepuce or by incorrect positioning of the catheter.

Complications that may occur from a catheterization procedure include:

- Trauma or introduction of bacteria into the urinary system, leading to infection and, rarely, septicemia.
- Trauma to the urethra or bladder from incorrect insertion or attempting to remove the catheter with the balloon inflated; repeated trauma may cause scarring or stricture (narrowing) of the urethra.
- Passage of urine around the catheter; inserting a different catheter size can minimize this problem.

The presence of residual urine in the bladder due to incomplete voiding provides an ideal environment for bacterial growth.

Urinary catheterization should be avoided whenever possible. Clean intermittent catheterization, when practical, is preferable to long-term catheterization.

Catheters should not be routinely changed. Before the catheter is changed, each man should be monitored



## QUESTIONS TO ASK THE DOCTOR

- Will the catheterization be intermittent or indwelling?
- Who will change the catheter and how long will it remain in place?
- Who will teach me or my caregiver how to insert and remove the catheter, monitor it, and perform routine care?

for indication of obstruction, infection, or complications. Some men require daily or weekly catheter changes, while others may need one change in several weeks. Fewer catheter changes will reduce trauma to the urethra and reduce the incidence of UTI.

Because the urinary tract is normally a sterile system, catheterization presents the risk of causing a UTI. The catheterization procedure must be sterile and the catheter must be free from bacteria.

Frequent intermittent catheterization and long-term use of indwelling catheterization predisposes a man to UTI. Care should be taken to avoid trauma to the urinary meatus or urothelium (urinary lining) with catheters that are too large or inserted with insufficient use of lubricant. Men with an indwelling catheter must be reassessed periodically to determine if alternative treatment will be more effective in treating the problem.

### Normal results

A catheterization program that includes correctly inserted catheters and is appropriately maintained will usually control urinary incontinence.

The man and his caregiver should be taught to use **aseptic technique** for catheter care. Nursing interventions and patient education can make a difference in the incidence of urinary tract infections in hospitals, **nursing homes**, and **home care** settings.

The sexuality of a man with an indwelling catheter for continuous urinary drainage is seldom considered. If the patient is sexually active, the man and his partner can be taught to remove the catheter before intercourse and replace it with a new one afterwards.

### Morbidity and mortality rates

Injuries resulting from catheterization are infrequent. Deaths are extremely rare. Both complications are usually due to infections that result from improper catheter care.

## Alternatives

An alternative to catheterization is to use a pad to absorb voided urine.

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CBC see **Complete blood count**

## Cephalosporins

### Definition

Cephalosporins are a type of antibiotic, or medicine that kills bacteria or prevents their growth.

### Purpose

Cephalosporins are used to treat infections in different parts of the body—the ears, nose, throat, lungs, sinuses, and skin, for example. Physicians may prescribe these drugs to treat pneumonia, strep throat, staph infections, tonsillitis, bronchitis, and gonorrhea. These drugs will *not* work for colds, flu, and other infections caused by viruses.

Cephalosporins are also commonly used for surgical prophylaxis—prevention of bacterial infection during or immediately after surgery. For this purpose, a single injection may be given during the surgical procedure. In some cases, the cephalosporin may be continued for 24 to 48 hours after surgery. If, in spite of all precautions, an infection develops, the **antibiotics** may be continued until the infection has resolved.

### Description

Examples of cephalosporins are cefaclor (Ceclor), cefadroxil (Duricef), cefazolin (Ancef, Kefzol, Zolicef), cefixime, (Suprax), cefoxitin (Mefoxin), cefprozil (Cefzil), ceftazidime (Ceptaz, Fortaz, Tazicef, Tazideme), cefuroxime (Ceftin), and cephalexin (Keflex). These medicines are available only with a physician's prescription. They are sold in tablet, capsule, liquid, and injectable forms.

Cephalosporins are sometimes referred to as first, second, and third generation. Each “generation” is effective against more types of bacteria than the one before it. In addition, each subsequent generation is better at getting into the central nervous system (the brain and spinal cord).

Cephalosporins are chemically similar to penicillins, and to other types of antibiotics called cephamycins.

### Recommended dosage

The recommended dosage depends on the type of cephalosporin. The physician who prescribed the drug or the pharmacist who filled the prescription should be consulted for the correct dosage.

The following recommendations do not apply when cephalosporins are given as a single intravenous dose prior to or during surgery. The recommendations

## KEY TERMS

**Bronchitis**—Inflammation of the air passages of the lungs.

**Colitis**—Inflammation of the colon (large bowel).

**Gonorrhea**—A sexually transmitted disease (STD) that causes infection in the genital organs and may cause disease in other parts of the body.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

**Phenylketonuria**—(PKU) A genetic disorder in which the body lacks an important enzyme. If untreated, the disorder can lead to brain damage and mental retardation.

**Pneumonia**—A disease in which the lungs become inflamed. Pneumonia may be caused by bacteria, viruses, or other organisms, or by physical or chemical irritants.

**Sexually transmitted disease**—A disease that is passed from one person to another through sexual intercourse or other intimate sexual contact. Also called STD.

**Staph infection**—Infection with *Staphylococcus* bacteria. These bacteria can infect any part of the body.

**Strep throat**—A sore throat caused by infection with *Streptococcus* bacteria. Symptoms include sore throat, chills, fever, and swollen lymph nodes in the neck.

**Tonsillitis**—Inflammation of a tonsil, a small mass of tissue in the throat.

should be considered if the drugs are used afterwards to treat a surgical infection, particularly if the cephalosporins are given by mouth.

Cephalosporins should be taken exactly as directed by the physician. The patient should never take larger, smaller, more frequent, or less frequent doses than prescribed. The drug should be taken for exactly as long as directed. No doses of the drug should be saved to take for future infections, because the medicine may not be right for other kinds of infections, even if the symptoms are the same. In addition, all of the medicine should be taken to treat the infection for which it was prescribed. The infection may not clear up completely if too little medicine is taken. Taking this medicine for too long, on the other hand, may open the door to new infections that do not respond to the drug.

Some cephalosporins work best when taken on an empty stomach. Others should be taken after meals. The physician who prescribed the medicine or the pharmacist who filled the prescription should give instructions as to how to take the medicine.

When given for surgical prophylaxis, it used to be common practice to give a dose of a cephalosporin as soon as the patient has been called to the **operating room**. More recently, the practice has been to give a single dose during the surgical procedure. This works just as well as the “on call” dose, and lowers the amount of antibiotic that the patient must take.

### Precautions

The following recommendations do not apply when cephalosporins are given as a single intravenous dose prior to or during surgery. They should be considered if the drugs are used afterwards to treat a surgical infection, particularly if the cephalosporins are given by mouth.

Certain cephalosporins should not be combined with alcohol or with medicines that contain alcohol. Abdominal or stomach cramps, nausea, vomiting, facial flushing, and other symptoms may result within 15–30 minutes and may last for several hours. Alcoholic beverages as well as other medicines that contain alcohol should be avoided while being treated with cephalosporins and for several days after treatment ends.

### Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take cephalosporins. Before taking these drugs, be sure to let the physician know about any of these conditions:

**ALLERGIES.** Severe allergic reactions to this medicine may occur. Anyone who is allergic to cephalosporins of any kind should not take other cephalosporins. Anyone who is allergic to penicillin should check with a physician before taking any cephalosporin. The physician should also be told about any allergies to foods, dyes, preservatives, or other substances. The type of allergic reaction should be discussed in detail, since some people have reactions to a drug that are not truly allergies. These people may be able to take cephalosporins safely.

**DIABETES.** Some cephalosporins may cause false positive results on urine sugar tests for diabetes. People with diabetes should check with their physicians to see if they need to adjust their medication or their diets.

**PHENYLKETONURIA.** Oral suspensions of cefprozil contain phenylalanine. People with phenylketonuria (PKU) should consult a physician before taking this medicine.

**PREGNANCY.** Women who are pregnant or who may become pregnant should check with their physicians before using cephalosporins.

**BREAST-FEEDING.** Cephalosporins may pass into breast milk and may affect nursing babies. Women who are breast-feeding and who need to take this medicine should check with their physicians. They may need to stop breast-feeding until treatment is finished.

**OTHER MEDICAL CONDITIONS.** Before using cephalosporins, people with any of these medical problems should make sure their physicians are aware of their conditions:

- History of stomach or intestinal problems, especially colitis. Cephalosporins may cause colitis in some people.
- Kidney problems. The dose of cephalosporin may need to be lower.
- Bleeding problems. Cephalosporins may increase the chance of bleeding in people with a history of bleeding problems.
- Liver disease. The dose of cephalosporin may need to be lower.

**USE OF CERTAIN MEDICINES.** Taking cephalosporins with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

### Side effects

The patient should get medical attention immediately if any of these symptoms develop while taking cephalosporins:

- shortness of breath;
- pounding heartbeat;
- skin rash or hives;
- severe cramps or pain in the stomach or abdomen;
- fever;
- severe watery or bloody diarrhea (may occur up to several weeks after stopping the drug); or
- unusual bleeding or bruising.

Other rare side effects may occur. Anyone who has unusual symptoms during or after treatment with cephalosporins should contact his or her physician.

### Interactions

Some cephalosporins cause diarrhea. Certain diarrhea medicines, such as diphenoxylate-atropine

(Lomotil), may make the problem worse. Check with a physician before taking any medicine for diarrhea caused by taking cephalosporins.

Birth control pills may not work properly when taken at the same time as cephalosporins. To prevent pregnancy, other methods of birth control in addition to the pills are advised while taking cephalosporins.

Taking cephalosporins with certain other drugs may increase the risk of excess bleeding. Among the drugs that may have this effect when taken with cephalosporins are:

- blood-thinning drugs (anticoagulants) such as warfarin (Coumadin)
- blood viscosity-reducing medicines such as pentoxifylline (Trental)
- the antiseizure medicines divalproex (Depakote) and valproic acid (Depakene)

Cephalosporins may also interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes cephalosporins should let the physician know all other medicines he or she is taking.

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Cerclage, cervical see **Cervical cerclage**

## Cerebral aneurysm repair

### Definition

Cerebral aneurysm repair involves corrective treatment of an abnormal blood-filled sac formed by localized expansion of an artery or vein within the brain. These sacs tend to form at the juncture between a primary vessel and a branch. If the vessel involved is an artery, the lesion is also known as a berry aneurysm because of its round, berry-like appearance.

### Purpose

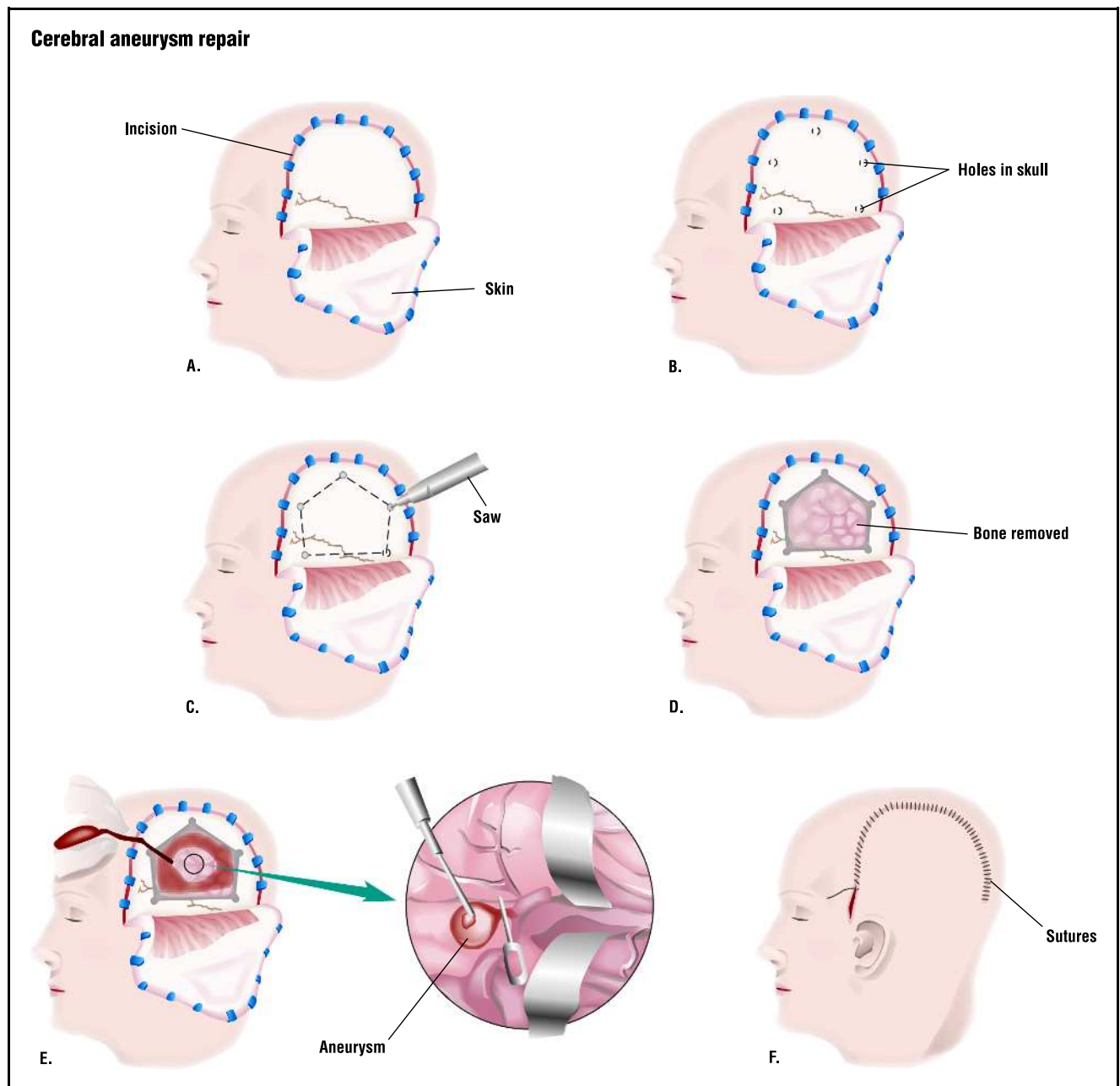
The purpose of the surgical treatment of cerebral aneurysms is to isolate the weakened vessel area from the blood supply. This is commonly done through the strategic placement of small, surgical clips to the neck of the lesion. Thus, the aneurysm becomes isolated from the normal circulation without damaging adjacent vessels or their branches and shrinks in size until it is undetectable, a process known as aneurysm obliteration.

### Demographics

Cerebral, or brain, aneurysms occur in about 2% of the American population. An estimated 15–33% of these patients have more than one aneurysm present. Occurrence of certain other medical conditions appears to increase the chances of developing aneurysms. These conditions include polycystic kidneys, systemic lupus erythematosus (SLE or lupus), and Ehlers-Danlos syndrome (EDS), a genetic disease that affects collagen, which is a primary component of connective tissue. Aneurysms in children are very rare, strongly suggesting that the condition develops, enlarges, and becomes symptomatic over a person's lifetime.

Other less frequent causes of aneurysms are infectious material from the heart, trauma, brain tumor, and brain arteriovenous malformation (AVM), which is a defect of the brain's circulatory system that results in the abnormal direct movement of blood from the arteries to the veins of the brain. The average age of cerebral aneurysm rupture is in the fifth decade of life and occurs more often in women than men by a slight margin. Environmental factors known to increase the chances of aneurysm development and rupture are cigarette smoking, excess alcohol consumption, and atherosclerotic heart disease. Some families have a definite genetic predisposition; in such families, aneurysms may run as high as 10%.





To repair a cerebral aneurysm by craniotomy, an incision is made in the skin on the side of the head (A). Small holes are drilled in the skull (B), and a special saw is used to cut the bone between the holes (C). The bone is removed (D), and the aneurysm is treated (E). The bone is replaced, and the skin is sutured closed (F). (Illustration by GGS Information Services. Cengage Learning, Gale.)

### Diagnosis/Preparation

Cerebral aneurysms become apparent in two general ways: from rupture followed by bleeding within the brain, or from enlargement and compression on surrounding critical brain structures, which leads to symptoms. The most life-threatening presentation is bleeding and is often described clinically as subarachnoid hemorrhage (SAH),

a term derived from the anatomic area of the brain that becomes contaminated with blood when an aneurysm ruptures. The surface of the brain is covered by three thin membranous layers, or meninges, called the dura mater, the pia mater, and the arachnoid. The dura mater adheres to the skull, while the pia mater adheres to the brain. The arachnoid lies between the other two meninges. The space between the pia mater and the

## KEY TERMS

**Computerized tomography (CT)**—A method of visualizing bleeding that has occurred in the brain.

**Fluoroscopic angiogram**—A method of precisely visualizing the brain cardiovascular system and its defects, including aneurysms.

**Gugliemini detachable coils**—A new method of treating aneurysms that is minimally invasive.

**Magnetic resonance imaging (MRI)**—A method of visualizing the vessels in the brain that is particularly effective at locating unruptured aneurysms.

**Subarachnoid hemorrhage**—Bleeding from a ruptured blood vessel in the brain that contaminates the cerebrospinal fluid.

**Stroke**—A brain attack that can be caused by bleeding in the brain.

**Vasospasm**—A deadly side effect of aneurysm rupture where the vessels in the brain spontaneously constrict; can cause brain damage or death.

arachnoid is known as the subarachnoid space and is normally filled with cerebrospinal fluid. SAH occurs when blood leaks into this space, contaminating the cerebrospinal fluid. About half of all SAH result from a ruptured cerebral aneurysm.

Clinically, the rupture causes the sudden explosive onset of a very severe headache that patients describe as the worst headache of their life. Other symptoms can include short-term loss of consciousness, neck stiffness, back pain, nausea or vomiting, and an inability to tolerate bright light. Sometimes a seizure can occur. About 40% of patients have symptoms and signs prior to the actual rupture, including minor headaches or dizziness, which are thought to result from swelling of the aneurysm or minor bleeding that occurs prior to the full rupture. Unfortunately, many of these events go undetected.

Rupture of a cerebral aneurysm is an emergency situation. About 10% of people with SAH die within the first day, and without treatment, 25% succumb within the next three months. More than half of those who survive have significant neurological damage. Partial paralysis, weakness, or numbness may linger or be permanent, as may vision and speech problems.

When SAH is suspected, a computerized tomography (CT) scan is performed to confirm the diagnosis by visualizing the bleeding. The aneurysm itself is only rarely seen using this test. CT scanning is positive

(detects the bleeding) in more than 90% of patients within the first 24 hours after the event, and for more than 50% within the first week. As time goes on, however, the bleeding becomes harder and harder to detect using this imaging method. If no bleeding is detected, a second test that could be performed is a lumbar puncture (LP), which involves drawing cerebrospinal fluid through a needle from the lower back of the patient. If SAH has occurred, the collected cerebrospinal fluid will contain blood and could be discolored yellow, caused by the presence of breakdown products of the blood cells. Other more sophisticated tests can also be performed to confirm the presence of blood and its breakdown products in the sample.

The definitive test for a cerebral aneurysm is a fluoroscopic angiogram, as it can often directly document the aneurysm, particularly its location and size. This procedure involves the placement of fluorescent material into the vein or artery of concern that increases the contrast between vessels and surrounding tissue so that their path can be clearly seen. The vessel is accessed through the insertion of a catheter in the femoral (leg) artery and threading it through the heart and into the blood vessels of the brain. A microcatheter is threaded through the larger one and used to deliver the contrast material to the precise location of the suspected aneurysm. Digital subtraction removes the bony structures from the image and leaves only the vessels. Generally, when SAH is suspected, a full cerebral angiogram that studies all four of the major cerebral arteries is performed. Modern angiograms are able to identify 85% of all cerebral aneurysms, with another 10% visible upon a second test seven to 10 days later. If this test is negative, magnetic resonance imaging (MRI), which is in some ways a more sensitive test, is often recommended.

If an aneurysm presents without rupture, some symptoms include seizures, double vision, progressive blindness in one eye, numbness on one side of the face, difficulty speaking, or, occasionally, hydrocephalus (accumulation of cerebrospinal fluid in the brain). Because of the sensitivity of available scanning techniques (particularly MRI), many aneurysms are discovered even before symptoms develop. This raises the issue of whether non-ruptured, asymptomatic aneurysms should be surgically treated.

Many health professionals view an unruptured aneurysm as a potential time bomb. In general, there is a 3% per year cumulative risk of rupture once an aneurysm is identified, or stated another way, about 0.5–0.75% of all aneurysms rupture each year. Each rupture brings with it the very high probability of

serious neurological damage or even **death**. Furthermore, there are certain aneurysms that rupture more commonly than others, and environmental factors such as smoking and high blood pressure contribute to these events. However, all other things being equal, research indicates that by 10 years after diagnosis, there is an approximately 30% chance the aneurysm will rupture. Yet, the surgery itself carries significant risk. Whether or not to treat an unruptured aneurysm is a difficult decision and should be made only after careful consideration of the many influencing factors.

After diagnosis with a cerebral aneurysm, a patient will be put on strict bed rest and receive medication to avoid complications, keep blood pressure under control, and for pain relief.

### Description

The exact timing for surgical treatment of cerebral aneurysms is historically a controversial subject in **neurosurgery** and is dependent on many factors including patient age, aneurysm size, aneurysm location, density of SAH, and whether the patient is comatose. Research indicates that early treatment, within the first 48 hours after hemorrhage, is generally associated with better outcomes, particularly because of the reduction of two serious complications of rupture: re-bleeding and vasospasm.

Re-bleeding is the most important cause of death if a patient survives the initial bleed and will happen in approximately 50% of all patients with a ruptured aneurysm who do not undergo surgical treatment. The peak occurrence of re-bleeding is within the first few days after rupture. About 60% of patients who re-bleed die.

The second major cause of death after rupture is vasospasm, a condition where the arteries at the base of the brain become irritated and constrict so tightly that blood cannot flow to critical brain regions. This spasm may result in further brain damage or induce re-bleeding, and much of the medical treatment after the aneurysm ruptures and prior to surgical treatment is designed to prevent this complication.

The procedure itself begins with **general anesthesia** of the patient and shaving of the area of the skull where the **craniotomy**, or opening of the skull bone, will occur. The exact position of the opening depends on the approach that the neurosurgeon will use to reach the aneurysm. The approach varies with the exact location of the aneurysm within the brain's cardiovascular system.

Once the bone flap is removed, the various layers of tissue are cut away to expose the brain. Blocking

brain tissue is gently retracted back to expose the area containing the abnormal vessel formation. Surgical techniques performed through a microscope are then utilized to dissect the aneurysm away from the feeding vessels and expose the neck to receive the clip. Clips are manufactured in various types, sizes, shapes, and lengths to accommodate the needs for the various positions, shapes, and sizes of aneurysms. Clips are made of different kinds of materials, with titanium being popular because the material will not interfere with later **magnetic resonance imaging (MRI)** testing.

The clip is placed on the neck of the aneurysm in order to isolate it from the normal circulation. Careful clip placement will stop the flow of blood into the aneurysm, causing it to deflate or obliterate. Proper placement causes aneurysm obliteration and avoids damage to the adjacent vessels or their branches. Once the clip is in place, the brain tissue is carefully lowered back into place, the various layers sutured closed, and the bone flap is resealed for healing. The skin and other outer layers are also sutured closed. **Bandages** protect the area during healing.

### Aftercare

Many times a postoperative angiogram is performed to confirm good clip placement, total obliteration of the aneurysm, and continued blood flow through the neighboring vessels. Because of the unpredictable nature of vessel behavior and the individual structure of each aneurysm, unexpected findings are seen in approximately 19% of postoperative angiograms. Patients stay in the hospital an average of 9.3 days after this procedure.

### Risks

A major risk during surgery is a second rupture of the aneurysm during the procedure. Intraoperative rupture is very serious and associated with an approximately 30–35% morbidity and mortality of the patient. It is particularly dangerous if it occurs during the administration of the anesthesia or before the opening of the dura mater, because the surgeon is not able to reach the area immediately and control the bleeding.

Although much rarer than without surgical treatment, re-bleeding can occur even after surgery, particularly with improper placement of the clip. If too close to the parent vessel, the clip can block blood flow and promote brain damage in that area. If it is too far away from the parent vessel, a condition known as an aneurysmal rest can develop, and the area will swell and rupture later. This re-bleeding can also be described

as a stroke, and occurs in between 1% and 10% of surgical patients.

Again rarer than without treatment, patients having their aneurysm clipped can also develop vasospasm after the procedure. The presence of vasospasm increases the occurrence of re-bleeding as well, making it a particularly dangerous complication. Treatments for vasospasm include giving medications that relax the smooth muscles in vessel walls, administering intravenous fluids to increase blood volume, or using drugs to increase blood pressure. In some cases, it may be necessary to open the vessel with a balloon catheter, a procedure called **angioplasty**. Angioplasty carries with it its own significant risks, including the formation of blood clots and rupture of the artery, and is effective only in some cases.

Other risks of the surgical treatment of cerebral aneurysms include neurological damage over and above what had occurred with the rupture. Special surgical procedures such as the use of temporary clips on the parent vessel, reduction of the patient's blood pressure, and administration of drugs that increase the brain tissue's ability to survive without oxygen are some techniques that minimize the amount of damage. Hypothermia (reduction of the patient's temperature during surgery) is sometimes also utilized to reduce the chance of this risk.

As this surgery involves opening of the cranium (skull), the procedure carries an increased risk of infection of brain and spinal tissues. This surgery also has all the risks of any other invasive procedure, such as infection at the incision site, and risks associated with anesthesia.

### Normal results

If the postoperative angiogram indicates the clip has been properly placed, the aneurysm has been totally obliterated, and vasospasm is avoided, most patients do extremely well. However, the results of the surgery are always limited by the amount of neurological damage that occurred with the rupture itself, as much of the damage is nonreversible with current treatment methods. This issue is not a consideration with elective repair of a pre-rupture aneurysm.

### Morbidity and mortality rates

Despite advances in **microsurgery**, anesthetic techniques, and critical care, the morbidity and mortality rates of SAH remains high at 25–35% and 40–50%, respectively. Age and neurologic status on hospital admission continue to be the best predictors of outcome.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Surgical repair of cerebral aneurysms is performed by neurosurgeons who specialize in this procedure. It is performed in a hospital. Inventional radiology is performed by an endovascular radiologist and is also performed in a hospital.

In contrast, the operative mortality rate for elective clipping is close to 0, with morbidity ranging between 0% and 10%, especially if the surgeon is experienced in the procedure and utilizes the latest microsurgical techniques. In this situation, morbidity is most closely related to aneurysm size and location. Generally, elective clipping of an unruptured aneurysm is associated with better outcomes than ruptured aneurysms because the brain has not been damaged by the SAH prior to the procedure.

### Alternatives

A promising new alternative to open surgery is the use of inventional neuroradiology to treat aneurysms. The greatest advantages to this technique are that it is less invasive and requires less recovery time in most patients. This technique is also more effective than craniotomy for certain positions of aneurysms or for patients that have complicating conditions that would make them unable to tolerate the stress of the more traditional surgery. The decision of whether an aneurysm should be treated surgically with a clip or through inventional neuroradiological techniques should be made as a team by the neurosurgeon and the endovascular radiologist.

Inventional neuroradiology, also known as endovascular neuroradiology, utilizes fluoroscopic **angiography**, described as a diagnostic imaging technique. Besides delivering the contrast material, the catheter can be used to place small coils, known as Gugliemini detachable coils, within the neck of the aneurysm using a delivery wire. Once the coil has been maneuvered into place, an electrical charge is sent through the delivery wire. This charge disintegrates the stainless steel of the coil, separating it from the delivery wire, which is removed from the body, leaving the coil. Anywhere from one to 30 coils may be necessary to block the neck of the aneurysm from the normal circulation and obliterate it, as occurs with the clip



## QUESTIONS TO ASK THE DOCTOR

- What are the risks of treatment of my aneurysm?
- What are the chances of recovery using this surgical treatment method?
- What are the risks if the aneurysm is left to heal on its own?
- What are the specific characteristics of my aneurysm and how does this affect the decision to treat the problem?
- Is interventional radiology a possible means of treating my aneurysm?

procedure. Although more research is needed to compare the two procedures, recent results indicate that intervention surgery for ruptured aneurysms may be safer than the traditionally more invasive procedure and may increase the chances of survival without disability after SAH.

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## Cerebrospinal fluid (CSF) analysis

### Definition

Cerebrospinal fluid (CSF) analysis is a set of laboratory tests that examine a sample of the fluid surrounding the brain and spinal cord. This fluid is an ultrafiltrate of plasma. It is clear and colorless. It contains glucose, electrolytes, amino acids, and other small molecules found in plasma, but has very little protein and few cells. CSF protects the central nervous system from injury, cushions it from the surrounding bone structure, provides it with nutrients, and removes waste products by returning them to the blood. CSF is withdrawn from the subarachnoid space through a needle by a procedure called a lumbar puncture or spinal tap. CSF analysis includes tests in clinical chemistry, hematology, immunology, and microbiology. Usually three or four tubes are collected. The first tube is used for chemical and/or serological analysis, and the last two tubes are used for hematology and microbiology tests. This reduces the chances of a falsely elevated white cell count caused by a traumatic tap (bleeding into the subarachnoid space at the puncture site), and contamination of the bacterial culture by skin germs or flora.

### Purpose

The purpose of a CSF analysis is to diagnose medical disorders that affect the central nervous system. Some of these conditions are:

- meningitis and encephalitis, which may be viral, bacterial, fungal, or parasitic infections

### Normal cerebrospinal fluid values in adults

Measurement	Value
Volume	90–150 mL; child 60–100 mL
Clarity	Crystal clear, colorless
Pressure	50–180 mm H <sub>2</sub> O
Total cell count	0–5 white blood cells/μL
Glucose	40–70 mg/dL
Protein	15–45 mg/dL (lumbar) 15–25 mg/dL (cisternal) 5–15 mg/dL (ventricular)
pH	7.30–7.40
CO <sub>2</sub> content	25–30 mEq/L

SOURCE: Fischbach, F.T. *A Manual of Laboratory Diagnostic Tests*. 4th ed. Philadelphia: J.B. Lippincott, 1992.

(Cengage Learning, Gale.)



**Administering a lumbar puncture for CSF analysis.** (BSIP / Phototake. Reproduced by permission.)

- metastatic tumors (e.g., leukemia) and central nervous system tumors that shed cells into the CSF
- syphilis, a sexually transmitted bacterial disease
- bleeding (hemorrhaging) in the brain and spinal cord
- multiple sclerosis, a degenerative nerve disease that results in the loss of the myelin coating of the nerve fibers of the brain and spinal cord
- Guillain-Barré syndrome, a demyelinating disease involving peripheral sensory and motor nerves

Routine examination of CSF includes visual observation of color and clarity and tests for glucose, protein, lactate, lactate dehydrogenase, red blood cell count, **white blood cell count** with differential, syphilis serology (testing for antibodies indicative of syphilis), Gram stain, and bacterial culture. Further tests may need to be performed depending upon the results of initial tests and the presumptive diagnosis. For example, an abnormally high total protein seen in a patient suspected of having a demyelinating disease such as multiple sclerosis dictates CSF protein electrophoresis and measurement of immunoglobulin levels and myelin basic protein.

**GROSS EXAMINATION.** Color and clarity are important diagnostic characteristics of CSF. Straw, pink, yellow, or amber pigments (xanthochromia) are abnormal and indicate the presence of bilirubin, hemoglobin, red blood cells, or increased protein. Turbidity (suspended particles) indicates an increased number of cells. Gross examination is an important aid to differentiating a subarachnoid hemorrhage from a traumatic tap. The latter is often associated with sequential clearing of CSF as it is collected; streaks of blood in an otherwise clear fluid; or a sample that clots.

**GLUCOSE.** CSF glucose is normally approximately two-thirds of the fasting plasma glucose. A glucose level below 40 mg/dL is significant and occurs in bacterial and fungal meningitis and in malignancy.

**PROTEIN.** Total protein levels in CSF are normally very low, and albumin makes up approximately two-thirds of the total. High levels are seen in many conditions including bacterial and fungal meningitis, multiple sclerosis, tumors, subarachnoid hemorrhage, and traumatic tap.

**LACTATE.** The CSF lactate is used mainly to help differentiate bacterial and fungal meningitis, which

## KEY TERMS

**Demyelination**—The loss of myelin with preservation of the axons or fiber tracts. Central demyelination occurs within the central nervous system, and peripheral demyelination affects the peripheral nervous system as with Guillain-Barré syndrome.

**Encephalitis**—An inflammation or infection of the brain and spinal cord caused by a virus or as a complication of another infection.

**Guillain-Barré syndrome**—A demyelinating disease involving nerves that affect the extremities and causing weakness and motor and sensory dysfunction.

**Meningitis**—An infection of the membranes that cover the brain and spinal cord.

**Multiple sclerosis**—A disease that destroys the covering (myelin sheath) of nerve fibers of the brain and spinal cord.

**Spinal canal**—The cavity or hollow space within the spine that contains the spinal cord and the cerebrospinal fluid.

**Subarachnoid**—The space underneath the anachnoid membrane, a thin membrane enclosing the brain and spinal cord.

**Treponeme**—A term used to refer to any member of the genus *Treponema*, which is an anaerobic bacteria consisting of cells, 3–8 µm in length, with acute, regular, or irregular spirals and no obvious protoplasmic structure.

**Vertebrae**—The bones of the spinal column. There are 33 along the spine, with five (called L1–L5) making up the lower lumbar region.

cause increased lactate, from viral meningitis, which does not.

**LACTATE DEHYDROGENASE.** This enzyme is elevated in bacterial and fungal meningitis, malignancy, and subarachnoid hemorrhage.

**WHITE BLOOD CELL (WBC) COUNT.** The number of white blood cells in CSF is very low, usually necessitating a manual WBC count. An increase in WBCs may occur in many conditions including infection (viral, bacterial, fungal, and parasitic), allergy, leukemia, multiple sclerosis, hemorrhage, traumatic tap, encephalitis, and Guillain-Barré syndrome. The WBC differential helps to distinguish many of these causes. For example, viral infection is usually associated with an increase in lymphocytes, while bacterial and fungal infections are associated with an increase in

polymorphonuclear leukocytes (neutrophils). The differential may also reveal eosinophils associated with allergy and ventricular shunts; macrophages with ingested bacteria (indicating meningitis), RBCs (indicating hemorrhage), or lipids (indicating possible cerebral infarction); blasts (immature cells) that indicate leukemia; and malignant cells characteristic of the tissue of origin. About 50% of metastatic cancers that infiltrate the central nervous system and about 10% of central nervous system tumors will shed cells into the CSF.

**RED BLOOD CELL (RBC) COUNT.** While not normally found in CSF, RBCs will appear whenever bleeding has occurred. Red cells in CSF signal subarachnoid hemorrhage, stroke, or traumatic tap. Since white cells may enter the CSF in response to local infection, inflammation, or bleeding, the RBC count is used to correct the WBC count so that it reflects conditions other than hemorrhage or a traumatic tap. This is accomplished by counting RBCs and WBCs in both blood and CSF. The ratio of RBCs in CSF to blood is multiplied by the blood WBC count. This value is subtracted from the CSF WBC count to eliminate WBCs derived from hemorrhage or traumatic tap.

**GRAM STAIN.** The Gram stain is performed on a sediment of the CSF and is positive in at least 60% of cases of bacterial meningitis. Culture is performed for both aerobic and anaerobic bacteria. In addition, other stains (e.g. the acid-fast stain for *Mycobacterium tuberculosis*, fungal culture, and rapid identification tests [tests for bacterial and fungal antigens]) may be performed routinely.

**SYPHILIS SEROLOGY.** This serology involves testing for antibodies that indicate neurosyphilis. The fluorescent treponemal antibody-absorption (FTA-ABS) test is often used and is positive in persons with active and treated syphilis. The test is used in conjunction with the VDRL test for nontreponemal antibodies, which is positive in most persons with active syphilis, but negative in treated cases.

## Precautions

In some circumstances, a lumbar puncture to withdraw a small amount of CSF for analysis may lead to serious complications. Lumbar punctures should be performed only with extreme caution, and only if the benefits are thought to outweigh the risks. In people who have bleeding disorders, lumbar puncture can cause hemorrhage that can compress the spinal cord. If there is increased spinal column pressure, as may occur with a brain tumor and other conditions, removal of CSF can cause the brain to



herniate, compressing the brain stem and other vital structures and leading to irreversible brain damage or **death**. Bacteria introduced during the puncture may cause meningitis. For this reason, **aseptic technique** must be followed strictly, and a lumbar puncture should never be performed at the site of a localized skin lesion.

Specimens should be handled with caution to avoid contamination with skin flora. They should be refrigerated if analysis cannot be performed immediately.

### Description

Lumbar puncture is performed by inserting the needle between the fourth and fifth lumbar vertebrae (L4-L5). This location is used because the spinal cord stops near L2, and a needle introduced below this level will miss the cord. In rare instances, such as a spinal fluid blockage in the middle of the back, a physician may perform a spinal tap in the cervical spine.

### Aftercare

After the procedure, the site of the puncture is covered with a sterile bandage. The patient should remain lying down for four to six hours after the lumbar puncture. **Vital signs** should be monitored every 15 minutes for four hours, then every 30 minutes for another four hours. The puncture site should be observed for signs of weeping or swelling for 24 hours. The neurological status of the patient should also be evaluated for such symptoms as numbness and/or tingling in the lower extremities.

### Risks

The most common side effect after the removal of CSF is a headache. This occurs in 10–30% of adult patients and in up to 40% of children. It is caused by a decreased CSF pressure related to a small leak of CSF through the puncture site. These headaches usually are a dull pain, although some people report a throbbing sensation. A stiff neck and nausea may accompany the headache. Lumbar puncture headaches typically begin within two days after the procedure and persist from a few days to several weeks or months.

### Normal results

- Gross appearance: Normal CSF is clear and colorless.
- CSF opening pressure: 50–175 mm H<sub>2</sub>O.
- Specific gravity: 1.006–1.009.
- Glucose: 40–80 mg/dL.
- Total protein: 15–45 mg/dL.

- LD: 1/10 of serum level.
- Lactate: less than 35 mg/dL.
- Leukocytes (white blood cells): 0–5/microL (adults and children); up to 30/microL (newborns).
- Differential: 60–80% lymphocytes; up to 30% monocytes and macrophages; other cells 2% or less. Monocytes and macrophages are somewhat higher in neonates.
- Gram stain: negative.
- Culture: sterile.
- Syphilis serology: negative.
- Red blood cell count: Normally, there are no red blood cells in the CSF unless the needle passes through a blood vessel on route to the CSF.

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Cerebrospinal fluid shunt see **Ventricular shunt**

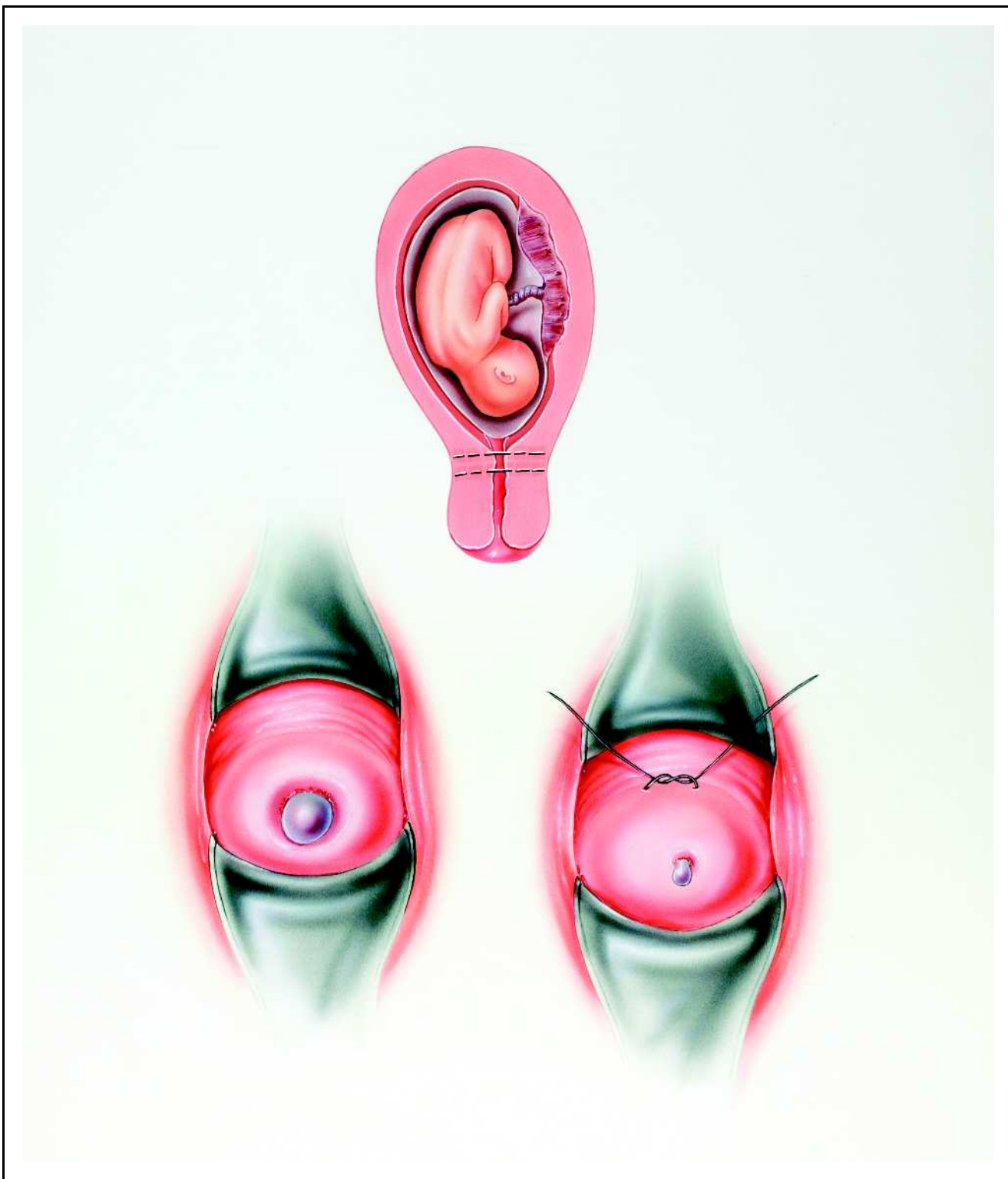
Cervical biopsy see **Cone biopsy**

## Cervical cerclage

### Definition

A cervical cerclage is a minor surgical procedure in which the opening to the uterus (the cervix) is stitched closed in order to prevent a miscarriage or premature birth.





**Cervical cerclage.** (Judith Glick/Phototake. Reproduced by permission.)

## Purpose

Approximately 10% of pregnancies end in preterm delivery, defined as a delivery that occurs before week 37 of pregnancy (the average pregnancy lasts 40 weeks). Premature birth is a major cause of serious health problems in neonates (newborn babies), including respiratory distress, difficulty regulating **body temperature**, and infection. More than 85% of long-term disabilities in otherwise healthy babies and 75% of deaths among newborns occur as a result of preterm delivery.

A woman with an incompetent cervix is 3.3 times more likely to deliver prematurely. The cervix is the neck-shaped opening at the lower part of the uterus and is normally closed tight during pregnancy until the baby is ready to be delivered, at which point it expands (dilates) to roughly 4 in (10 cm) in diameter. An incompetent cervix is prone to dilating and/or effacing (shortening) prematurely during the second trimester. The growing fetus subsequently places too great a strain on the cervix, leading to miscarriage (loss before week 20 of pregnancy) or premature delivery (loss after week 20). Approximately 1% of women will be diagnosed with an incompetent cervix (one in 500–2,000 pregnancies). It is the cause of 25% of losses during the second trimester.

A doctor might recommend a cerclage be performed if a woman has one or more of the following risk factors:

- a previous preterm delivery
- previous trauma or surgery to the cervix
- early rupture of membranes (“breaking water”)
- hormonal influences
- abnormalities of the uterus or cervix
- exposure as a fetus to diethylstilbestrol (DES), a synthetic hormone that was used in the mid-twentieth century to treat recurrent miscarriages

## Demographics

Racial and socioeconomic factors influence a woman’s risk of delivering prematurely: African-American women are at more risk (16–18%) than white women (7–9%); women under 18 and over 35 are also at greater risk. Less educated women are more likely to deliver prematurely. Smoking during pregnancy is associated with a 20–30% greater risk of delivering prematurely. Male fetuses are more likely to be born prematurely and have a higher rate of fetal **death** than female fetuses (a difference of 2.8–9.8%).

## KEY TERMS

**Cervix**—The neck-shaped opening at the lower part of the uterus.

**Chorioamnionitis**—Infection of the amniotic sac.

**Diethylstilbestrol (DES)**—A synthetic hormone that was used in the mid-twentieth century to treat recurrent miscarriages; exposure to DES as a fetus is a risk factor for premature labor.

**Epidural anesthesia**—Similar to the procedure for spinal anesthesia except that a catheter is inserted so that numbing medications may be administered when needed.

**Neonate**—A newborn baby.

**Tocolytics**—Drugs that are used to stop or delay labor.

**Spinal anesthesia**—Involves inserting a needle into a region between the vertebrae of the lower back and injecting numbing medications.

## Description

Elective cervical cerclage is a minor surgical procedure that is generally performed between 12 and 14 weeks of pregnancy (at the beginning of the second trimester) before symptoms of premature labor begin. Emergent cerclages are those placed later in pregnancy when cervical changes have already begun.

The patient will usually receive regional (epidural or spinal) anesthesia during the procedure, although **general anesthesia** is sometimes used. Spinal anesthesia involves inserting a needle into a region between the vertebrae of the lower back and injecting numbing medications. An epidural is similar to a spinal except that a catheter is inserted so that numbing medications may be administered as needed. Some women experience a drop in blood pressure when a regional anesthetic is administered; this effect can be countered with fluids and/or medications.

While there are numerous techniques for performing cerclage, the McDonald and Shirodkar techniques are the most common. The McDonald cerclage involves stitching the cervix with a 0.2 in (5 mm) band of suture. The cerclage is placed high on the cervix when the lower part has already started to efface. The stitch is usually removed around week 37 of pregnancy. The classic Shirodkar procedure involves a permanent “purse-string” stitch around the cervix; because it will not be removed, a **cesarean section** will be necessary to deliver the baby. Most Shirodkar cerclages are now

performed with a modified technique that allows the sutures to be later removed.

Some less common methods of cerclage include:

- Hefner (or Wurm) cerclage (usually reserved for later in pregnancy when there is little cervix to work with)
- abdominal cerclage (a permanent stitch performed through an abdominal incision instead of the vagina; reserved for when a vaginal cerclage has failed or is not possible)
- Lash cerclage (a permanent stitch performed before pregnancy because of trauma to the cervix or an anatomical abnormality)

### Diagnosis/Preparation

Diagnosis of an incompetent cervix is usually done by medical history and/or by examination (manually during a pelvic exam or using **ultrasound** technology). Some symptoms of an incompetent cervix used to decide if a cerclage is necessary are:

- cervical dilation
- shortening of the cervix
- funneling of 25% or more (when the internal opening of the cervix has begun to dilate but the external opening remains closed)

Women who are more than 1.5 in (4 cm) dilated, who have already experienced rupture of membranes, or whose fetus has died are ineligible for cerclage.

Before the procedure may be performed, there are a number of preparatory steps that must be taken. A complete medical history will be taken. A cervical exam will be necessary to assess the state of the cervix; usually a transvaginal (through the vagina) ultrasound will be performed. No food or drink will be allowed after midnight before the day of surgery to avoid nausea and vomiting during and after the procedure. The patient will also be instructed to avoid sexual intercourse, tampons, and douches for 24 hours before the procedure. Before the procedure is performed, an intravenous (IV) catheter will be placed in order to administer fluids and medications.

### Aftercare

After the cerclage has been placed, the patient will be observed for at least several hours (sometimes overnight) to ensure that she does not go into premature labor. The patient will then be allowed to return home, but will be instructed to remain in bed or avoid physical activity for two to three days. Follow-up appointments will usually take place so that her doctor can

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A cervical cerclage is generally performed in a hospital operating room by an obstetrician/gynecologist who specializes in the areas of women's general health, pregnancy, labor and childbirth, prenatal testing, and genetics. Anesthesia will be administered by an anesthesiologist.

monitor the cervix and stitch and watch for signs of premature labor.

### Risks

While cerclage is generally a safe procedure, there are a number of potential complications that may arise during or after surgery. These include:

- risks associated with regional or general anesthesia
- premature labor
- premature rupture of membranes
- infection of the cervix
- infection of the amniotic sac (chorioamnionitis)
- cervical rupture (may occur if the stitch is not removed before onset of labor)
- injury to the cervix or bladder
- bleeding

### Normal results

The success rate for cervical cerclage is approximately 80–90% for elective cerclages, and 40–60% for emergent cerclages. A cerclage is considered successful if labor and delivery is delayed to at least 37 weeks (full term).

### Morbidity and mortality rates

Approximately 1–9% of women will experience premature labor after cerclage. The risk of chorioamnionitis is 1–7%, but increases to 30% if the cervix is dilated greater than 1.2 in (3 cm). The risks associated with premature delivery, however, are far greater. Babies born between 22 and 25 weeks of pregnancy are at significant risk of moderate to severe disabilities (46–56%) or death (approximately 10–30% survive at 22 weeks, increasing to 50% at 24 weeks, and 95% by 26 weeks).

## QUESTIONS TO ASK THE DOCTOR

- How many cerclages do you perform each year?
- What is your rate of complications?
- Why is cerclage recommended for my particular condition?
- What are my options for anesthesia?
- After the cerclage is placed, do I have to alter my day-to-day routine?
- What alternatives to cerclage are available to me?

### Alternatives

Depending on her specific condition, a woman may have some alternative therapies available to her to avoid or delay premature labor. These include:

- **Bed rest.** At least 20% of pregnant women in the United States have at least one week of bed rest prescribed to them at some point of their pregnancy. The idea of bed rest is to avoid putting unnecessary pressure on the cervix.
- **Tocolytics.** These are drugs that are designed to stop or delay labor. Ritrodine, terbutaline, and magnesium sulfate are some common tocolytics.
- **Antibiotics.** Some infections are associated with a high risk of preterm labor (e.g., upper genital tract infection). Antibiotics may be successful in preventing preterm labor from occurring by treating the infection.

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American Board of Obstetrics and Gynecology. 2915 Vine Street, Dallas, TX 75204. (214) 871 1619. <http://www.abog.org>.

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## Cervical cryotherapy

### Definition

Cervical **cryotherapy** is a procedure which involves freezing an area of abnormal tissue on the cervix. This tissue gradually disappears and the cervix heals. One cervical cryotherapy is usually sufficient to destroy the abnormal tissue.

### Purpose

Cervical cryotherapy is a standard method used to treat cervical dysplasia, meaning the removal of abnormal cell tissue on the cervix.

### Description

Cervical cryotherapy, or freezing, usually lasts about five minutes and causes a slight amount of



## KEY TERMS

**Biopsy**—Procedure that involves obtaining a tissue specimen for microscopic analysis to establish a precise diagnosis.

**Cervix**—Opening of the uterus (womb) that leads into the vagina.

**Colposcopy**—Examination of the cervix through a magnifying device to detect abnormal cells.

**Cryotherapy**—The therapeutic use of cold to reduce discomfort, or remove abnormal tissue.

**Dysplasia**—Abnormality of development, or change in size, shape, and organization of adult cells.

**Electrocautery**—The cauterization of tissue using an electric current that generates heat.

**Loop electrocautery excision procedure (LEEP)**—Electrocautery performed to excise abnormal cervical tissue.

**Pap smear**—A test performed using a special stain applied on a smear taken from the cervix.

**Squamous cells**—Scaly or plate-like cells.

discomfort. The procedure is usually performed in an outpatient setting.

Cervical cryotherapy is done by placing a small freeze-probe (cryoprobe) against the cervix that cools the cervix to sub-zero temperatures. The cells destroyed by freezing are shed afterwards in a heavy watery discharge. The main advantage of cryotherapy is that it is a simple procedure that requires inexpensive equipment.

The cryogenic device consists of a gas tank containing a refrigerant and non-explosive, non-toxic gas (usually nitrous oxide). The gas is delivered using flexible tubing through a gun-type attachment to the cryoprobe.

## Diagnosis/Preparation

Women who undergo cervical cryotherapy typically have had an abnormal Pap smear which has led to a diagnosis of cervical squamous dysplasia and usually confirmed by biopsy after an adequate colposcopic exam.

Preparation for cervical cryotherapy involves scheduling the procedure when the patient is not experiencing heavy menstrual flow. Ibuprofen, ketoprofen, or naproxen sodium may be given before cryotherapy

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Cervical cryotherapy can be done in the treating physician's office. The physician is usually a gynecologist.

to decrease cramping. If there is any doubt about the pregnancy status, a pregnancy test is performed.

## Aftercare

Cervical cryotherapy is often followed by a heavy and often odorous discharge during the first month after the procedure. The discharge is due to the dead tissue cells leaving the treatment site, and Aminocerv cream may be prescribed. The patient should abstain from sexual intercourse and not use tampons for a period of three weeks after the procedure. Excessive **exercise** should also be avoided to lessen the occurrence of post-therapy bleeding.

## Risks

The following risks have been associated with cervical cryotherapy:

- Uterine cramping. Often occurs during the cryotherapy but rapidly subsides after treatment.
- Bleeding and infection. Rare, but incidences have been reported.
- More difficult Pap smears. Future Pap smears and colposcopy may be more difficult after cryotherapy.

## Normal results

A normal result is no recurrence of the abnormal cervix cells. The first follow-up Pap smear is done within three to six months. If normal, Pap smears are repeated every six months for two years. If any, recurrences usually occur within two years of treatment. Another option is to replace the initial and each yearly Pap smear with a colposcopic examination.

If a follow-up Pap smear is abnormal, a **colposcopy** with biopsy is usually performed. Other treatment methods, usually the loop electrocautery excision procedure (LEEP) are then used if persistent disease is discovered.

Following the procedure, it is considered normal to experience the following:

## QUESTIONS TO ASK THE DOCTOR

- How is cervical cryotherapy performed?
- Why is cryotherapy required?
- What are the risks of cryotherapy?
- Is cryotherapy painful?
- What is the purpose of my cryotherapy?
- How long will it take to recover from the surgery?
- What are the after-effects of cryotherapy?
- How much cervical cryotherapy do you perform each year?

- slight cramping for two to three days
- watery discharge requiring several pad changes daily
- bloody discharge, especially 12–16 days after the procedure

### Alternatives

Alternatives to cryotherapy include:

- Laser treatment. A carbon dioxide laser focuses a beam of light to vaporize the abnormal cells. This technique can be used in the physician's office with very little discomfort.
- Loop electrocautery excision procedure (LEEP). This procedure uses a fine wire loop with an electric current flowing through it to remove the desired area of the cervix. Loop excision is usually done under local anesthesia and causes very little discomfort.

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## Cesarean section

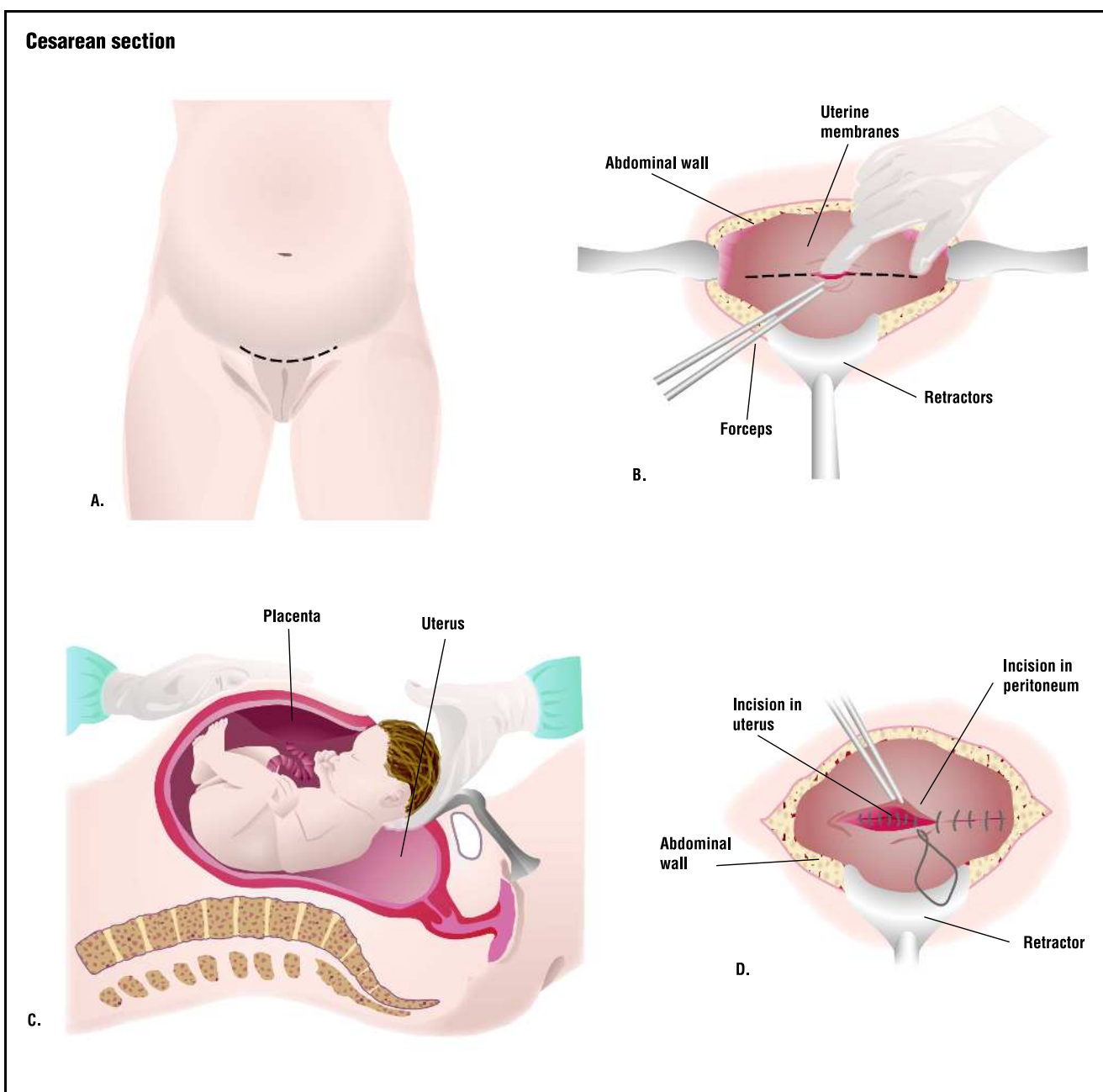
### Definition

A cesarean section is a surgical procedure in which incisions are made through a woman's abdomen and uterus to deliver her baby.

### Purpose

Cesarean sections, also called c-sections or cesarean deliveries, are performed whenever abnormal conditions complicate labor and vaginal delivery, threatening the life or health of the mother or the baby. Dystocia, or difficult labor, is the other common cause of c-sections. The procedure is performed in the United States on nearly one of every four babies delivered—more than 900,000 babies each year. The procedure is often used in cases where the mother has had a previous c-section.

The most common reason that a cesarean section is performed (in 35% of all cases, according to the United States Public Health Service) is the woman has had a previous c-section. The "once a cesarean, always a cesarean" rule originated when the uterine incision was made vertically (termed a "classical incision"); the resulting scar was weak and had a risk of rupturing in subsequent deliveries. Today, the incision



To remove a baby by cesarean section, an incision is made into the abdomen, usually just above the pubic hairline (A). The uterus is located and divided (B), allowing for delivery of the baby (C). After all the contents of the uterus are removed, the uterus is repaired, and rest of the layers of the abdominal wall are closed (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

is almost always made horizontally across the lower end of the uterus (called a low transverse incision), resulting in reduced blood loss and a decreased chance of rupture. This kind of incision allows many women to have a vaginal birth after a cesarean (VBAC).

The second most common reason that a c-section is performed (in 30% of all cases) is difficult childbirth due to non-progressive labor (dystocia). Difficult

labor is commonly caused by one of the three following conditions: abnormalities in the mother's birth canal; abnormalities in the position of the fetus; or abnormalities in the labor, including weak or infrequent contractions. The mother's pelvic structure may not allow adequate passage for birth. When the baby's head is too large to fit through the pelvis, the condition is called cephalopelvic disproportion (CPD).

## KEY TERMS

**Breech presentation**—The condition in which the baby enters the birth canal with its buttocks or feet first.

**Cephalopelvic disproportion (CPD)**—The condition in which the baby's head is too large to fit through the mother's pelvis.

**Classic incision**—In a cesarean section, an incision made vertically along the uterus.

**Dystocia**—Failure to progress in labor, either because the cervix will not dilate (expand) further or (after full dilation) the head does not descend through the mother's pelvis.

**Hematoma**—A collection of blood localized to an organ, tissue, or space of the body.

**Low transverse incision**—Incision made horizontally across the lower end of the uterus.

**Placenta previa**—The placenta totally or partially covers the cervix, preventing vaginal delivery.

**Placental abruption**—Separation of the placenta from the uterine wall before the baby is born, cutting off blood flow to the baby.

**Preeclampsia**—A pregnancy-related condition that causes high blood pressure and swelling.

**Prolapsed cord**—The umbilical cord is pushed into the vagina ahead of the baby and becomes compressed, cutting off blood flow to the baby.

**Respiratory distress syndrome (RDS)**—Difficulty breathing; found in infants with immature lungs.

**Transverse presentation**—The baby is laying sideways across the cervix instead of head first.

**VBAC**—Vaginal birth after cesarean.

Another 12% of c-sections are performed to deliver a baby in a breech presentation (buttocks or feet first). Breech presentation is found in about 3% of all births.

In 9% of all cases, c-sections are performed in response to fetal distress, which refers to any situation that threatens the baby such as the umbilical cord wrapped around the baby's neck. This may appear on the fetal heart monitor as an abnormal heart rate or rhythm. Fetal brain damage can result from oxygen deprivation. Fetal distress is often related to abnormalities in the position of the fetus or abnormalities in the birth canal, causing reduced blood flow through the placenta.

The remaining 14% of c-sections are indicated by other serious factors. One is prolapse of the umbilical cord: the cord is pushed into the vagina ahead of the baby and becomes compressed, cutting off blood flow to the baby. Another is "placental abruption," whereby the placenta separates from the uterine wall before the baby is born, cutting off blood flow to the baby. The risk of this is especially high in multiple births (twins, triplets, or more). A third factor is "placenta previa," in which the placenta covers the cervix partially or completely, making vaginal delivery impossible. In some cases requiring c-section, the baby is in a transverse position, lying horizontally across the pelvis, perhaps with a shoulder in the birth canal.

The mother's health may make delivery by c-section the safer choice, especially in cases of maternal diabetes, hypertension, genital herpes, malignancies of the genital tract, and preeclampsia (high blood pressure related to pregnancy).

### Choosing cesarean section

A 1997 survey of female obstetricians found that 31% would choose to have a c-section without trial of labor if they had an uncomplicated pregnancy. This finding mirrors a growing movement to allow women the right to choose c-section over vaginal delivery, even when no indications for c-section exist.

There are a number of reasons why a woman might choose a c-section in the absence of the usual indications. These include:

- Convenience. A scheduled c-section would allow a woman to choose the time and date of delivery to avoid conflicting with work or family obligations.
- Fear of childbirth. A woman might fear the pain of labor and delivery and feel that a scheduled c-section would allow her to circumvent it.
- Avoiding risks of vaginal delivery. Certain risks inherent to vaginal delivery (urinary or rectal incontinence, sexual dysfunction, dystocia) are avoided in a c-section.

### Demographics

Women of higher socioeconomic status are more likely to have a c-section, 22.9%, compared to 13.2% of women who live in low-income families. C-section rates are highest among non-Hispanic white women (20.6%). Asian-American women have a c-section rate of 19.2%; African-American women, a rate of 18.9%, and Hispanic women, a rate of 13.9%.



## Description

Regional anesthesia, either a spinal or epidural, is the preferred method of pain relief during a c-section. The benefits of regional anesthesia include allowing the mother to be awake during the surgery, avoiding the risks of **general anesthesia**, and allowing early contact between mother and child. Spinal anesthesia involves inserting a needle into a region between the vertebrae of the lower back and injecting numbing medications. An epidural is similar to a spinal except that a catheter is inserted so that numbing medications may be administered continuously. Some women experience a drop in blood pressure when a regional anesthetic is administered; this can be countered with fluids and/or medications.

In some instances, use of general anesthesia may be indicated. General anesthesia can be more rapidly administered in the case of an emergency (e.g., severe fetal distress). If the mother has a coagulation disorder that would be complicated by a drop in blood pressure (a risk with regional anesthesia), general anesthesia is an alternative. A major drawback of general anesthesia is that the procedure carries with it certain risks such as pulmonary aspiration and failed intubation. The baby may also be affected by the anesthetics since they cross the placenta; this effect is generally mild if delivery occurs within 10 minutes after anesthesia is administered.

Once the patient has received anesthesia, the abdomen is washed with an antibacterial solution and a portion of the pubic hair may be shaved. The first incision opens the abdomen. Infrequently, it will be vertical from just below the navel to the top of the pubic bone or, more commonly, it will be a horizontal incision across and above the pubic bone (informally called a “bikini cut”).

The second incision opens the uterus. In most cases, a transverse incision is made. This is the favored type because it heals well and makes it possible for a woman to attempt a vaginal delivery in the future. The classical incision is vertical. Because it provides a larger opening than a low transverse incision, it is used in the most critical situations such as placenta previa. However, the classic incision causes more bleeding, a greater risk of abdominal infection, and a weaker scar.

Once the uterus is opened, the amniotic sac is ruptured and the baby is delivered. The time from the initial incision to birth is typically five minutes. The umbilical cord is clamped and cut, and the newborn is evaluated. The placenta is removed from the mother, and her uterus and abdomen are stitched closed (surgical **staples** may be used instead in closing

the outermost layer of the abdominal incision). From birth through suturing may take 30–40 minutes; the entire surgical procedure may be performed in less than one hour.

## Diagnosis/Preparation

There are several ways that obstetricians and other doctors diagnose conditions that may make a c-section necessary. **Ultrasound** testing reveals the positions of the baby and the placenta and may be used to estimate the baby’s size and gestational age. Fetal heart monitors, in use since the 1970s, transmit any signals of fetal distress. Oxygen deprivation may be determined by checking the amniotic fluid for meconium (feces); a lack of oxygen may cause an unborn baby to defecate. Oxygen deprivation may also be determined by testing the pH of a blood sample taken from the baby’s scalp; a pH of 7.25 or higher is normal, between 7.2 and 7.25 is suspicious, and below 7.2 is a sign of trouble.

When a c-section becomes necessary, the mother is prepped for surgery. A catheter is inserted into her bladder and an intravenous (IV) line is inserted into her arm. Leads for monitoring the mother’s heart rate, rhythm, and blood pressure are attached. In the **operating room**, the mother is given anesthesia, usually a regional anesthetic (epidural or spinal), making her numb from below her breasts to her toes. In some cases, a general anesthetic will be administered. Surgical drapes are placed over the body, except the head; these drapes block the direct view of the procedure.

## Aftercare

A woman who undergoes a c-section requires both the care given to any new mother and the care given to any patient recovering from major surgery. She should be offered pain medication that does not interfere with breastfeeding. She should be encouraged to get out of bed and walk around eight to 24 hours after surgery to stimulate circulation (thus avoiding the formation of blood clots) and bowel movement. She should limit climbing stairs to once a day, and avoid lifting anything heavier than the baby. She should nap as often as the baby sleeps, and arrange for help with the housework, meals, and care of other children. She may resume driving after two weeks, although some doctors recommend waiting for six weeks, the typical recovery period from major surgery.

## Risks

Because a c-section is a surgical procedure, it carries more risk to both the mother and the baby. The

maternal **death** rate is less than 0.02%, but that is four times the maternal death rate associated with vaginal delivery. Complications occur in less than 10% of cases.

The mother is at risk for increased bleeding (a c-section may result in twice the blood loss of a vaginal delivery) from the two incisions, the placental attachment site, and possible damage to a uterine artery. The mother may develop infection of the incision, the urinary tract, or the tissue lining the uterus (endometritis); infections occur in approximately 7% of women after having a c-section. Less commonly, she may receive injury to the surrounding organs such as the bladder and bowel. When a general anesthesia is used, she may experience complications from the anesthesia. Very rarely, she may develop a wound hematoma at the site of either incision or other blood clots leading to pelvic thrombophlebitis (inflammation of the major vein running from the pelvis into the leg) or a pulmonary embolus (a blood clot lodging in the lung).

Undergoing a c-section may also inflict psychological distress on the mother, beyond hormonal mood swings and postpartum depression (“baby blues”). The woman may feel disappointment and a sense of failure for not experiencing a vaginal delivery. She may feel isolated if the father or birthing coach is not with her in the operating room, or if an unfamiliar doctor treats her rather than her own doctor or midwife. She may feel helpless from a loss of control over labor and delivery with no opportunity to actively participate. To overcome these feelings, the woman must understand why the c-section was necessary. She must accept that she could not control the unforeseen events that made the c-section the optimum means of delivery, and recognize that preserving the health and safety of both her and her child was more important than her delivering vaginally. Women who undergo a c-section should be encouraged to share their feelings with others. Hospitals can often recommend support groups for such mothers. Women should also be encouraged to seek professional help if negative emotions persist.

### Normal results

The aftereffects of a c-section vary, depending on the woman’s age, physical fitness, and overall health. Following this procedure, a woman commonly experiences gas pains, incision pain, and uterine contractions (also common in vaginal delivery). Her hospital stay may be two to four days. Breastfeeding the baby is encouraged, taking care that it is in a position that keeps the baby from resting on the mother’s incision. As the woman heals, she may gradually increase

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Cesarean sections are considered to be major surgery and are therefore usually performed under the strict conditions of a hospital operating room. The procedure is generally performed by an obstetrician who specializes in the areas of women’s general health, pregnancy, labor and childbirth, prenatal testing, and genetics.

appropriate exercises to regain abdominal tone. Full recovery may be achieved in four to six weeks.

The prognosis for a successful vaginal birth after a cesarean (VBAC) may be at least 75%, especially when the c-section involved a low transverse incision in the uterus and there were no complications during or after delivery.

### Morbidity and mortality rates

Surgical injuries to the ureter or bowel occur in approximately 0.1% of c-sections. The risk of infection to the incision ranges from 2.5% to 15%. Urinary tract infections occur in 2–16% of patients post-c-section. The risk for developing a deep-vein thrombosis is three to five times higher in patients undergoing c-section than vaginal delivery.

Of the hundreds of thousands of women in the United States who undergo a c-section each year, about 500 die from serious infections, hemorrhaging, or other complications. The overall maternal mortality rate is estimated to be between six and 22 deaths per 100,000 births; approximately one-third of maternal deaths that occur after c-section can be attributed to the procedure. These deaths may be related to the health conditions that made the operation necessary, and not simply to the operation itself.

### Alternatives

When a c-section is being considered because labor is not progressing, the mother should first be encouraged to walk around to stimulate labor. Labor may also be stimulated with the drug oxytocin. A woman should receive regular prenatal care and be able to alert her doctor to the first signs of trouble. Once labor begins, she should be encouraged to move around and to urinate. The doctor should be conservative in diagnosing dystocia and fetal distress, taking a position of “watchful waiting” before deciding to operate.

## QUESTIONS TO ASK THE DOCTOR

- What is your medical training and how many c-sections have you performed?
- What percentage of women receive c-sections in your practice?
- If I have an elective c-section, what happens if I go into labor before the procedure is scheduled?
- What options are available to me for pain relief during and after the c-section?
- May a person of my choice remain with me during the procedure?
- When will I be able to hold/breastfeed my child?

Approximately 3–4% of babies present at term in the breech position. Before opting to perform an elective c-section, the doctor may first attempt to reposition the baby; this is called external cephalic version. The doctor may also try a vaginal breech delivery, depending on the size of the mother's pelvis, the size of the baby, and the type of breech position the baby is in. However, a c-section is safer than a vaginal delivery when the baby is 8 lb (3.6 kg) or larger, in a breech position with the feet crossed, or in a breech position with the head hyperextended.

A vaginal birth after cesarean (VBAC) is an option for women who have had previous c-sections and are interested in a trial of labor (TOL). TOL is a purposeful attempt to deliver vaginally. The success rate for VBAC in patients who have had a prior low transverse uterine incision is approximately 70%. The most severe risk associated with TOL is uterine rupture: 0.2–1.5% of attempted VBACs among women with a low transverse uterine scar will end in uterine rupture, compared to 12% of women with a classic uterine incision. To minimize this risk, the American College of Obstetricians and Gynecologists (ACOG) recommends that VBAC be limited to women with full-term pregnancies (37–40 weeks) who have only had one previous low transverse c-section.

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### ORGANIZATIONS

American Academy of Family Physicians. 8880 Ward Parkway, Kansas City, MO 64114. (816) 333 9700. <http://www.aafp.org>.

American Board of Obstetrics and Gynecology. 2915 Vine Street, Dallas, TX 75204. (214) 871 1619. <http://www.abog.org>.

American College of Obstetricians and Gynecologists. 409 12th St., SW, PO Box 96920, Washington, DC 20090 6920. <http://www.acog.org>.

International Cesarean Awareness Network. 1304 King sdale Ave., Redondo Beach, CA 90278. (310) 542 6400. <http://www.ican online.org>.

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Bethany Thivierge  
Stephanie Dionne Sherk

Charts see **Medical charts**

Cheiloplasty see **Cleft lip repair**

Chemical debridement see **Debridement**

## Chemistry screen

### Definition

A chemistry screen is a blood test done to check for normal levels of various blood elements. A chemistry screen measures levels of the following blood parameters: electrolytes, specific proteins, lipids, sugar, enzymes associated with specific organs, blood gases, waste products, and other blood elements.

## Purpose

There are many different reasons a physician may order a blood chemistry screen. A chemistry screen may be done as part of a routine examination to assess normal body function or a routine blood laboratory workup prior to surgery. Chemistry screens are used to identify potential disease states present in a patient, to monitor the progression of a patient's disease, to monitor disease treatment or recurrence of a disease, to observe levels of certain prescription medicines, or to assess the effects of prescription medicines that may be harmful.

## Demographics

Chemistry screens are performed whenever medically necessary regardless of age, gender, or race. They are routinely done on patients before surgical procedures.

## Description

Chemistry screens provide information on the quantity of specific chemical parameters in the blood. The patient's blood levels are listed along with a reference range of values for each component. The reference range indicates what the normal range of values is, from low to high. The chemistry screen compares the patient's blood levels to the reference range, and flags the patient's blood values as falling outside of the normal range when necessary. If the patient's values fall within the reference range, the value is considered normal. If the patient's value is higher or lower than the reference range, the physician then evaluates the results and follows a proper course of action. Whether or not a patient's blood chemistry screen demonstrates normal results can help determine whether a patient has a condition requiring surgery, or whether they are fit enough for a particular surgical procedure to be successful.

Chemistry screens can test for many different blood parameters, and can be customized by the physician to fit a particular patient's medical needs. When chemistry screens are customized, the physician merely indicates on the prescription that parameters not usually included in a standardized screen are to be included. Standardized forms of chemistry screens often used in the hospital include the Chem-6, Chem-7, Chem-12, and Chem-20, which measure 6, 7, 12, and 20 different blood components, respectively. The type of chemistry screen chosen by the physician is determined by the reason for the chemistry screen, any diseases the patient has, and specific medical symptoms the patient is experiencing that need to be explored via the results of the screen. The Chem-20 is

the most thorough, and includes all the parameters measured in the smaller screens with some additions.

### *The Chem-20 Chemistry Screen*

The Chem-20 chemistry screen is also known as a Sequential Multi-channel Analysis -20 (SMA-20) screen. The Chem-20 tests for 20 different chemical parameters listed below.

Blood Parameters Measured in the Chem-20 Chemistry Screen

- alanine aminotransferase (ALT);
- albumin;
- alkaline phosphatase (ALP);
- aspartate aminotransferase (AST);
- bicarbonate;
- blood urea nitrogen (BUN);
- calcium;
- carbon dioxide;
- chloride;
- conjugated bilirubin;
- creatinine;
- gamma glutamyl transpeptidase (GGT);
- glucose;
- lactate dehydrogenase (LDH);
- phosphate;
- potassium;
- sodium;
- total bilirubin;
- total cholesterol; and
- uric acid.

The blood components measured in the chemistry screen may be affected by various disease or nutritional states. A physician can learn much about the health condition of a patient by interpreting the results of a chemistry screen. The overall picture of health presented by the combined measurements in the chemistry screen are more informative than any one value alone.

### *General Description of Blood Parameters Measured in a Chemistry Screen*

Albumin is a blood component made in the liver. Albumin binds to and carries certain substances in the blood, including some medications. It is important for keeping the proper amount of fluid within blood vessels, tissue growth, and healing. Albumin is measured to help assess liver and kidney function, as well as nutritional state.



### NORMAL RESULTS REFERENCE RANGE (MAY VARY SLIGHTLY BY TESTING LABORATORY)

- alanine aminotransferase: 4–36 U/L;
- albumin: 3.5–5.5 g/dl;
- alkaline phosphatase: males 38–126 U/L, females 70–230 U/L;
- aspartate aminotransferase: 8–35 U/L;
- bicarbonate: 21–27 mEq/L;
- blood urea nitrogen: 7–18 mg/dl;
- calcium: 8.4–10.2 mg/dl;
- carbon dioxide: 35–45 mm Hg;
- chloride: 98–106 mEq/L;
- conjugated bilirubin: 0–0.2 mg/dl;
- creatinine: 0.6–1.2 mg/dl;
- gamma glutamyl transpeptidase: 7–50 U/L;
- glucose: 70–115 mg/dl;
- lactate dehydrogenase: 90–190 U/L;
- phosphate: 2.7–4.5 mg/dl; males >60 years old 2.3–3.7, females 2.8–4.1 mg/dl;
- potassium: 3.5–5.1 mEq/L;
- sodium: 135–145 mEq/L;
- total bilirubin: 0.2–1.0 mg/dl;
- total cholesterol: <200 mg/dl; and
- uric acid: males 3.5–7.2 mg/dl, females 2.6–6.0 mg/dl.

Blood urea nitrogen tests how well the kidneys are functioning to remove waste from the body for excretion in the urine. Creatinine is another parameter measured to help assess kidney function. The ratio of the amount of BUN and creatinine present in the blood provides a more detailed picture of kidney function than either measurement alone. Uric acid is an indicator of kidney function in removing waste from the blood.

ALT, ALP, AST, GGT, and LDH are all enzymes associated with the liver whose levels help assess liver function and whether the liver is damaged. In addition to the liver, ALP is associated with the kidney, bones, and placenta. LDH is also associated with many different organs including the heart, brain, and skeletal muscle and is released with tissue damage. Bilirubin is a breakdown product of red blood cells that is taken up from the blood by the liver, altered, and secreted through the bile into the digestive tract where it is partially excreted in feces. Measurements involving

### QUESTIONS TO ASK YOUR DOCTOR

- Why do I need a chemistry screen?
- Is the screen being done to look for signs of a specific disease?
- Do I need to fast before the chemistry screen?
- Will any of my prescription or non-prescription medications, herbal, or nutritional supplements affect the results of the chemistry screen?
- When will I get the results of the screen?
- Could any of the results affect my surgery if they are abnormal?

bilirubin assess how well the liver and associated biliary tract is functioning.

Electrolytes such as potassium, sodium, and chloride are measured in chemistry screens. Electrolytes are minerals found naturally in the body; are necessary to keep a balance in body fluids; to maintain normal body functions such as heart rhythm, muscle contraction, and brain function. Electrolyte imbalances can be caused by various disease states, including kidney disease. Calcium and phosphate levels may also be affected by kidney function, parathyroid disorders, and certain bone diseases. Both chloride and bicarbonate levels are indicative of acid base disorders and the ability of the blood to buffer acid and base to determine the pH value.

Cholesterol is measured to assess the level of fatty substances in the blood that affect the arteries and the heart. Glucose levels are potential indicators of liver function, pancreatic function, and the body's ability to utilize sugar for energy. Carbon dioxide gas levels in the blood assess the function of both the lungs and the kidneys. Each component of the chemistry screen can be affected in distinct ways by many different disease states. Interpreting the results of the chemistry screen requires much training and experience.

### How the Chemistry Screen is Done

Chemistry screens are done using blood samples. Having blood drawn from a vein with a syringe, usually in the arm, is necessary. Some parameters of the chemistry screen may require a period of fasting from all food and drink (except water) before the test. Patients should also avoid high fat foods or alcohol the night before the test. Since some medications may affect the results of the chemistry screen, it is critical

## KEY TERMS

**Bile**—Green fluid secreted by the liver, stored in the gallbladder, and released into the digestive tract. Bile aids in the digestion of fat.

**Biliary Tract**—The passages that allow the flow of bile from the gallbladder to the intestines.

**Parathyroid Gland**—Small endocrine glands that release hormones to regulate calcium and phosphorous.

**pH**—A value that indicates the balance between acid and base in a given substance.

**Phlebitis**—Inflammation of a vein.

that the physician take into account all prescription medications, non-prescription medications, herbal, and nutritional supplements that the patient is taking before running the chemistry screen. Some people may have slightly high or low values as their normal level. Age and gender may also affect the results in predictable patterns.

### Risks Associated with the Procedure

There is very little risk associated with having blood drawn for a chemistry screen. Most people have no side effects; some may get a small bruise where the syringe was inserted. With any blood draw there is a small chance that the area around the punctured vein may develop phlebitis, the inflammation of a vein. Phlebitis may also involve a bacterial infection if the site of the blood draw was not appropriately cleaned before the needle was inserted. Phlebitis can be locally painful but usually resolves in a short period of time.

Additionally, patients with disorders involving the inability of the blood to form normal blood clots should discuss their condition and their medications with the physician before the blood draw and chemistry screen is done.

### Who Performs the Procedure?

A chemistry screen is prescribed by a physician. It is a routine test that is run before a surgical procedure. A nurse often draws the blood sample from the patient. The blood sample is then sent to a specific hospital laboratory that tests the blood. The results of the chemistry screen are then sent to the physician for review.

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Maria Basile, Ph.D.

Chest radiography see **Chest x ray**

Chest surgery see **Thoracic surgery**

## Chest tube insertion

### Definition

A chest tube insertion is a procedure to place a flexible, hollow drainage tube into the chest in order to remove an abnormal collection of air or fluid from the pleural space (located between the inner and outer lining of the lung).

### Purpose

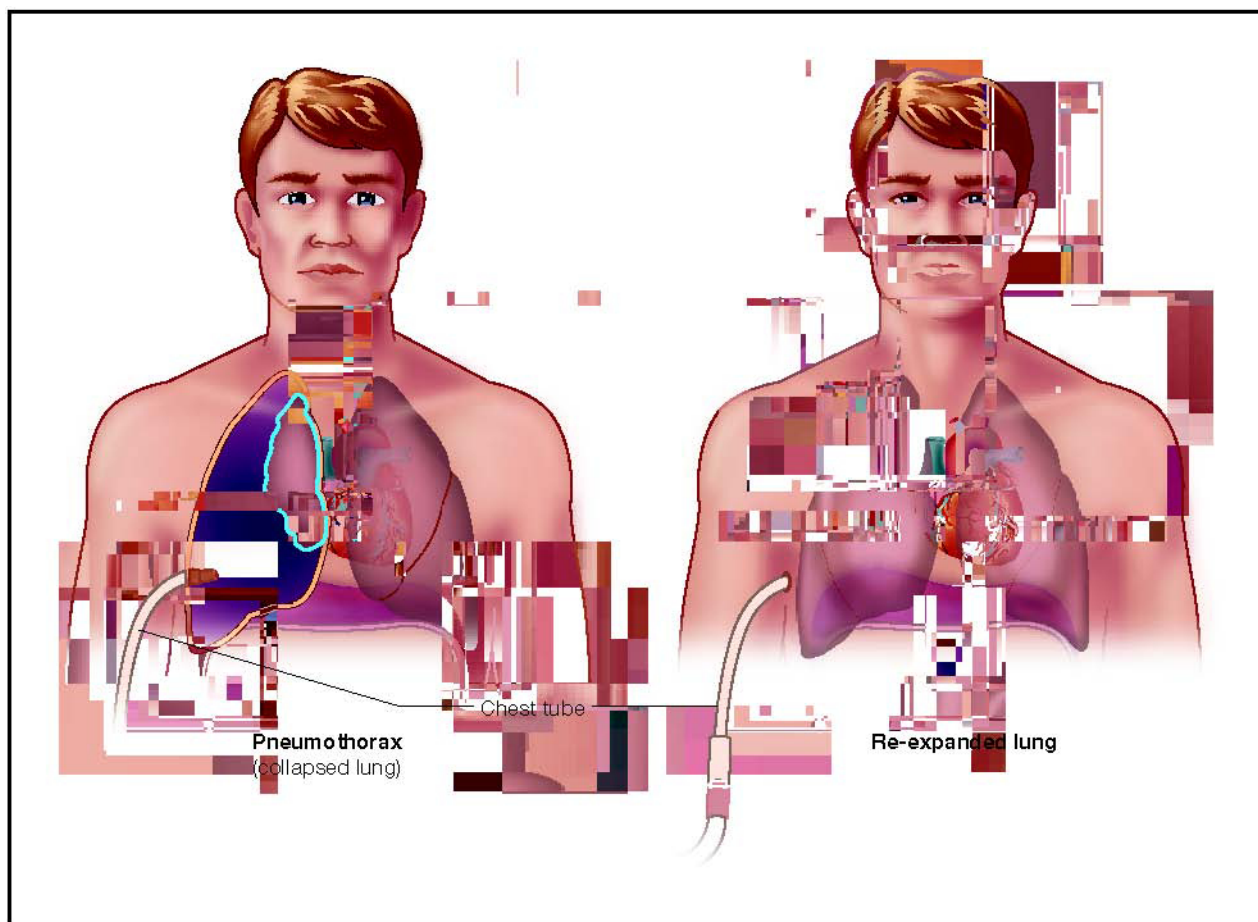
Chest tube insertions are usually performed as an emergency procedure. Chest tubes are used to treat conditions that can cause the lung to collapse, which occurs because blood or air in the pleural space can hamper the ability of a patient to breathe.

There are four common conditions that can require surgical chest tube insertion, including:

- pneumothorax (air leak from the lung into the chest)
- hemothorax (bleeding into the chest)
- empyema (lung abscess or pus in the chest)
- pneumothorax or hemothorax after surgery or from trauma to the chest

### Demographics

There is no available data concerning the demographics of chest tube insertion since this is a common procedure performed in emergency rooms and surgical departments. However, pneumothorax seems to occur most often in males 25–40 years of age.



(Illustration by Electronic Illustrators Group.)

### Description

The point of insertion in the chest most commonly occurs on the side (lateral thorax), at a line drawn from the armpit (anterior axillary line) to the side (lateral) of the nipple in males, or to the side (about 2 in [5 cm]) above the sternoxiphoid junction (lower junction of the sternum, or chest bone) in females. The skin is sterilized with antiseptic solution covering a wide area, and **local anesthesia** is administered to minimize discomfort. At the rib chosen for insertion, the skin over the rib is anesthetized with lidocaine (a local chemical anesthetic agent) using a 10-cc syringe and 25-gauge needle. At the rib below the rib chosen for pleural insertion, the tissues, muscles, bone, and lining covering the lung are also anesthetized using a 22-gauge needle.

All health-care providers will take precautions to keep the procedure sterile, including the usage of sterile gown, facemask, and eye protection. All equipment must be sterile as well and universal precautions are followed for blood and body fluids. Chest tube size is selected depending on the problem; an 18–20 F (rench) catheter

is used for pneumothorax, a 32–26 F catheter for hemothorax, and trauma patients usually require a 38–40 F catheter size; children generally require smaller tube sizes.

The patient's arm is placed over the head with a restraint on the affected side. For an insertion line down the armpit (axillary line insertion), the patient's head is elevated from the bed 30–60°. Using the anesthetic needle and syringe, the physician will insert a needle (aspirate) into the pleural cavity to check for the presence of air or fluid. Then, an incision is made and a clamp is used to open the pleural cavity. At this stage, either air or fluid will rush out when the pleural cavity is opened. The chest tube is positioned for insertion with a clamp and attached to the suction-drain system. A silk suture is used to hold the tube firmly in place. The area is wrapped, and an x ray is taken to visualize the status of the tube placement.

### Diagnosis/Preparation

The diagnosis for chest tube insertion depends on the primary cause of fluid or air in the pleural cavity.

## KEY TERMS

**Clavicle**—Also called the collar bone, it is a doubly curved long bone that connects the upper limb to the trunk.

**Diminished breath sounds**—A lack of breath sound due to fluid or air accumulation.

**Diminished chest expansion**—A decrease in the chest expansion due to an inability of the lungs to fully pull air in and push it out.

**Hyperresonance on percussion**—A highly resonating sound when the physician taps gently on a patient's back; this is not a normal finding and should be investigated with an x ray.

**Intercostal artery**—Runs from the aorta.

**Sternoxiphoid junction**—The lower junction of the sternum or breastbone.

For malignancy (cancer)-causing pleural effusion (fluid in the pleural space filled with malignant cells), the diagnosis can be established with positive cytopathology (cancer cell visualization and analysis) and a **chest x ray** that shows fluid accumulation.

The typical diagnostic signs and symptoms of empyema (lung infection) include fever, cough, and sputum discharge as well as the development of pleural effusion (causing chest pain and shortness of breath). This type of lung infection can progress to systemic disease with such signs as weakness, and loss of appetite (anorexia). Chest x rays can readily allow the clinician to view the pleural effusion and can also help to detect pneumothorax, since there is visual proof in the displacement of the tissues covering the lungs as a result of air in the pleural cavity. Additionally, during physical examinations, people with pneumothorax have diminished breath sounds, hyperresonance on percussion (a highly resonating sound when the physician taps gently on a patient's back), and diminished ability to expand the chest. Computed axial tomography (CAT) scans can be used to visualize and analyze complicated cases that may require chest tube insertion.

## Aftercare

The chest tube typically remains secure and in place until imaging studies such as x rays show that air or fluid has been removed from the pleural cavity. This removal of air or fluid will allow the affected lung to fully re-expand, allowing for adequate or improved

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The procedure is simple and widely utilized. Chest tube insertion is performed in a hospital, usually in the emergency department by an emergency room doctor, resident-in-training, or medical house officer. The medical and nursing team will monitor the patient at the hospital until the tube is removed.

breathing. After chest tube insertion, the patient will stay in the hospital until the tube is removed. It is common to expect complete recovery from chest tube insertion and removal. During the stay, the medical and nursing staff will carefully and periodically monitor the chest tube for air leaks or if the patient is having breathing difficulties. Deep breathing and coughing after insertion can help with drainage and lung re-expansion.

Aftercare should also include chest tube removal and follow-up care. The patient is placed in the same position in which the tube was inserted. Using precautions to maintain a sterile field, the suture holding the tube in place is loosened and the chest is prepared for tying the insertion-point wound. The chest tube is then clamped to disconnect the suction system. At this point, the patient will be asked to hold his or her breath, and the clinician will remove the tube with a swift motion. After the suture is tied, dressing (gauze with antibiotic ointment) and tape is securely applied to close the wound. A chest x ray should be repeated soon after tube removal and, within 48 hours, a routine **wound care** clinic follow-up is advised to remove the dressing and to further assess the patient's medical status and condition.

## Risks

Although chest tube insertion is a commonly used as a therapeutic measure, there are several complications that can develop, including:

- bleeding from an injured intercostal artery (running from the aorta)
- accidental injury to the heart, arteries, or lung resulting from the chest tube insertion
- a local or generalized infection from the procedure
- persistent or unexplained air leaks in the tube



## QUESTIONS TO ASK THE DOCTOR

- How is the procedure performed?
- Why do I need this procedure?
- Will I need to be sedated?
- When will I be able to resume normal activities?
- What aftercare is recommended?

- the tube can be dislodged or inserted incorrectly
- insertion of chest tube can cause open or tension pneumothorax

### Normal results

Chest tube insertion is a commonly used procedure, and it is typical for patients to recover fully from insertion and removal. If no complications develop, the procedure can relieve air or fluid accumulation in the pleural cavity that caused breathing impairment. Breathing is usually improved, and follow-up within the immediate 48 hours after hospital discharge is advised so that the patient can be further assessed with x rays and in the wound care clinic.

### Morbidity and mortality rates

Mortality and morbidity for chest tube insertion is not strongly associated with the procedure itself. The primary cause responsible for fluid or air accumulation in the pleural cavity is related to continued illness and outcome such as pleural effusions caused by cancer (malignant pleural effusions). Cancer, and not the insertion of a chest tube, determines a patient's sickness and outcome. Chest tube insertion may be problematic in persons affected with certain connective tissue diseases.

### Alternatives

The diagnosis, indications, and procedure for chest tube insertion are specific and unambiguous. There is no other alternative to rapidly remove accumulation of fluid or air within the pleural cavity.

### Resources

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*American Thoracic Society Homepage*.<http://www.thoracic.org>.

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## Chest x ray

### Definition

A chest x ray is a procedure used to evaluate organs and structures within the chest for symptoms of disease. Chest x rays include views of the lungs, heart, small portions of the gastrointestinal tract, thyroid gland, and the bones of the chest area. X rays are a form of radiation that can penetrate the body and produce an image on an x-ray film. Another name for the film produced by x rays is radiograph.

### Purpose

Chest x rays are ordered for a wide variety of diagnostic purposes. In fact, this is probably the most frequently performed type of x ray. In some cases, chest x rays are ordered for a single check of an organ's condition, and at other times, serial x rays are ordered to compare to previous studies. Some common reasons for chest x rays include the following.

#### *Pulmonary disorders*

Chest films are frequently ordered to diagnose or rule out pneumonia. One type, tuberculosis, can be observed on chest x rays, as can cardiac disease and damage to the ribs or lungs. Other pulmonary disorders such as pneumothorax (presence of air or gas in the chest cavity outside the lungs) or emphysema may be detected or evaluated through the use of chest x ray.

#### *Cancer*

A chest x ray may be ordered by a physician to check for possible tumors of the lungs, lymphoid tissue, or bones of the thorax. These may be primary tumors, or the areas in which cancer originates in the body. X rays also check for secondary spread of cancer from another organ to the chest.

## KEY TERMS

**Bronchi**—Plural of bronchus. The air passages in the lungs through which inhaled air passes on its way through the lungs.

**Diaphragm**—The large muscle that is located between the abdomen and the chest area. The diaphragm aids in breathing.

**Gastrointestinal**—The digestive organs and structures, including the stomach and intestines.

**Interstitial lung disease**—About 180 diseases fall into this category of breathing disorders. Injury or foreign substances in the lungs (such as asbestos fibers) as well as infections, cancers, or inherited disorders may cause the diseases. They can lead to breathing or heart failure.

**Lymphoid**—Tissues relating to the lymphatic system. A thin, yellowish fluid called lymph fluid, travels throughout the body. The lymphatic system helps control fluids in the body.

**Portable chest x ray**—An x ray procedure taken by equipment that can be brought to the patient. The resulting radiographs may not be as high in quality as stationary x-ray radiographs, but allow a technologist to come to the patient.

**Pulmonary**—Refers to the lungs and the breathing system and function.

**Serial x rays**—A number of x rays performed at set times in the disease progression or treatment intervals. The radiographs will be compared to one another to track changes.

**Sternum**—Also referred to as the breast bone, this is the long flat bone in the middle of the chest.

**Thorax**—The chest area, which runs between the abdomen and neck and is encased in the ribs.

**X ray**—A form of electromagnetic radiation with shorter wavelengths than normal light. X rays can penetrate most structures.

### *Cardiac disorders*

While less sensitive than **echocardiography**, chest x ray can be used to check for disorders such as congestive heart failure or pulmonary edema.

### *Other*

Chest x rays are used to see foreign bodies that may have been swallowed or inhaled, and to evaluate response to treatment for various diseases. Often the

chest x ray is also used to verify correct placement of chest tubes or catheters. Chest x rays can be used to check for fluid surrounding the lungs (pleural effusion).

## Description

Routine chest x rays consist of two views, the frontal view (referred to as posterioranterior or PA) and the lateral (side) view. It is preferred that the patient stand for this exam, particularly when studying collection of fluid in the lungs.

During the actual time of exposure, the technologist will ask the patient to hold his or her breath. It is very important in taking a chest x ray to ensure there is no motion that could detract from the quality and sharpness of the film image. The procedure will only take a few minutes and the time patients must hold their breath is a matter of a few seconds.

The chest x ray may be performed in a physician's office or referred to an outpatient radiology facility or hospital radiology department. In some cases, particularly for patients who cannot get out of bed, a portable chest x ray may be taken. Portable films are sometimes of poorer quality than those taken with permanent equipment, but are the best choice for some patients or situations when the patient cannot be moved or properly positioned for the chest x ray. Patients confined to bed may be placed in as upright a position as possible to get a clear picture, particularly of chest fluid.

## Preparation

There is no advance preparation necessary for chest x rays. Once the patient arrives in the exam area, a hospital gown will replace all clothing on the upper body and all jewelry must be removed.

## Aftercare

No aftercare is required by patients who have chest x rays.

## Risks

The only risk associated with chest x ray is minimal exposure to radiation, particularly for pregnant women and children. Those patients should use protective lead aprons during the procedure. Technologists are cautioned to check carefully possible dislodging of any tubes or monitors in the chest area from the patient's placement during the exam.

## Normal results

A radiologist, or physician specially trained in the technique and interpretation of x rays, will evaluate the results. A normal chest x ray will show normal structures for the age and medical history of the patient. Findings, whether normal or abnormal, will be provided to the referring physician in the form of a written report.

Abnormal findings on chest x rays are used in conjunction with a physician's physical exam findings, patient medical history, and other diagnostic tests, including laboratory tests, to reach a final diagnosis. For many diseases, chest x rays are more effective when compared to previous chest x-ray studies. The patient is asked to help the radiology facility in locating previous chest radiographs from other facilities.

## Pulmonary disorders

Pneumonia shows up on radiographs as patches and irregular areas of density (from fluid in the lungs). If the bronchi (air passages in the lungs which are usually not visible) can be seen, a diagnosis of bronchial pneumonia may be made. Shifts or shadows in the hila (lung roots) may indicate enlarged lymph nodes of a malignancy. Widening of the spaces between ribs and increased lucency of the lung fields suggests emphysema. Other pulmonary diseases may also be detected or suspected through chest x ray.

## Cancer

In nearly all patients with lung cancer, some sort of abnormality can be seen on a chest radiograph. Hilar masses (enlargements at that part of the lungs where vessels and nerves enter) are one of the more common symptoms as are abnormal masses and fluid buildup on the outside surface of the lungs or surrounding areas. Interstitial lung disease, which is a large category of disorders, many of which are related to exposure of substances (such as asbestos fibers), may be detected on a chest x ray as increased prominence of the interstitial pattern, often in the lower portions of the lungs.

## Other

Congestive heart failure and other cardiac diseases may be indicated on the view of a heart and lung in a chest radiograph. Fractures of the sternum and ribs are sometimes detected as breaks on the chest x ray, though often dedicated bone films are needed. In some instances, the radiologist's view of the diaphragm may indicate an abdominal problem. Foreign bodies that may have been swallowed or inhaled can

usually be located by the radiologist, as they will look different from any other tissue or structure in the chest. Serial chest x rays may be ordered to track changes over a period of time, usually to evaluate response to therapy of a malignancy.

## Resources

### ORGANIZATIONS

American Lung Association. 1740 Broadway, New York, NY 10019. (800) 586 4872. <http://www.lungusa.org>.  
Emphysema Anonymous, Inc. P.O. Box 3224, Seminole FL 34642. (813) 391 9977.  
National Heart, Lung and Blood Institute. P.O. Box 30105, Bethesda, MD 20824 0105. (301) 251 1222. <http://www.nhlbi.nih.gov>.

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Children's surgery see **Pediatric surgery**

Chin cosmetic surgery see **Mentoplasty**

Chloride test see **Electrolyte tests**

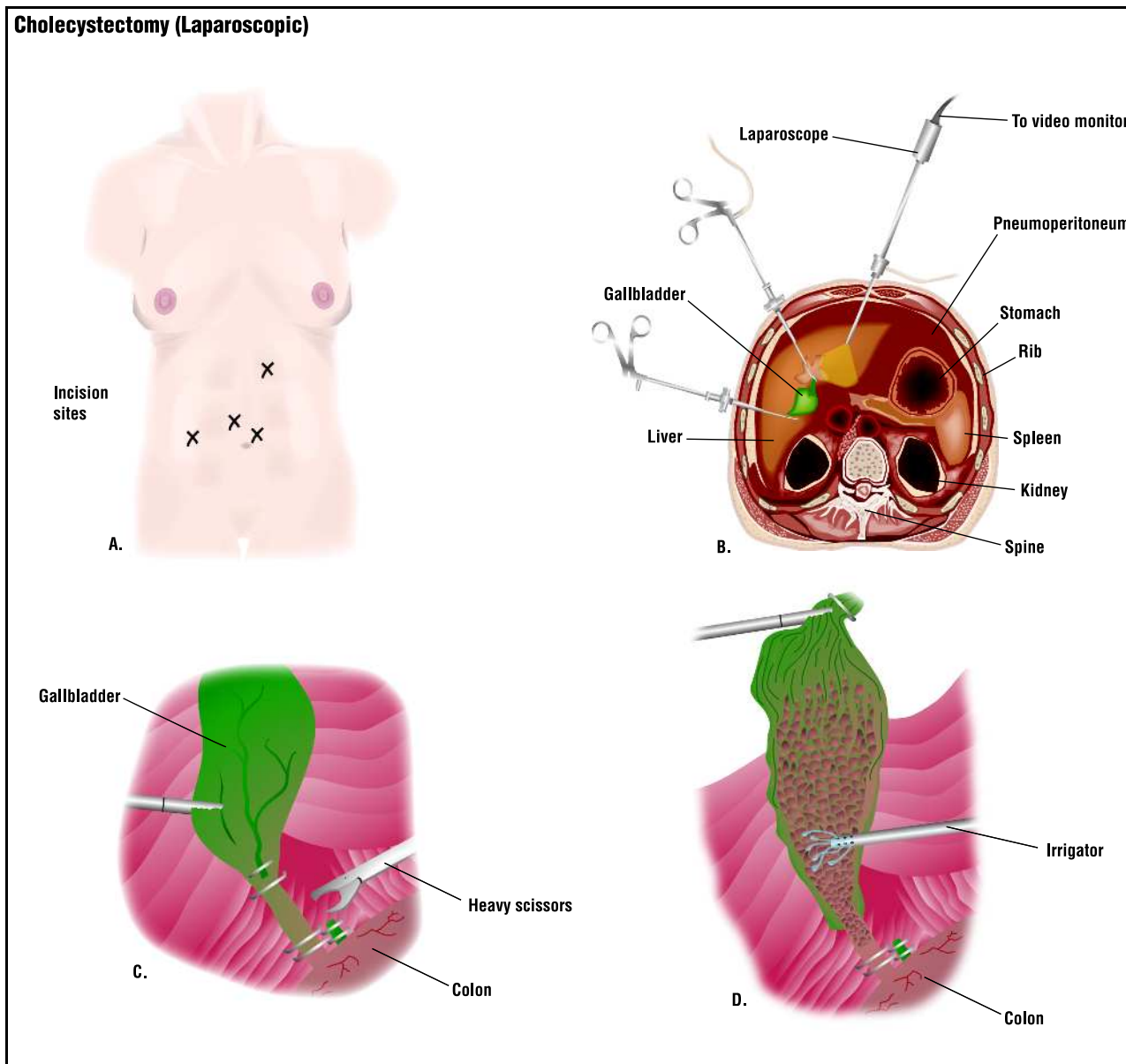
# Cholecystectomy

## Definition

A cholecystectomy is the surgical removal of the gallbladder. The two basic types of this procedure are open cholecystectomy and the laparoscopic approach. It is estimated that the laparoscopic procedure is currently used for approximately 80% of cases.

## Purpose

A cholecystectomy is performed to treat cholelithiasis and cholecystitis. In cholelithiasis, gallstones of varying shapes and sizes form from the solid components of bile. The presence of these stones, often referred to as gallbladder disease, may produce symptoms of excruciating right upper abdominal pain radiating to the right shoulder. The gallbladder may become the site of acute infection and inflammation, resulting in symptoms of upper right abdominal pain, nausea, and vomiting. This condition is referred to as cholecystitis. The surgical removal of the gallbladder can provide relief of these symptoms. Cholecystectomy is used to treat both acute and chronic cholecystitis when there are significant pain symptoms. The typical composition of gallstones is predominately cholesterol, or a compound called calcium bilirubinate.



In a laparoscopic cholecystectomy, four small incisions are made in the abdomen (A). The abdomen is filled with carbon dioxide, and the surgeon views internal structures with a video monitor (B). The gallbladder is located and cut with laparoscopic scissors (C). It is then removed through an incision (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

### *Cholelithiasis*

Most patients with cholelithiasis have no significant physical symptoms. Approximately 80% of gallstones do not cause significant discomfort. Patients who develop biliary colic generally do have some symptoms. When gallstones obstruct the cystic duct, intermittent, extreme, cramping pain typically develops in the right upper quadrant of the abdomen. This pain generally occurs at night and can last from a few

minutes to several hours. An acute attack of cholecystitis is often associated with the consumption of a large, high-fat meal.

The medical management of gallstones depends to a great degree on the presentation of the patient. Patients with no symptoms generally do not require any medical treatment. The best treatment for patients with symptoms is usually surgery. Laparoscopic cholecystectomy is typically preferred over the open surgical



## KEY TERMS

**Cholecystitis**—Infection and inflammation of the gallbladder, causing severe pain and rigidity in the upper right abdomen.

**Cholelithiasis**—Also known as gallstones, these hard masses are formed in the gallbladder or passages, and can cause severe upper right abdominal pain radiating to the right shoulder, as a result of blocked bile flow.

**Gallbladder**—A hollow pear-shaped sac on the under surface of the right lobe of the liver. Bile comes to it from the liver, and passes from it to the intestine to aid in digestion.

**Laparoscope**—A device consisting of a tube and optical system for observing the inside of the abdomen and its organs.

approach because of the decreased recovery period. Patients who are not good candidates for either type of surgery can obtain some symptom relief with drugs, especially oral bile salts.

### *Cholecystitis*

Cholecystitis is an inflammation of the gallbladder, both acute and chronic, that results after the development of gallstones in some individuals. The most common symptoms and physical findings associated with cholecystitis include:

- pain and tenderness in the upper right quadrant of the abdomen
- nausea
- vomiting
- fever
- jaundice
- history of pain after eating large, high-fat meals

### Demographics

Overall, cholelithiasis is found in about 20,000,000 Americans. An overwhelming majority of these individuals do not ever develop symptoms. Overall, about 500,000–600,000 (2–3%) are treated with cholecystectomies every year. Typically, the incidence of cholelithiasis increases with age. The greatest incidence occurs in individuals between the ages of 40 and 60 years. The following groups are at an increased risk for developing cholelithiasis:

- pregnant women
- females

- family history of gallstones
- obesity
- certain types of intestinal disease
- age greater than 40 years
- oral contraceptive use
- diabetes mellitus
- estrogen replacement therapy
- rapid weight loss

Overall, patients with cholelithiasis have about a 20% chance of developing biliary colic (the extremely painful complication that usually requires surgery) over a 20-year period.

Acute cholecystitis develops most commonly in women between the ages of 40 and 60 years. Some ethnic groups, such as Native Americans, have a dramatically higher incidence of cholecystitis.

## Description

The laparoscopic cholecystectomy involves the insertion of a long, narrow cylindrical tube with a camera on the end, through an approximately 0.4 in (1 cm) incision in the abdomen, which allows visualization of the internal organs and projection of this image onto a video monitor. Three smaller incisions allow for insertion of other instruments to perform the surgical procedure. A laser may be used for the incision and cautery (burning unwanted tissue to stop bleeding), in which case the procedure may be called laser laparoscopic cholecystectomy.

In a conventional or open cholecystectomy, the gallbladder is removed through a surgical incision high in the right abdomen, just beneath the ribs. A drain may be inserted to prevent accumulation of fluid at the surgical site.

## Diagnosis/Preparation

The initial diagnosis of acute cholecystitis is based on the following symptoms:

- constant, dull pain in upper right quadrant of abdomen
- fever
- chills
- nausea
- vomiting
- pain aggravated by moving or coughing

Most patients have elevated leukocyte (white blood cells) levels. Leukocyte levels are determined using laboratory analysis of blood samples. Traditional x rays are not particularly useful in diagnosing

cholecystitis. Ultrasonography of the gallbladder usually provides evidence of gallstones, if they are present. Ultrasonography can also help identify inflammation of the gallbladder. Nuclear imaging may also be used. This type of imaging cannot identify gallstones, but it can provide evidence of obstruction of the cystic and common bile ducts.

Cholelithiasis is initially diagnosed based on the following signs and symptoms:

- history of biliary colic or jaundice
- nausea
- vomiting
- sudden onset of extreme pain in the upper right quadrant of the abdomen
- fever
- chills

Laboratory blood analysis often finds evidence of elevated bilirubin, alkaline phosphatase, or aminotransferase levels. Ultrasonography, computed tomography (CT) scanning, and radionuclide imaging are able to detect the impaired functioning of bile flow and of the bile ducts.

As with any surgical procedure, the patient will be required to sign a consent form after the procedure is explained thoroughly. Food and fluids will be prohibited after midnight before the procedure. Enemas may be ordered to clean out the bowel. If nausea or vomiting are present, a suction tube to empty the stomach may be used, and for laparoscopic procedures, a urinary drainage catheter will also be used to decrease the risk of accidental puncture of the stomach or bladder with insertion of the trocar (a sharp, pointed instrument).

### Aftercare

**Postoperative care** for the patient who has had an open cholecystectomy, as with those who have had any major surgery, involves monitoring of blood pressure, pulse, respiration, and temperature. Breathing tends to be shallow because of the effect of anesthesia, and the patient's reluctance to breathe deeply due to the pain caused by the proximity of the incision to the muscles used for respiration. The patient is shown how to support the operative site when breathing deeply and coughing and is given pain medication as necessary. Fluid intake and output is measured, and the operative site is observed for color and amount of wound drainage. Fluids are given intravenously for 24–48 hours, and then the patient's diet is gradually advanced as bowel activity resumes. The patient is generally encouraged to walk eight hours after surgery and discharged from the hospital within three to five

days, with return to work approximately four to six weeks after the procedure.

Care received immediately after laparoscopic cholecystectomy is similar to that of any patient undergoing surgery with **general anesthesia**. A unique postoperative pain may be experienced in the right shoulder related to pressure from carbon dioxide used in the laparoscopic tubes. This pain may be relieved by lying down on the left side with right knee and thigh drawn up to the chest. Walking will also help increase the body's reabsorption of the gas. The patient is usually discharged the day after surgery and allowed to shower on the second postoperative day. The patient is advised to gradually resume normal activities over a three-day period, while avoiding heavy lifting for about 10 days.

### Risks

Potential problems associated with open cholecystectomy include respiratory problems related to location of the incision, wound infection, or abscess formation. Possible complications of laparoscopic cholecystectomy include accidental puncture of the bowel or bladder and uncontrolled bleeding. Incomplete reabsorption of the carbon dioxide gas could irritate the muscles used in respiration and cause respiratory distress. While most patients with acute cholecystitis respond well to the laparoscopic technique, about 5–30% of these patients require a conversion to the open technique because of complications. Some patients undergoing elective laparoscopic cholecystectomy will require conversion to an open procedure.

### Normal results

The prognosis for cholecystitis and cholelithiasis patients who receive cholecystectomy is generally good. Overall, cholecystectomy relieves symptoms in about 95% of cases.

### Morbidity and mortality rates

The complication rate is less than 0.5% with open cholecystectomy and about 1% with laparoscopic cholecystectomy. The primary complication with the open technique is infection, whereas bile leak and hemorrhage are the most common complications associated with the laparoscopic technique. The overall mortality rate associated with cholecystectomy is less than 1%. However, the rate of mortality in the elderly is higher.

In a small minority of cases, symptoms will persist in patients who receive cholecystectomy. This has been named the post-cholecystectomy syndrome, and

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Cholecystectomy, including the laparoscopic approach, is usually performed by a general surgeon who has completed a five-year residency training program in all components of general surgery and, in particular, proper techniques involving the use of the laparoscope. If surgery is being considered, it is a good idea to find out how many laparoscopic cholecystectomies the surgeon performs on a yearly basis. Laparoscopic cholecystectomies are often performed in the specialized department of a general hospital, but they are also performed in specialized gastrointestinal clinics or institutes for gastrointestinal disorders.

usually results from functional bowel disorder, errors in diagnosis, technical errors, overlooked common bile duct stones, recurrence of common bile duct stones, or the spasm of a structure called the sphincter of Oddi.

### Alternatives

Acute cholecystitis usually improves following conservative therapy in most patients. This conservative therapy involves the withholding of oral feedings, the use of intravenous feedings, and the administration of **antibiotics** and **analgesics**. This is only a short-term alternative in hospitalized patients. Most of these patients should receive cholecystectomy within a few days to prevent recurrent attacks. In the short term, patients often receive narcotic analgesics such as meperidine to relieve the intense pain associated with this condition. Patients who have evidence of gallbladder perforation or gangrene need to have an immediate cholecystectomy.

In patients with cholelithiasis who are deemed unfit for surgery, alternative treatments are sometimes effective. These individuals often have symptom improvement after lifestyle changes and medical therapy. Lifestyle changes include dietary avoidance of foods high in polyunsaturated fats and gradual weight loss in obese individuals. Medical therapy includes the administration of oral bile salts. Patients with three or fewer gallstones of cholesterol composition and with a gallstone diameter less than 0.6 in (15 mm) are more likely to receive medical therapy and have positive results. The primary requirements for receiving

## QUESTIONS TO ASK THE DOCTOR

- What are my alternatives?
- Can you recommend a surgeon who performs the laparoscopic procedure?
- If surgery is appropriate for me, what are the next steps?
- How many times have you performed open or laparoscopic cholecystectomy?
- Are you a board-certified surgeon?
- What type of outcomes have you had?
- What are the most common side effects or complications?
- What should I do to prepare for surgery?
- What should I expect following the surgery?
- Can you refer me to one of your patients who has had this procedure?
- What diagnostic procedures are performed to determine if I require surgery?
- Will I need to see another specialist for the diagnostic procedures?

medical therapy include the presence of a functioning gallbladder and the absence of calcification on **CT scans**. Other non-surgical alternatives include using a solvent to dissolve the stones and using sound waves to break up small stones. A major drawback to medical therapy is the high recurrence rate of stones in those treated, as well as the possibility of successfully removing stones, but leaving an infected gallbladder behind, requiring a later operation for its removal.

### Resources

#### BOOKS

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## Cholesterol and triglyceride tests

### Definition

Cholesterol and triglyceride tests are components of a **lipid profile** that provide important data about an individual's risk for developing cardiovascular (heart) disease.

### Purpose

The purpose of cholesterol and triglyceride tests is to evaluate an individual's risk of cardiovascular (heart) disease.

### Description

The body uses cholesterol when building cells and producing hormones. An excess of cholesterol in the blood can build up along the inside of the artery walls, forming plaque. Large amounts of plaque increase the chances of having a heart attack or stroke.

Triglycerides are a type of fat the body uses for storing energy. Only small amounts are found in the blood. Having a high triglyceride level along with a high LDL cholesterol may increase a person's risk of having heart disease more than having only a high LDL cholesterol level.

Cholesterol and triglyceride testing is done for several reasons.

- As a component of a routine physical examination to screen for a lipid disorder.
- To evaluate an individual's risk for heart disease.
- To evaluate an individual's response to drugs used to treat lipid disorders.
- To check for a rare genetic disease that causes very high cholesterol levels in persons that have unusual symptoms such as yellow fatty deposits in the skin (xanthomas).

Cholesterol and triglyceride tests are components of a lipid profile. A lipid profile includes four blood tests: total cholesterol, HDL cholesterol, LDL cholesterol and triglycerides.

Dietary fats, including cholesterol, are absorbed from the small intestines. They are converted into triglycerides, which are then packaged into lipoproteins. All of these products are transported into the liver by chylomicrons. After a fast (not eating) lasting at least 12 hours, chylomicrons are absent from the

### WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

- Cholesterol and triglyceride tests are typically ordered by a family doctor, internist or geriatrician.
- A blood sample is usually obtained by a nurse, phlebotomist or medical technologist.
- The blood sample is tested or processed by a medical technologist.
- Results are usually reviewed, returned to the person being tested and interpreted by the physician initially ordering the lipid profile.

bloodstream. This is the reason why persons that are having an LDL test must fast overnight.

A desirable cholesterol level is less than 200 mg/dL.

- Desirable: Less than 200 mg/dL
- Borderline high: 200-239 mg/dL
- High: 240 mg/dL or more

A healthy triglyceride level is 150 mg/dL or less.

- Normal: Less than 150 mg/dL
- Borderline high: 150-199 mg/dL
- High: 200-499 mg/dL
- Very high: 500 mg/dL and higher

Pharmaceutical interventions are based, in part, on cholesterol and triglyceride test values.

Cholesterol and triglyceride levels vary according to a person's age and gender.

Ranges for cholesterol and triglyceride values vary slightly among different laboratories.

Cholesterol and triglyceride tests can be ordered at any time. Routine lipid profiles that are used to monitor the effectiveness of drugs intended to reduce serum cholesterol are usually performed every three months.

Some medical experts recommend routine cholesterol and triglyceride testing to screen for problems that affect the way cholesterol is produced, used, carried in the blood, or disposed of by the body.

### Precautions

A fast (not eating) for a minimum of 12 hours before drawing blood contributes to a more accurate



## QUESTIONS TO ASK YOUR DOCTOR

- Why are cholesterol and triglyceride tests needed?
- What do the results indicate for my health?
- What treatment options do I have?

measurement of cholesterol and triglycerides in the blood. No other precautions are needed.

At the time of drawing blood, the only precaution needed is to clean the venipuncture site with alcohol.

### Side effects

The most common side effects of cholesterol or triglyceride tests are minor bleeding (hematoma) or bruising at the site of venipuncture.

### Interactions

There are no interactions for a cholesterol or triglyceride test.

### Resources

#### BOOKS

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## KEY TERMS

**Hematoma**—A collection of blood that has entered a closed space.

**Phlebotomist**—Health care professional trained to obtain samples of blood.

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### ORGANIZATIONS

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- National Accreditation Agency for Clinical Laboratory Sciences. "Information about laboratory tests." 2008 [cited February 25, 2008]. <http://www.nacls.org/>.

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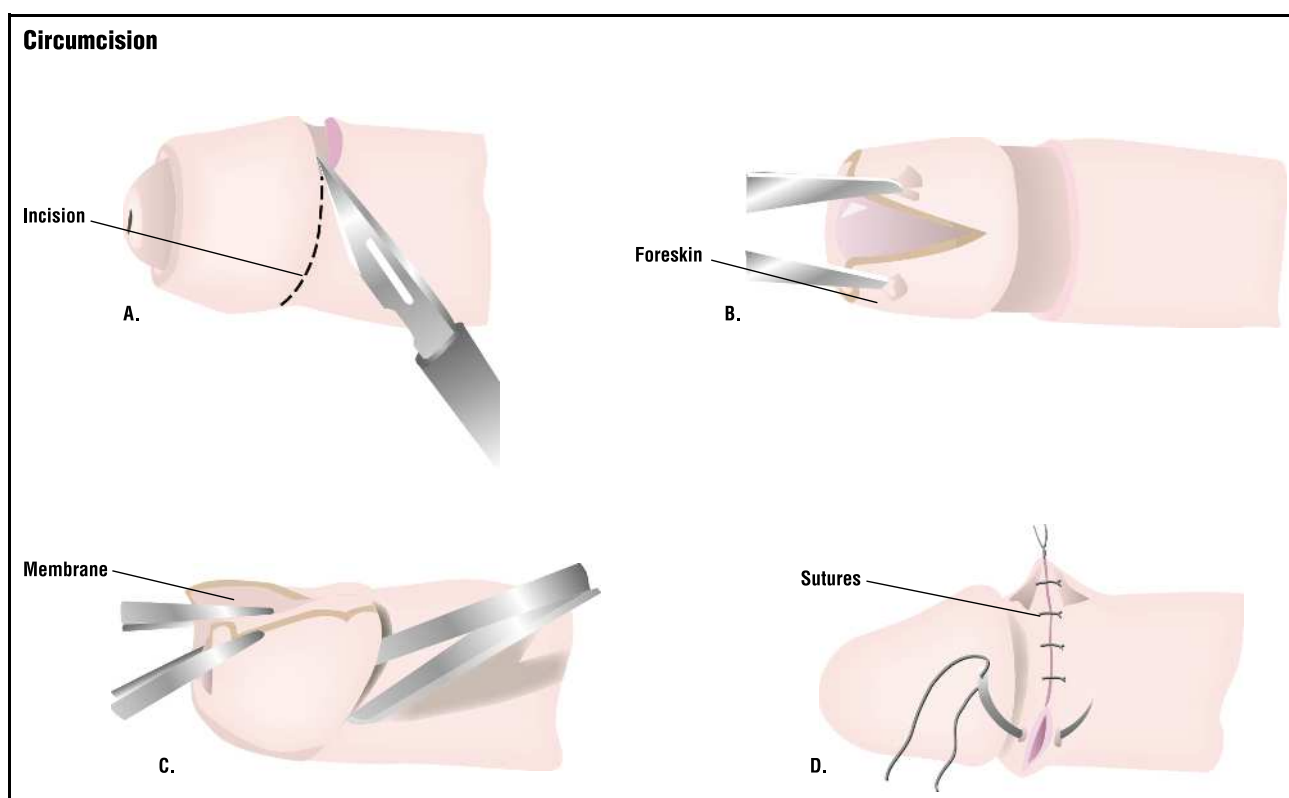
Cholesterol tests see **Lipid tests**

Circulation support see **Mechanical circulation support**

## Circumcision

### Definition

Circumcision is the surgical removal of the foreskin of the penis, or the prepuce of the clitoris.



During a circumcision, the outer layer of the foreskin around the penis is cut (A). The foreskin is pulled away (B), and the remaining membrane is cut away (C). Sutures are used to stitch the area (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

### Purpose

In the United States, circumcision in infant boys is performed for social, medical, or cultural/religious reasons. Once a routine operation urged by pediatricians and obstetricians for newborns in the middle of the twentieth century, circumcision has become an elective option that parents make for their sons on an individual basis. Families who practice Judaism or Islam may select to have their sons circumcised as a religious practice. Others choose circumcision for medical benefits.

Female circumcision (also known as female genital mutilation) is usually performed for cultural and social reasons by family members and others who are not members of the medical profession, with no anesthesia. Not only is the prepuce of the clitoris removed, but often the vaginal opening is sewn to make it smaller. This practice is supposed to ensure the virginity of a bride on her wedding day. It also prevents the woman from achieving sexual pleasure during coitus. This practice is not universally approved by the medical profession and is considered by many to be a human rights violation.

Some of the medical reasons parents of male infants choose circumcision are to protect against infections of the urinary tract and the foreskin, prevent cancer, lower the risk of getting sexually transmitted diseases, and prevent phimosis (a tightening of the foreskin that may close the opening of the penis). Though studies indicate that uncircumcised boys under the age of five are 20 times more likely than circumcised boys to have urinary tract infections (UTIs), the rate of incidence of UTIs is quite low and treatable with **antibiotics**. There are also indications that circumcised men are less likely to suffer from penile cancer, inflammation of the penis, or have many sexually transmitted diseases. Here again, there is a low rate of incidence. Good hygiene usually prevents most infections of the penis. Phimosis and penile cancer are very rare, even in men who have not been circumcised. Education and safe sex practices can prevent sexually transmitted diseases in ways that a surgical procedure cannot because these are diseases acquired through risky behaviors.

In 2002, however, research indicated that circumcised men may be less at risk for contracting HIV

## KEY TERMS

**Foreskin**—A covering fold of skin over the tip of the penis.

**Glans**—The cone-shaped tip of the penis.

**Hernia**—Bulging of abdominal structures through an abnormal opening in the muscular wall.

**Hydrocele**—Collection of fluid in the scrotum.

**Hypospadias**—A congenital deformity of the penis where the urinary tract opening is not at the tip of the glans.

**Phimosis**—A tightening of the foreskin that may close the opening of the penis.

**Prepuce**—A fold like the foreskin that covers the clitoris; another name for foreskin.

infections than uncircumcised men, whose foreskins have higher concentrations of cells that are targeted specifically by HIV. Genital hygiene and safe sex practices are still crucial to preventing the spread of HIV.

Another study found that circumcised men who engaged in risky sexual behaviors were less likely to contract penile human papillomavirus (HPV), which has been implicated in the incidence of cervical cancer in women. There was little difference between circumcised and uncircumcised men's incidence of the virus if the men were in a monogamous relationship.

With these factors in mind, the American Academy of Pediatrics has issued a policy statement that maintains that though there is existing scientific evidence that indicates the medical benefits of circumcision, the benefits are not strong enough to recommend circumcision as a routine practice.

### Demographics

Though the incidence of male circumcision has decreased from 90% in 1979 to 60% in 1999, it is still the most common surgical operation in the United States. Circumcision rates are much lower for the rest of the industrialized world. In Britain, it is only done for religious practices or to correct a specific medical condition of the penis.

### Description

The foreskin of the penis protects the sensitivity of the glans and shields it from irritation by urine, feces, and foreign materials. It also protects the urinary opening against infection and incidental injury.

In circumcision of infants, the foreskin is pulled tightly into a specially designed clamp, which forces the foreskin away from the broadened tip of the penis. The clamp applies pressure that stops bleeding from blood vessels that supply the foreskin. In older boys or adults, an incision is made around the base of the foreskin, the foreskin is pulled back, and then it is cut away from the tip of the penis. **Stitches** are usually used to close the skin edges.

Circumcision should not be performed on infants with certain deformities of the penis that may require a portion of the foreskin for repair. The most common condition for surgery using the foreskin is hypospadias, a congenital deformity of the penis where the urinary tract opening is not at the tip of the glans. Also, infants with a large hydrocele, or hernia, may suffer complications through circumcision. Premature infants and infants with serious infections are also poor candidates to be circumcised, as are infants with hemophilia, other bleeding disorders, or whose mothers had taken **anticoagulant drugs**. In older boys or men, circumcision is a minor procedure and can be performed on virtually anyone without a serious illness or unusual deformity.

### Diagnosis/Preparation

Despite a long-standing belief that infants do not experience serious pain from circumcision, physicians now believe that some form of **local anesthesia** is necessary. Over 80% of pediatric residents, 80% of family practice residents, and 60% of obstetric/gynecological residents are routinely given instruction on pain control for circumcisions. Local anesthesia is often injected at the base of the penis (dorsal penile nerve block) or under the skin around the penis (subcutaneous ring block). Both anesthetics block key nerves and provide significantly lowered perceived pain. EMLA cream (lidocaine 2.5% and prilocaine 2.5%) can also be used.

### Aftercare

After circumcision, the wound should be washed daily. An antibiotic ointment or petroleum jelly may be applied to the site. If there is an incision, a wound dressing will be present and should be changed each time the diaper is changed. Sometimes a plastic ring is used instead of a bandage. The ring will usually fall off in 5–8 days. The penis will heal in 7–10 days.

Infants who undergo circumcision may be fussy for some hours afterward, so parents should be prepared for crying, feeding problems, and sleep problems. Generally, these go away within a day. In older

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Medical circumcisions are performed in the hospital by a pediatrician for an infant or child. For an adult, a general surgeon or urologist may perform a circumcision, especially if there are other urinary tract repairs to be made.

A Jewish religious circumcision, a *Bris Milah*, is performed when an infant male is eight days old. It is conducted by a trained *mohel*, with family and friends present, in a non-medical setting.

boys, the penis may be painful, but this will go away gradually. A topical anesthetic ointment or spray may be used to relieve this temporary discomfort. There may also be a bruise on the penis, which typically disappears with no particular attention.

### Risks

Complications following newborn circumcision appear in between two and six of every 1,000 procedures. Most complications are minor. Bleeding occurs in half of the complications and is usually easy to control. Infections are rare and occur at the circumcision site, the opening to the bladder, or at the tip of the penis as a result of contact with urine or feces. Infections are indicated by fever and signs of inflammation, and are treatable with antibiotics.

There may be injuries to the penis itself, and these may be difficult to repair.

### Normal results

When an infant or an adult is circumcised, the surgical wound should heal quickly, with normal urinary function resuming immediately. An infant or older child should have no complications. After a period of recovery, an adult male should be able to resume sexual intercourse normally.

### Morbidity and mortality rates

Complications as a result of circumcision are usually minor if the physician is experienced and makes sure the Mogen or Gomco clamps that are used are in good working order. Severe penile injuries are rare, but they are serious, and include penile **amputation** (partial or total), laceration, hemorrhage, and damage to the urinary tract. Other serious complications such

## QUESTIONS TO ASK THE DOCTOR

- Is there a medical reason for performing a circumcision on my child?
- Is there new research about the benefits of circumcisions that I should be aware of?
- What kind of anesthesia will be used during the procedure?
- What should I be aware of when I go home with the baby?
- When should I call the doctor?

as meningitis, penile necrosis, necrotizing fasciitis, and sepsis can occur. Some of these, like meningitis and sepsis, can even cause **death**.

Hidden complications also occur. Subcutaneous masses have been detected under the skin of the penis. These masses usually have no symptoms, but, left untreated, could lead to more serious outcomes. Physicians should examine the penis at every well-baby checkup during the first year. If a mass is detected, it can easily be removed under a local anesthesia and sent to a pathology lab.

### Alternatives

The only alternative to this surgery is to make an informed decision not to have an infant circumcised. Some Jewish parents are even electing not to hold a *Bris Milah*, a religious circumcision, for their sons, and choosing instead to hold a *Brit Shalom*, a naming ceremony, similar to that given for their infant daughters.

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Claw toe surgery see **Hammer, claw, and  
mallet toe surgery**

## Cleft lip repair

### Definition

Cleft lip repair (cheiloplasty) is a surgical procedure to correct a groove-like defect in the lip.

### Purpose

A cleft lip does not join together (fuse) properly during embryonic development. Surgical repair corrects the defect, preventing future problems with breathing, speaking, and eating, and improving the person's physical appearance.

### Demographics

Cleft lip is the second most common embryonic (congenital) deformity. (Club foot is the most common congenital deformity.) Cleft lip, with or without cleft palate, occurs in approximately one in 750 live births. The highest incidence exists in Native American Indians and Japanese (approximately one in 350 births). African Americans and Africans represent the lowest incidence of cleft lip deformity (approximately one in 1,500 births). There is a higher frequency of clefting in certain populations of Scandinavia and Middle European countries.

Cleft lip occurs more commonly in males, while cleft palate is more likely to occur in females. Cleft lip alone (without cleft palate) occurs in approximately 20% of cases across both genders. The majority of cases, fully 80%, have both cleft lip and cleft palate. A unilateral cleft lip, commonly occurring on the left side, is more common than a bilateral cleft lip.

### Potential causes

Most cases of cleft lip have no known cause. However, there is a strong genetic correlation. Other single gene defects that are associated with cleft lip include: Van der Woude syndrome, Opitz Syndrome, Aarskog syndrome, Fryns syndrome, Waardenburg syndrome, and Coffin-Siris syndrome. Approximately 5% of cleft

conditions are associated with a genetic syndrome. Most of these syndromes do not include mental retardation.

Facial cleft has been implicated with maternal exposure to environmental causes, such as rubella or medications that can harm the developing embryo. These medications include steroids, anti-seizure drugs, vitamin A, and oral anti-acne medications (such as Accutane) taken during the first three months of pregnancy. Cleft lip is also associated with fetal alcohol syndrome and maternal diabetes.

Risk of cleft lip increases with paternal age, especially over 30 years at the time of conception. Generally, the risk is higher when both parents are over 30 years of age. However, most cases seem to be isolated within the family with no obvious causation.

When the affected child has unilateral cleft lip and palate, the risk for subsequent children increases to 4.2%. Advances in high-resolution ultrasonography (prenatal **ultrasound** exam) have made it possible to detect facial abnormalities in the developing embryo (in utero).

### Description

#### *Developmental anatomy*

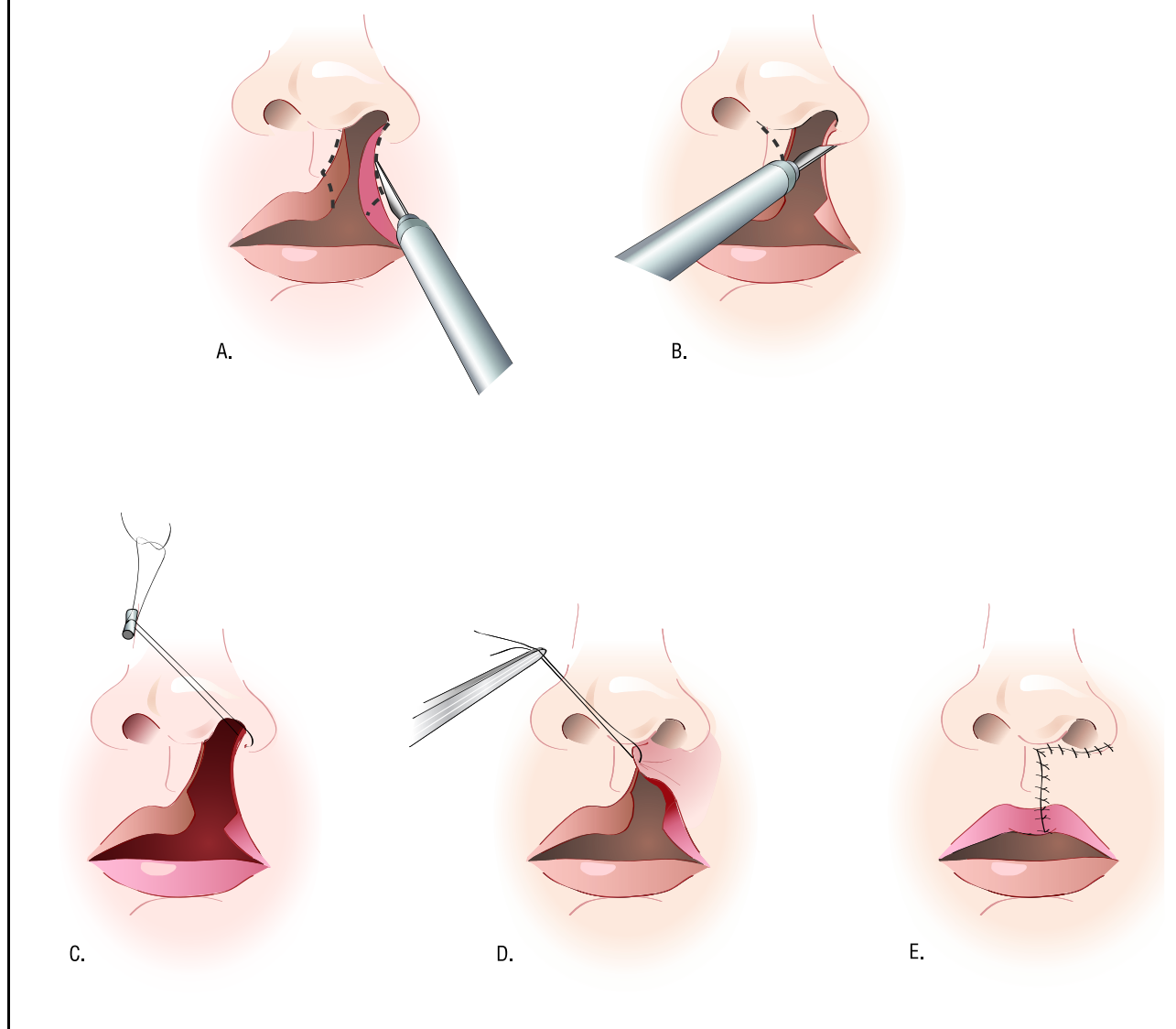
Important structures of the embryo's mouth form at four to seven weeks of gestation. Development during this period entails migration and fusion of mesenchymal cells with facial structures. A cleft can develop along the lip if this migration and fusion is interrupted (usually by a combination of genetic and environmental factors). The type of clefting varies with the embryonic stage when its development occurred.

There are several types of cleft lip, ranging from a small groove on the border of the upper lip to a larger deformity that extends into the floor of the nostril and part of the maxilla (upper jawbone).

Unilateral cleft lip results from failure of the maxillary prominence on the affected side to fuse with medial nasal prominences. The result is called a persistent labial groove. The cells of the lip become stretched and the tissues in the persistent groove break down, resulting in a lip that is divided into medial (middle) and lateral (side) portions. In some cases, a bridge of tissue (simart band) joins together the two incomplete lip portions.

Bilateral cleft lip occurs in a fashion similar to the unilateral cleft. Patients with bilateral cleft lip may have varying degrees of deformity on each side of the defect. An anatomical structure, intermaxillary segment, projects to the front and hangs unattached. Defects associated with bilateral cleft lip are particularly problematic

## Cleft lip repair



The edges of the cleft between the lip and nose are cut (A and B). The bottom of the nostril is formed with suture (C). The upper part of the lip tissue is closed (D), and the stitches are extended down to close the opening entirely (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

due to discontinuity of the muscle fibers of the orbicularis oris (primary muscle of the lip.) This deformity can result in closure of the mouth and pursing of the lip.

### Classification

In addition to classification as unilateral or bilateral, cleft lips are further classified as complete or incomplete. A complete cleft involves the entire lip, and typically the alveolar arch. An incomplete cleft

involves only part of the lip. The Iowa system (which also classifies cleft palate) classifies cleft lip in five groups, including:

- group I—clefts of the lip only
- group II—clefts of palate only
- group III—clefts of lip, alveolus, and palate
- group IV—clefts of lip and alveolus
- group V—miscellaneous

## KEY TERMS

**Alveolar arch**—An arch formed by the ridge of the alveolar process of the mandible (jawbone) or maxilla.

**Alveolar part of the maxilla**—The part of the bony upper jaw that contains teeth (the upper gum).

**Bilateral cleft lip**—Cleft that occurs on both sides of the lip.

**Buccal sulcus**—Groove in the upper part of the upper jaw (where there are teeth).

**Cleft**—Split or opening, which can occur in the lip or palate or both.

**Columella**—Outer portion of the nose that divides the nostrils.

**Cupid's bow**—Double curve of the upper lip.

**Epithelium**—Protective membranous layer of tissue, usually a single layer of cells very close together, which lines the cavities outside of an organism.

**Flap**—Anatomical section that is surgically cut using special incisions and moved (rotated/advanced) to repair a defect.

**Inferior turbinate**—Bony projections on each side of the nose.

**Labial**—Of or pertaining to the lips.

**Lateral**—Of or pertaining to a side (opposite of medial).

**Maxilla**—Bony upper jaw.

**Medial**—Toward the middle or center (i.e., the chest is medial to the arm).

**Medial (or lateral) nasal prominence**—The medial (toward the middle) or lateral (toward the sides) are anatomical structures that form and merge the nose of the developing embryo during weeks six to nine in utero.

**Mesenchymal cells**—Embryonic cells that develop into many structures, including the soft tissues in the lip.

**Mixed dentition**—A mix of both “baby teeth” and permanent teeth.

**Myringotomy**—A procedure that involves making a small incision in the eardrum to release pressure caused by excess fluid accumulation.

**Orbicularis oris**—Concentrically shaped muscle that surrounds the upper and lower lips.

**Oropharynx**—The part of the throat at the back of the mouth.

**Palate**—The roof of the mouth composed of two anatomical structures, the hard and soft palates.

**Philtral units**—Consists of several anatomical landmarks: the philtral dimple (the skin or depression below the nose extending to the upper lip in the midline); philtral columns (the skin columns on the right and left side of the philtral dimple); philtral tubercle (in the midline of the upper lip); white roll (a linear tissue prominence that joins the upper lip portion of the philtral dimple and vermilion the dark pink tissue that makes up the lip); nasal columella (the outer portion of the nose that divides the nostrils).

**Philtral dimple**—The skin or depression below the nose, extending to the upper lip in the midline.

**Septal mucosa**—The epithelium in the nasal mucosa.

**Unilateral cleft lip**—A cleft that occurs on either the right or left side of the lip.

**Vermilion**—The dark pink tissue that makes up the lip.

Another widely accepted cleft lip classification is based on recommendations of the American Cleft Palate Association. This classification divides cleft lip into unilateral or bilateral (right, left, or extent) in thirds (i.e., one-third, two-thirds, three-thirds), or median cleft lip, the extent of which is also measured in thirds.

### *Surgical procedure*

Cleft lip repair can be initiated at any age, but optimal results occur when the first operation is performed between two and six months of age. Surgery is usually scheduled during the third month of life.

While the patient is under **general anesthesia**, the anatomical landmarks and incisions are carefully demarcated with methylene blue ink. An endotracheal tube prevents aspiration of blood. The surgical field is injected with a local anesthetic to provide further numbing and blood vessel constriction (to limit bleeding). Myringotomy (incisions in one or both eardrums) is performed, and myringotomy tubes are inserted to permit fluid drainage.

There are several operative techniques for cleft lip reconstruction. The Millard rotation advancement (R-A) technique is the most widely accepted form of

repair. This method involves rotation of the entire philtral dimple (groove in the upper lip) and Cupid's bow (double curve of the upper lip). The scar falls along the new philtral column (central section of the upper lip), and is adjusted as required since the procedure allows for flexibility.

The Millard procedure begins with an incision on the edge of the cleft side of the philtrum, and the cutting continues upward, medially, and to the side. A second incision extends to the buccal sulcus (top part of the upper jaw). The length of this incision depends on the size of the gap to be closed. In this second incision, the surgeon frees soft tissue, which allows him or her to completely lift the lip from the underlying bone. This dissection should be tested to ensure free advancement toward the middle, as inadequate dissection is the root cause of poor results. Nasal deformity can be dealt with by a procedure known as the McComb nasal tip plasty, which elevates the depressed nasal dome and rim. Cartilage from the cleft side is freed from the opposite side, and is positioned and reshaped using nylon sutures.

Advantages of the Millard rotation advancement technique include:

- It is the most common procedure (i.e., surgeons are more familiar with it).
- The technique is adaptable and flexible.
- It permits construction of a normal-looking Cupid's bow.
- A minimal amount of tissue is discarded.
- The suture line is camouflaged.

The disadvantage of the Millard rotation advancement technique is the possible development of a vermilion notch (shortening of the entire lip in the vertical direction), resulting from contracture of the vertical scar. Cupid's bow is a critical part of the repair, making it very important to accurately determine the high point of Cupid's bow on the lateral lip.

### Diagnosis/Preparation

Facial clefting has a wide range of clinical presentations, ranging from a simple microform cleft to the complete bilateral cleft involving the lip, palate, and nose. A comprehensive **physical examination** is performed immediately after birth, and the defect is usually evident by visual inspection and examination of the facial structures.

Care must be taken to diagnose other physical problems associated with a genetic syndrome. Weight, nutrition, growth, and development should be assessed and closely monitored.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A plastic and reconstructive surgeon performs the procedure in a hospital equipped with a surgical department. Plastic surgeons typically have five years of training in general surgery (or orthopedic surgical training), and two additional years of specialized plastic and reconstructive surgery training. A plastic surgeon should be certified by the American Board of Plastic and Reconstructive Surgery.

Many plastic surgeons who operate on cleft lip (or palate) patients have received additional surgical training in pediatric plastic surgery. However, completion of a surgical training program does not guarantee clinical expertise, and parents should seek surgeons who have both training and experience.

Presurgical tests include a variety of procedures, such as hemoglobin studies. It is important for the patient's parents and physician to discuss the operation prior to surgery.

### Aftercare

The postoperative focus is on ensuring proper nutrition, as well as lip care and monitoring the activity level. Breast milk or full-strength formula is encouraged immediately after surgery or shortly thereafter. Lip care for patients with sutures should include gentle cleansing of suture lines with cotton swabs and diluted hydrogen peroxide. Liberal application of topical antibiotic ointment several times a day for 10 days is recommended. There will be some scar contracture, redness, and firmness of the area for four to six weeks after surgery. Parents should gently massage the area, and avoid sunlight until the scar heals.

The patient's activities may be limited. Some surgeons use elbow immobilizers to minimize the risk of accidental injury to the lip. Immobilizers should be removed several times a day in a supervised setting, allowing the child to move the restricted limb(s).

Interaction between the orthodontist and surgeon as part of the treatment team begins in the neonatal period, and continues through the phases of mixed dentition.

### Risks

There may be excessive scarring and contraction of the lips. Two types of scars, hypertrophic or keloid,



## QUESTIONS TO ASK THE DOCTOR

- How many cleft palate surgeries has the surgeon performed?
- How is nutrition managed after surgery?
- What lip care will be required after surgery?
- How much activity will be allowed, and will the patient be immobilized following the surgery?
- How much follow-up is required?
- What cosmetic and functional results are expected?
- How long is the surgical procedure?
- What follow-up reconstructive surgery is anticipated?

may develop. Hypertrophic scars appear as raised and red areas that usually flatten, fade in color, and soften within a few months. Keloids form as a result of the accelerated growth of tissue in response to the surgery or trauma to the area. The keloid can cause itching and a burning sensation. Scratching must be avoided because it can lead to healing problems. Some patients require minimal revision surgery, but in most cases, the initial redness and contracture is part of the normal healing process.

### Normal results

Ideal surgical results for cleft lip include symmetrically shaped nostrils, and lips that appear as natural as possible and have a functional muscle. Many characteristics of the natural lip can be achieved; however, the outcome ultimately depends on a number of factors, including the skill of the surgeon, accurate pre-surgery markings, alignment of bones within the affected area, uncomplicated healing of the initial repair, and the effect of normal growth on the repaired lip. Additional surgical correction to reconstruct nasal symmetry is sometimes necessary.

### Morbidity and mortality rates

Generally, cleft lip repair is well-tolerated in healthy infants. No major health problems are associated with this **reconstructive surgery**. Depending on the results, it may be necessary to perform additional operations to achieve desired functional and cosmetic outcomes.

### Alternatives

There are no alternatives for this surgery. Obvious deformity and impairments of speech, hearing, eating,

and breathing occur as a direct result of the malformation. These issues cannot be corrected without surgery.

## Resources

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Closed fracture reduction see **Fracture repair**

## Closures: stitches, staples, and glue

### Definition

Stitches, staples, surgical glue, and tapes are four methods used to close wounds. Stitches use specialized needles and thread to “sew” the wound. Staples are thin pieces of metal that are placed with a stapling device through the edges of a wound to close it. Glues and adhesive tapes are materials used to close wounds without puncturing or penetrating the skin around the edges of an incision.

## Description

Wounds to the skin, fat, muscle, blood vessels, and other structures in the body may occur accidentally (as in a cut) or purposefully (as in a surgical incision). A number of different methods exist to close a wound; the method selected depends on the type of injury, the type of tissue injured, the location and depth of the injury, and the patient's general health. Stitches and staples are two commonly used wound closure methods.

### Stitches

Sutures, as stitches are often called, are the way that most wounds are closed. They are the oldest method of wound closure, having been described over two millennia ago by the Indian surgeon Susruta (sixth century B.C.), sometimes called the “father of plastic surgery,” and the Roman physician Claudius Galen (129–200 A.D.), who treated several Roman emperors. These ancient doctors used such natural materials as human hair, hemp, silk, and catgut (a tough thread made from the dried intestines of sheep or horses). Silk and catgut are still used for sutures in the twenty-first century. Synthetic materials were first used for sutures in the 1950s; they are preferred by some surgeons because they are less likely to cause allergic tissue reactions around the edges of the wound. On the other hand, many synthetic suture materials are more difficult to knot securely. Suture materials have various characteristics that determine their use; no single material is ideal for all purposes. The surgeon must often decide whether ease of knot tying is more important than strength or longevity in tissue. The two main components of suture materials are the needle and thread.

**MATERIALS.** Suture thread is often categorized by how long it retains its strength in tissue. Absorbable stitches lose their strength in a matter of days or weeks and are eventually absorbed by the tissue. This characteristic is useful for the suturing of subcutaneous tissues. Nonabsorbable stitches retain their strength for months to years and may never be absorbed by the tissue. They are generally used for skin and are removed once the wound has sufficiently healed. Suture thread is made of various natural or synthetic components and comes in different diameters for use in different types of tissues. Very fine suture threads are used to close cuts on the face, while threads with a larger diameter are required for subcutaneous tissues.

Suture thread is also categorized by its structure, as either monofilament (one strand or filament) or multifilament, which has a braided structure. Monofilament

sutures are less likely to cause infection and can be pulled through tissue with less damage to the skin, but are easily damaged by **surgical instruments**.

Stainless steel wire is a specialized, nonabsorbable suturing material, used in **orthopedic surgery** or to close the sternum (breastbone) following heart surgery.

To minimize the risk of infection, all types of suture materials are sterilized before use in a chamber containing ethylene oxide, a gas that kills bacteria, mold, and fungi. A newer technique to further lower the risk of bacterial contamination is to coat the suture material with an antimicrobial substance.

In the United States, the diameter of suturing materials is defined by the United States Pharmacopoeia (USP). The largest diameter is designated as #5, for heavy multifilament sutures used in orthopedic surgery; the smallest is #11-0, extremely fine monofilament sutures used primarily in ophthalmology.

Suture needles may resemble a conventional sewing needle with an eye through which suture material is threaded, or they come with suture thread attached at one end; this connection is said to be swaged (forged). Swaged needles have the advantage of causing less damage to tissue because the swaged end is smaller than the needle body and is less likely to rip tissue than the older type of threaded needle.

Needles may be straight or curved; the most commonly used shape is the semicircle, which permits easier manipulation through tissues by the clinician. Needles vary in length from less than 0.1 in (2 mm) to 2.4 in (60 mm). The point of a needle may be cutting (for tougher tissues such as the skin), rounded (for easily penetrable tissues such as the subcutaneous layers), or blunt (for easily damaged tissues such as the liver).

**TECHNIQUE.** While various stitching techniques may be used depending on the location of the wound and type of tissue to be sutured, basic suturing technique remains the same. Several instruments are necessary for proper wound closure, including dissecting scissors (for cleaning the wound); suture scissors (for cutting suture thread); a needle holder (for manipulating the needle); and forceps (for manipulating tissue). Wounds resulting from an injury must be cleaned before closure; dead tissue and foreign bodies are removed and the area is cleansed with an antiseptic. Sutures may be interrupted (each stitch is separately placed, tied, and cut) or continuous (one continuous piece of thread composes all the stitches); they may be placed at different angles and depths.

## KEY TERMS

**Anastomosis (plural, anastomoses)**—The surgical connection of two structures, such as blood vessels or sections of the intestine.

**Antiseptic**—A substance that inhibits the growth of harmful bacteria and other organisms.

**Catgut**—A tough natural suture material made from the dried intestines of sheep or horses.

**Cyanoacrylate**—The chemical name of liquid surgical adhesive.

**Ethylene oxide**—A colorless gas used to sterilize surgical sutures, bandages, and most other surgical materials or implements.

**Monofilament**—A single untwisted strand of suture material.

**Multifilament**—A braided strand of suture material. Multifilament sutures are generally thicker than monofilament and used in such specialties as orthopedic surgery.

**Polyglycolic acid (PGA)**—A polyester compound used to make bioabsorbable sutures and staples. It is also used in tissue engineering.

**Subcutaneous**—Under the skin.

**Swaged needle**—An eyeless surgical needle with the suture material preattached by the manufacturer. Most surgical needles used in the early 2000s are swaged needles.

**United States Pharmacopoeia (USP)**—An authoritative book, updated annually, that contains lists of medicines, dietary supplements, and surgical supplies; defines their doses or other units of measurement; and sets quality standards for their production and proper use. The USP is used by 130 countries around the world in addition to the United States.

Nonabsorbable stitches should be removed several days to weeks after their placement, depending on their location. For instance, sutures on the face should be removed in approximately 5 days; sutures on the legs and abdomen, in 7 to 10 days; and sutures on the back, in 10 to 14 days. Strips of adhesive tape may be placed over the wound to help support the tissue while it is healing.

### *Staples*

Staples are a relatively new method of wound closure, having been introduced in 1908 by a Hungarian

surgeon named Humer Hultl. The primary purpose of Hultl's invention was reliable closure of bowel anastomoses, that is, the joining together of two segments of intestine. Leakage of intestinal contents from anastomoses was a common cause of postoperative mortality in the early twentieth century. The early staplers were large and cumbersome. It was not until the mid-1960s that reliable and easy-to-use surgical staplers were manufactured by the United States Surgical Corporation.

A distinct advantage that modern surgical staples have over sutures is their quick placement—stapling is approximately three to four times faster than suturing. Staples are also associated with a lower risk of infection and tissue reaction than sutures. It is, however, more difficult to correctly align the edges of a wound for stapling, and staples generally cost more than sutures. Common locations of wounds that may be stapled are the arms, legs, abdomen, back, or scalp; wounds on the hands, feet, neck, or face should not be stapled. Additionally, staples are still used to connect cut ends of larger blood vessels or segments of the bowel.

A newer form of stapling uses clips that do not penetrate the skin to close the edges of a wound.

**MATERIALS.** Most surgical staples used inside the body are made of titanium, a lightweight silvery metal that is less likely to trigger the patient's immune system or interfere with MRI scanners. Staples used to close skin wounds or incisions are composed of stainless steel and have a crossbar that lies parallel to the skin, two legs that enter each edge of the wound, and tips that hold the staple in place. Staples are placed with the aid of a stapling device that generally holds between 5 and 25 staples. As of 2007, most skin staplers are disposable plastic instruments that contain a single cartridge of staples. Staplers used to place staples inside the body are more commonly made of stainless steel and are not disposable. Forceps are also necessary to help align the edges of the wound together and hold them in place until staples can be placed.

**TECHNIQUE.** The wound is first cleaned of dead tissue and foreign bodies and washed with an antiseptic. The edges of the wound are aligned and held together with forceps or the clinician's fingers. The stapling device is held against the wound at the point at which the staple is to be placed. By squeezing the trigger on the stapling device, the staple is automatically placed into the skin; the depth of placement is controlled by how firmly the stapling device is held against the skin. The staples should be removed at approximately the same time as sutures; removal is done with a specialized staple remover.

A newer type of surgical staple is bioabsorbable, meaning that it does not require removal after the wound has healed. These staples are made from polyglycolic acid (PGA), a material that is also used to make absorbable sutures and scaffolds for tissue engineering. Staples made of PGA lose about half their strength within two weeks and are completely absorbed by the body within 4 months.

### Glues

Tissue glues have been used in surgery on an experimental basis since the mid-1960s; they were formally approved by the U.S. Food and Drug Administration (FDA) for surgical use in 1998. As early as 1964, Eastman Kodak submitted an application to the FDA for the use of cyanoacrylate glues in surgery; the formula was used by Dr. Harry Coover during the Vietnam War to seal chest wounds or other open wounds until the patient could be taken to a military hospital.

In addition to wound closure, surgical glues were approved by the FDA in 2001 as sealants against certain types of bacteria, including staphylococci and pseudomonads.

**MATERIALS.** Cyanoacrylate glues are familiar to most people in the form of such compounds as Krazy Glue or Superglue, used as household adhesives to bond nonporous materials, including metals. These glues are also used in criminal investigations to develop latent fingerprints on smooth surfaces like glass or plastics. Instructions for the use of cyanoacrylate industrial glues always contain warnings about their capacity to bond with skin; it is this characteristic that led to their use in surgery. The chemical formula of cyanoacrylate approved for medical use is 2-octyl cyanoacrylate; its trade names include Dermabond, Band-Aid Liquid Adhesive Bandage, and Soothe-N-Seal.

Dermabond has several advantages: rapid application, good cosmetic results, strength, and flexibility. It also has several drawbacks: it can only be used to close the uppermost layers of skin, as it causes inflammation to subcutaneous tissues. It cannot be used close to the eyes or mouth, on hairy parts of the body, or to close wounds with jagged or torn edges. The surgeon must use subcutaneous sutures to draw the edges of a deep wound together before applying the surgical glue to the surface of the skin. Last, a small percentage of patients are allergic to cyanoacrylate and develop a skin rash.

**TECHNIQUE.** Dermabond comes in an applicator that resembles a fountain pen with a thicker barrel. It

contains a vial that snaps open inside the barrel when the doctor removes the cap. The adhesive itself is tinted purple and comes out through a porous tip about the size of a pencil eraser when a black button on the side of the barrel is pushed. The doctor or nurse holds the edges of the wound together while applying a layer of Dermabond to the wound with the tip of the applicator. After 15 seconds, the first layer is dry and the doctor can apply the second layer of adhesive. After about 45 seconds to a minute, the closure is complete. It reaches its full strength about three minutes after the second layer has been applied. The patient does not need to cover the Dermabond with a bandage. It is safe to get the closure wet in the course of normal bathing or showering, although patients are usually instructed not to soak the wound.

Dermabond does not have to be removed like staples or nonabsorbable stitches; it wears off the skin in 5–10 days, which is usually enough time for the upper layer of skin to heal.

Over-the-counter (OTC) forms of surgical adhesive have been available since 2004; they come in bottles that contain about 10 applications. As of 2007, these products cost between \$5.50 and \$7.00 in most parts of the United States.

### Tapes

Surgical tapes have been used for wound closure since the Renaissance period, when the French surgeon Ambroise Paré (1510–1590) made tapes out of strips of sticking plaster for treating facial wounds. This technique allowed the wound edges to be splinted as well as joined together. In modern surgery, adhesive strips can be used to hold the edges of the wound together before suturing or by themselves without sutures.

**MATERIALS.** The first modern type of adhesive strip used for wound closure was introduced in the early 1960s and is commonly called Steri-Strips. Still used in the early 2000s, Steri-Strips are reinforced strips of a microporous synthetic material backed by an acrylic polymer adhesive that holds the edges of a wound together for 5–7 days. They can be removed at home by the patient after the wound has healed.

A newer type of adhesive strip was known as ClozeX when it was introduced in 2004. Its name was changed to Steri-Strip S Surgical Skin Closure in 2007. The product comes in a range of 11 different sizes to cover a variety of injuries and surgical incision. The original ClozeX was a transparent film with an adhesive backing, designed to hold the edges of a wound together. In 2005, the company introduced a second



version with a center pad. According to a report published in 2006, a sample group of both surgeons and patients preferred the new method of wound closure to standard monofilament sutures for speed of application, greater comfort, lower cost, and better cosmetic effect. The limitations of the Steri-Strip S device are similar to those of surgical glues: it cannot be used on hairy portions of the body, infected wounds, wounds that are oozing tissue fluid, or wounds on parts of the body used for repetitive motion (such as knee or finger joints).

**TECHNIQUE.** Steri-Strips and the newer skin closure device are applied after the patient's skin has been cleansed with rubbing alcohol or sterile saline solution and dried thoroughly. If the skin closure device is to be used, the surgeon chooses the proper size for the wound and removes a series of liners inside the device, pressing the clear adhesive pad first along one side of the wound and then the other while holding the edges of the wound together. After the adhesive pad is in place, the surgeon applies a series of filament straps that hold the adhesive pad in place. The device is left in place for 7 days. It can then be removed in the doctor's office or by the patient.

Steri-Strips are commonly used with a liquid adhesive, usually either Mastisol or tincture of benzoin, to help them adhere to the wound longer. After the patient's skin has been cleansed and dried, the liquid adhesive is applied over the edges of the wound and the entire area where the Steri-Strips will be placed. After the adhesive is partly dry, the strips are placed across the wound (perpendicular to it rather than parallel) without overlapping one another.

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## Club foot repair

### Definition

Club foot repair, also known as foot tendon release or club foot release, is the surgical repair of a birth defect of the foot and ankle called club foot.

### Purpose

Club foot, or *talipes equinovarus*, is the most common birth defect of the lower extremity, characterized by the foot turning both downward and inward. The defect can range from mild to severe. The purpose of club foot repair is to provide the child with a functional foot that looks as normal as possible and that is painless, plantigrade, and flexible. Plantigrade means

## KEY TERMS

**Orthopedics**—The branch of medicine that deals with bones and joints.

that the child is able to stand with the sole of the foot on the ground, and not on the heels or the outside of the foot.

## Demographics

In the United States, club foot is a common birth defect, and occurs at a rate of one to two cases per 1,000 live births among whites. More than 4,000 babies with club foot are born in the United States each year. Boys are affected with club foot twice as often as girls. The risk increases 30-fold in individuals who have a relative of the first degree affected by the defects.

## Description

A newborn baby's club foot is first treated with applying a cast because the tendons, ligaments, and bones are quite flexible and easy to reposition. The procedure involves stretching the foot into a more normal position and using a cast to maintain the corrected position. The cast is removed every week or two, so as to stretch the foot gradually into a correct position. Serial casting goes on for approximately three months.

In 30% of cases, manipulation and casting is successful, and the foot can be placed in a brace to maintain the correction. In about 70% of cases, manipulation and castings alone do not correct the deformity completely, and the child's physicians and parents must decide whether to attempt surgery.

The type of surgery depends on how severe the club foot is. The deformity features tight and short tendons around the foot and ankle. Surgery consists of releasing all the tight tendons and ligaments in the posterior (back) and medial (inside) aspects of the foot and repairing them in a lengthened position. Metal pins may also be used to maintain the bones in place for some six weeks. Surgery usually involves an overnight stay in hospital. After surgery, the foot is put into a cast for approximately three months, followed by the use of a brace to hold the correction. The brace is worn for approximately 6–12 months after surgery.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Club foot repair is performed in a hospital. Club foot surgery is difficult and requires meticulous attention to details. It is accordingly performed by experienced pediatric orthopedic surgeons who are specialists in the field.

## Diagnosis/Preparation

Presurgical diagnosis requires radiography (x rays). The evaluation usually includes only the acquisition of weight-bearing images because the stress involved is reproducible. In babies, weight bearing is simulated by holding the baby upright on a flat surface.

Some surgeons prefer to wait until the child is about one year old before performing surgery, so that the foot may grow a little larger. Other surgeons operate as early as three months of age when it becomes clear that further castings will not achieve any more correction.

## Aftercare

The patient usually stays in the hospital for two days after club foot repair. The foot is put into a cast and kept elevated, with application of ice packs to reduce swelling and pain. Painkillers may also be prescribed to relieve pain. During the 48 hours following surgery, the skin near the cast and the toes are examined carefully to ensure that blood circulation, movement, and feeling are maintained. After leaving the hospital, the cast is usually left on for about three months. Skin irritations due to the cast or infections may occur. A course of physical therapy may be indicated after removal of the cast to help keep the repaired foot in good position, improve its flexibility, and strengthen the muscles.

## Risks

The risks involved in club foot repair are the general risks associated with anesthesia and surgery.

Risks associated with anesthesia include:

- adverse reactions to medications
- breathing problems

Risks associated with surgery include:

- excessive bleeding
- infections

## QUESTIONS TO ASK THE DOCTOR

- Is there any treatment needed to prevent the club foot from coming back after surgery?
- What are the chances that my child's club foot will get corrected?
- How long will it take to recover from the surgery?
- What procedures do you follow?
- How much club foot surgery do you perform each year?

### Normal results

If club foot repair is required, the foot usually becomes quite functional after surgery. In some cases, the foot and calf may remain smaller throughout the patient's life. Most children who have undergone club foot repair develop normally and participate fully in any athletic or recreational activity that they choose.

### Morbidity and mortality rates

If left untreated, club foot will result in an abnormal gait, and further deformity may occur on the side of the foot due to preferential weight bearing.

### Alternatives

#### *The Ponseti non-surgical treatment*

Dr. Ignacio Ponseti developed this method, which consists of a weekly series of gentle manipulations followed by the application of casts that are placed from the toes to the upper thigh. Five to seven casts are applied every week. Before applying the last cast, which is worn for three weeks, the heel cord is cut to finalize the correction of the foot. By the time the cast is removed, the heel cord has healed. After this two-month period of casting, a splint is worn full time by the patient for a few months and is then worn only at night for two to four years. Special shoes also maintain the foot in the corrected position.

#### *The French treatment*

This method consists of daily physical therapy, featuring gentle and painless stretching of the foot. The foot is then taped to maintain the corrected position until the next day's visit. At night, the taped foot is inserted into a continuous passive-motion machine at home to maximize the amount of stretching. The

tape is removed for a few hours each day to wash the foot, air the skin, and perform exercises. Removable splints are also used to support the taped foot. The one-hour physical therapy sessions are conducted five days each week for approximately three months. Taping is stopped when the child starts walking.

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Coarctation of the aorta see **Heart surgery for congenital defects**

## Cochlear implants

### Definition

A cochlear implant is a small, complex electronic device used to treat severe to profound hearing loss. It is surgically implanted underneath the skin behind the patient's ear.

### Purpose

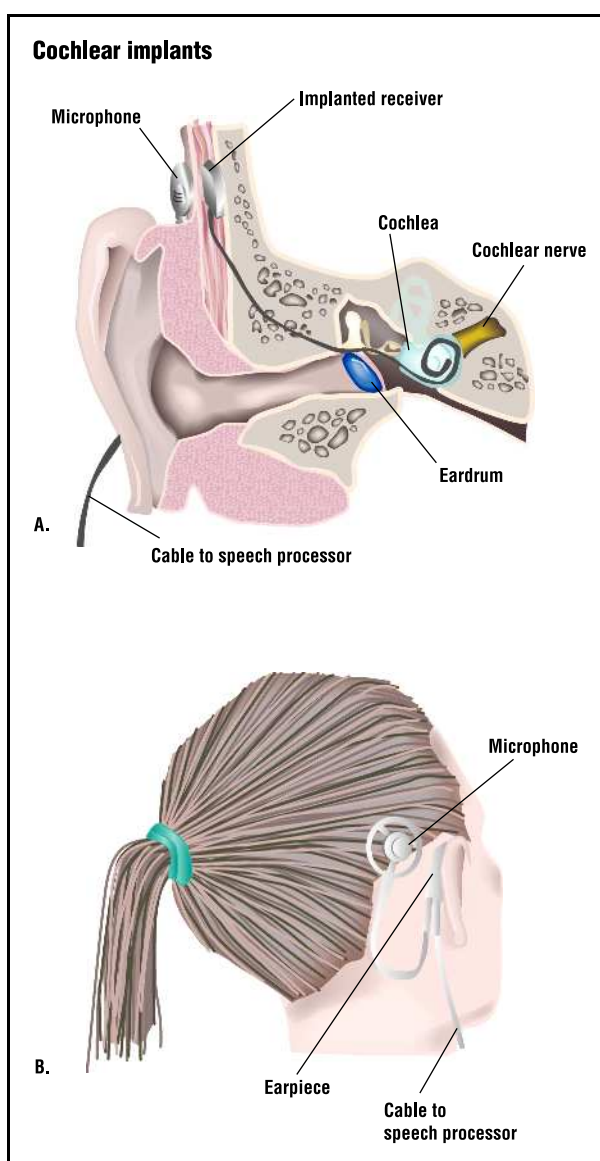
A cochlear implant delivers useful auditory signals from the environment to the patient by electronically bypassing nonfunctional parts of the ear and directly stimulating the auditory nerve. Unlike a hearing aid, it does not merely amplify sound. Instead, an implant increases the amount of nervous response to sound. Although it does not restore normal hearing, the additional input provided by the implant often improves sound detection and increases speech understanding.

### Description

Normal hearing occurs because sound travels from the outer ear into the ear canal and vibrates the eardrum. The vibration is carried through the middle ear by three small bones attached to the eardrum and on to a fluid-filled part of the inner ear called the cochlea. Movement in the cochlear fluid is transferred to hair fibers within the cochlea. The movement of these hair cells stimulates nerve cells called ganglion cells, which send an electrical current to the auditory nerve. In turn, the nerve carries the current to the brain, where the electrical stimulation is recognized as sound.

A common cause of hearing loss is damage to the hair cells within the cochlea. This kind of deafness, called sensorineural deafness, can often be treated with cochlear implants. This is particularly true if damage to the hair cells is not accompanied by damage to the auditory nerve itself. It has been estimated that more than 100,000 individuals have received cochlear implants.

Cochlear implants consist of internal and external parts. The external parts include a microphone, a speech processor, and a transmitter. The internal parts include a receiver-stimulator and an electrode. Some models include a small headpiece that is worn just behind the ear and contains all the external parts, while other models also use body-worn modules that are placed in a shoulder pouch, in a pocket, or worn on a belt. The convenience of the all-in-one headpiece is balanced by shorter life for the batteries used in the smaller units, although systems using rechargeable batteries do solve some of these issues.



**A cochlear implant has a microphone outside the ear that transmits sounds to an implanted receiver. In turn, the receiver transmits electrical impulses to the cochlea and cochlear nerve, which is stimulated in normal hearing.** (Illustration by GGS Information Services. Cengage Learning, Gale.)

Within the headpiece, the microphone picks up sound in the environment. The speech processor converts these sounds into a digital signal. The content of the generated digital signal is determined by the programming of the processor and is complex. It includes information about the pitch, loudness, and timing of sound signals, and attempts to filter out extraneous noise. The transmitter converts the digital signals into FM radio signals and sends them through the skin to the internal parts of the implant. The transmitter and



## KEY TERMS

**Auditory nerve**—The nerve that carries electrical signals from the cochlea to the brain.

**Cochlea**—The hearing part of the inner ear. This snail-shaped structure contains fluid and thousands of microscopic hair cells tuned to various frequencies.

**Hair cells**—Sensory receptors in the inner ear that transform sound vibrations into messages that travel to the brain.

**Inner ear**—The interior section of the ear, where sound vibrations and information about balance are translated into nerve impulses.

**Middle ear**—The small cavity between the eardrum and the oval window that houses the three tiny bones of hearing.

**Sensorineural deafness**—Hearing loss due to the inability to convert sound from vibration to electrical signals. Often involves defects in the function of cochlear hair cells.

the internal parts are kept in correct alignment by using magnets present in both the internal and external parts of the device.

The internal parts are those that are surgically implanted into the patient. The receiver-stimulator is disk-shaped and is about the size of a quarter. It receives the digital signals from the transmitter and converts them into electrical signals. A wire connects the receiver to a group of electrodes that are threaded into the cochlea when the implant is placed. As many as 24 electrodes, depending on the type of the implant, stimulate the ganglion cells in the cochlea. These cells transmit the signals to the brain through the auditory nerve. The brain then interprets the signals as sound.

The sounds heard through an implant are different from the normal hearing sounds and have been described as artificial or robot-like. This is because the implant's handful of electrodes cannot hope to match the complexity of a person's 15,000 hair cells. However, as more electrodes are added, electrode placement issues are solved, and the software for the implant speech processor takes into account more and more aspects of sound, the perceived results are moving closer to how speech and other sounds are naturally perceived.

Despite the benefits that the implant appears to offer, some hearing specialists and members of the

deaf community believe that the benefits may not outweigh the risks and limitations of the device. Because the device must be surgically implanted, it carries some **surgical risk**. Manufacturers cannot promise how well a person will hear with an implant. Moreover, after getting an implant, some people say they feel alienated from the deaf community, while at the same time not feeling fully a part of the hearing world. The decision to undergo cochlear implant surgery is a complex one, and a person should take into account the risks and realistic rewards of the device.

### *Surgical procedure*

The procedure can be preformed on an outpatient basis for adult and adolescent patients. With children, it is often performed with a one-night stay in the hospital.

The internal parts of the implant are placed under the skin behind the patient's ear. The area is shaved, although newer procedures allow for sterilization of the hair in the area so less shaving has to occur. Once the sterile field is established, the surgeon makes an 2–3 in (5–7.6 cm) incision behind the ear and opens the mastoid bone (the ridge on the skull behind the ear) leading into the middle ear. A depression is made in the bone next to the opening to allow the receiver-stimulator to sit flush with the skull surface. After seating, the receiver-stimulator is held in place with a long-lasting suture.

The surgeon then goes through the opening in the mastoid bone to create a new opening in the cochlea for the implant electrodes. The electrode is then very slowly and carefully threaded through this new opening. The electrode structure itself is designed to align the electrodes as closely as possible to the ganglion cells, as this allows the electrical signals that function to be less powerful. Once in place, the device is tested to be certain it is working. If all is well, the surgeon then closes up the incision with absorbable sutures, so the area does not need to be revisited to remove the **stitches**.

The entire operation takes between one and two hours, although the procedure is more complex for younger patients due to the smaller size of their middle ear structures and tends to take longer.

### **Aftercare**

For a short period of time after the surgery, a special bandage is worn on the head during sleep. After about one month, the surgical wounds heal. The patient then returns to the implant clinic to be fitted with the external parts of the device and to have

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Cochlear implants are inserted during a surgery performed by a specialist in otolaryngology (ear, nose, and throat medicine). The surgery is performed in a larger hospital, usually on an outpatient basis, but sometimes with an overnight hospital stay.

it turned on and mapped. Mapping involves fine tuning the speech processor and setting levels of stimulation for each electrode, from soft to loud.

The patient is then trained in how to interpret the sounds heard through the device. The length of the training varies from days to years, depending on how well the person can interpret the sounds heard through the device.

### Risks

As with all operations, there are risks with this surgery, including:

- infection at the incision site
- bleeding
- complications related to anesthesia
- transient dizziness
- facial paralysis (rarely)
- temporary taste disturbances
- additional hearing loss
- device failure

However, it should be noted that serious surgical complications have been observed in only one in 10,000 procedures of this type.

Some long-term risks of the implant include the unknown effects of electrical stimulation on the nervous system. It is also possible to damage the implant's internal components by a blow to the head, which will render the device unworkable.

A further consideration is that the use of **magnetic resonance imaging (MRI)** for patients with cochlear implants is not recommended because of the magnets present in the devices. Several companies have developed implants that do not use magnets, or have altered the receiver-stimulator to make it easier to remove the magnets before testing. One fact that reduces the concern about MRI testing is that for many medical indications, MRI can be replaced with a computer assisted

## QUESTIONS TO ASK THE DOCTOR

- How “normal” will the implant make the patient’s hearing?
- What kind of training does the patient undergo to learn how to use the device?
- How does the patient care for the device?

tomography (CAT, CT) scan, which is not a problem for persons with cochlear implants.

Additionally, in July 2002, the Food and Drug Administration (FDA) issued a warning about a possible connection between increased incidence of meningitis and the presence of a cochlear implant. This warning included special vaccine recommendations for those with implants, as well as the voluntary removal from the market of certain devices. Specifically, those implants that included a positioner to hold the electrodes in place in the cochlea appear to be associated with an increased risk of the disease.

### Normal results

Most profoundly deaf patients who receive an implant are able to discern medium and loud sounds, including speech, at comfortable listening levels. Many use sound clues from the implant, together with speech reading and other facial cues, to achieve understanding. Almost all adults improve their communication skills when combining the implant with speech reading (lip reading), and some can understand spoken words without speech reading. More than half of adults who lost hearing after they learned to speak can understand some speech without speech reading. Especially with the use of accessory devices, the great majority can utilize the telephone with their implants.

Children who were born deaf or who lost their hearing before they could speak have the most difficulty in learning to use the implant. Research suggests, however, that most of these children are able to learn spoken language and understand speech using the implant. In general, the earlier the implant occurs, the greater the chance of the implant providing sufficient sound input to provide speech understanding. As with the use of the telephone in adults, accessory devices such as special microphones often help the function of the implant in classroom settings.

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Colectomy see **Bowel resection; Bowel resection, small intestine**

## Collagen periurethral injection

### Definition

Collagen periurethral injection is a procedure in which collagen is injected around the urethra and bladder neck as a treatment for stress incontinence in women.

### Purpose

The bladder and urethra are supported by muscles, ligaments, and connective tissues around the base of the bladder. This support prevents the leakage of urine, along with the watertight seal provided by the urethra.

## KEY TERMS

**Anesthetic**—A drug that causes unconsciousness or a loss of general sensation.

**Bladder**—A membranous sac that serves as a reservoir for urine. Contraction of the bladder results in urination.

**Catheterization**—The placement of a catheter in a specific anatomic area most commonly for the purpose of treatment or diagnosis.

**Collagen**—The protein substance of the white fibers (collagenous fibers) of skin, tendon, bone, cartilage, and all other connective tissue.

**Cystoscope**—An instrument that allows the doctor to see inside the bladder and remove tissue samples.

**Epidural**—Located within the spinal canal, on or outside the dura mater, the tough membrane surrounding the spinal cord.

**Incontinence**—The inability to control excretory functions, as defecation (fecal incontinence) or urination (urinary incontinence).

**Periurethral**—Surrounding the urethra.

**Stress incontinence**—Involuntary loss of urine that occurs during physical activity such as coughing, sneezing, laughing, or exercise.

**Urethra**—The tube that passes urine from the bladder to the outside.

As a result of pregnancy, childbirth, and aging, or damage by scarring from surgery or radiotherapy, these structures may become damaged or weakened, thus causing stress incontinence, meaning an involuntary loss of urine that occurs during physical activity such as coughing, sneezing, laughing, or **exercise**.

The injection of bulking agents, such as collagen, around the urethra aims to improve the lost support of the bladder and urethra. The substance most commonly used for injection is collagen; other bulking agents are being developed; for example, a silicon base suspended in a viscous gel called Macroplastique. Teflon paste, introduced in the 1970s, initially gave good results, but was discontinued after reported problems with excessive scarring and with the migration of Teflon particles to other tissues in the body. The collagen used in the procedure comes from the cartilage of cattle and has been extensively sterilized to produce a viscous paste for injection. There is no risk

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Collagen periurethral injection is a procedure that is performed in a hospital or clinic on an outpatient basis by a surgeon.

of bovine spongiform encephalopathy (BSE) transmission because the processing of the paste destroys any bacterial or viral particles.

### Description

The collagen periurethral injection procedure is quick, and usually over within 15–20 minutes. No incisions are made, meaning that it can be carried out using a local anesthetic or a regional anesthetic such as an epidural. The surgeon uses a fine fiber-optic cystoscope to examine the inside of the urethra and bladder, and then inserts a fine needle to inject the collagen. Usually three injections are made around the urethra. The exact amount of collagen used depends on how much closure the urethra requires.

### Aftercare

Since the procedure is very short and there is little discomfort afterwards, it is performed on an outpatient basis, and women can go home the same day. Recovery from the operation is very quick.

### Risks

Periurethral injection is not associated with major complications. Urinary tract infection is common in up to a fifth of the women having undergone the procedure, but is usually quickly and easily treated with **antibiotics**. Some women experience difficulty urinating immediately after the procedure, but this is not unexpected following an operation involving the bladder and urethra that may easily lead to swelling and bruising of the tissues. It is an uncommon problem after periurethral injection. The condition usually settles quickly, but may require catheterization. Long-term problems are very rare.

### Normal results

Since periurethral injection is so quick and easy with very few complications, it would appear to be an ideal treatment for stress incontinence; however, there is a problem with the longer-term results. Within three

## QUESTIONS TO ASK THE DOCTOR

- How is a collagen periurethral injection performed?
- Why is the collagen injection required?
- What are the risks of the procedure?
- Is the injection procedure painful?
- Are there alternatives?
- How long will it take for me to recover?
- What are the after-effects of the injection?
- How many collagen periurethral injections do you perform each year?

months after injection, good results are reported with at least 80% of women cured or improved. After two years, less than half of these women will still be cured. Longer-term studies are still being performed, but it is likely that positive results will continue to diminish. This is due to the injected collagen dispersing away from the urethra over time. Injections can be repeated and some women do require more than one injection before they are cured. Ongoing research into new injection substances may improve these results. The results in younger, physically active women are also less successful, usually lasting for a shorter time. Repeated injections are not a simple solution because collagen is very expensive and the long-term effects of repeated injections are unknown. Physicians prefer one of the alternative operations if long-term cure of stress incontinence is the aim.

### Alternatives

Other treatments are available to treat incontinence. They include:

- Physiotherapy—this treatment aims to increase the strength and support provided by the pelvic floor muscles.
- Surgical procedures—operations such as colposuspension, sling procedures, needle-suspensions, and vaginal repair operations are all based on lifting and re-supporting the bladder and urethra.

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- Office of Women's Health, U.S. Food and Drug Administration, 5600 Fishers Lane, Rockville, MD, 20857, (301) 827-0350, <http://www.fda.gov/womens/default.htm>.

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Colon anastomosis see **Ileoanal anastomosis**

## Colonic stent

### Definition

A colonic stent is a tubular device made out of artificial materials that is positioned within the intestine in order to keep the intestine patent (open). A colonic stent is placed in order to relieve the symptoms of a bowel obstruction, which often occur when tumors are blocking the intestine. A stent is not a cure for the

tumors, but it can provide relief of the unpleasant symptoms that accompany bowel obstruction, such as nausea and vomiting, intractable constipation, inability to pass gas, bloating, and abdominal pain.

### Purpose

A colonic stent is used when a patient has an intestinal obstruction, meaning that there is something (often a tumor) blocking the intestine. During an intestinal obstruction, nothing can travel past the point of the obstruction. Therefore, the patient cannot pass gas or feces. If the patient continues to eat and/or drink while obstructed, he or she usually begins vomiting, since nothing he or she eats or drinks can proceed through the intestine. Other symptoms of intestinal obstruction include abdominal pain and uncomfortable bloating (abdominal swelling).

A colonic stent is often employed to relieve the symptoms of intestinal obstruction for either palliative purposes or as a bridge to surgery. "Palliative" treatments are things that are intended for symptom relief, but which do not hold the hope of cure. In the case of colon cancer, if the tumors are inoperable, a palliative procedure such as colonic stenting can allow the patient to experience a better quality of life, although it does not treat the actual underlying disease. In the case of a bridge procedure, colonic stenting can allow relief of symptoms until such time as surgery is deemed safe for the individual.

### Demographics

Statistics on cancer of the large intestine (colon) are often linked with statistics on cancer of the rectum. Together, they are referred to as colorectal cancer. Colorectal cancer is the third most common cancer in the United States. Projections for 2008 suggest that 108,070 new cases of colon cancer alone will be diagnosed (about 14% of all cancer cases), with 53,760 cases striking men and 54,310 cases striking women. Colorectal cancer is an extremely serious form of cancer, and is responsible for about 14% of all cancer deaths annually. In 2008, the projection is that 49,960 people will die of colorectal cancer (24,260 men and 25,700 women). This means that colorectal cancer ranks third for causing cancer-related deaths in the United States.

About 90% of the time, colorectal cancer strikes people over the age of forty; most people receive the diagnosis while they are in their 50s or 60s. People with certain other conditions are more likely to develop colorectal cancer. This includes patients who have or have had breast, uterine, or ovarian cancer, ulcerative

## KEY TERMS

**Colon**—The large intestine.

**Colonoscopy**—The fiberoptic device used to view the inside of the large intestine, and through which a variety of procedures can be performed, including biopsies and colonic stent placement.

**Colorectal**—Pertaining to the large intestine and the rectum.

colitis, or Crohn's disease. Additionally, a family history of either intestinal polyps or colorectal cancer increases an individual's risk of colorectal cancer.

## Description

Most colonic stents are placed in the intestine during the course of a **colonoscopy**. The same type of scope used for the diagnostic or screening exam is utilized. The stent is made of wire mesh, and is self-expanding.

While a regular screening colonoscopy can sometimes be performed in a clinic or doctor's office, stent placement requires that the procedure take place in a hospital, so that the position of the stent can be confirmed through x rays. The procedure is usually performed by a specialist in intestinal disease, a gastroenterologist. The procedure is performed under either extensive sedation, given through an intravenous line, or with full **general anesthesia**.

The patient is placed on his or her side, with knees pulled up towards the chest. The colonoscope is thoroughly lubricated, then introduced into the anus. As the colonoscope progresses through the colon, the gastroenterologist will be watching carefully on a monitor, to see whether there are any other problems within the intestine. Mucus, blood, or feces that block the view may be suctioned out through the colonoscope. Air may be pumped into the intestine through the colonoscope, in order to open up the field for better viewing. During the course of the procedure, samples of the intestine (biopsies) may also be taken.

When the colonoscope reaches the level of the obstruction, the colonic stent is guided through the scope into the intestine. Once inside the intestine, the stent will expand itself into a wire-mesh tube. The colonoscope is then withdrawn through the anus, and the procedure is over.

## Diagnosis/Preparations

As with any procedures involving the intestine, one of the most important ways to prepare involves cleaning the colon very thoroughly of any stool. Patients whose intestine is completely obstructed may require admittance to a hospital for this to be accomplished. Patients with only partial obstruction may be able to do this at home.

Patients who are allowed to eat solid food should assume a low-residue diet three days prior to the procedure. In general, a low-fiber/low-residue diet involves avoiding whole-grain and whole-wheat foods, processed meats, heavy, deep-fried foods, and foods in thick cream sauces.

The day before the procedure, the patient must follow a careful regimen of taking oral stool softeners, and then using a colon cleansing agent. This can be in a solution that is drunk, or in the form of multiple capsules that are taken with a great deal of water. In some cases, the patient may be required to receive one or more enemas, to make sure that all stool has been evacuated from the intestine.

The patient is usually required to stop eating all solid foods for the twenty-four hours prior to the procedure. They are usually allowed to drink clear fluids until about twelve hours prior to the procedure.

Patients who are using anticoagulant (blood thinning) medications, aspirin, or **nonsteroidal anti-inflammatory drugs** should discuss with their doctor whether these should be discontinued prior to the procedure, in order to decrease the risk of bleeding.

## Aftercare

Patients who have had a colonic stent placed are usually kept in the hospital for a day or two after the procedure, in order to carefully monitor them. They will be slowly progressed to clear fluids, then full fluids, then a soft diet, and then a full diet.

## Normal results

Successful placement of a colonic stent allows for the passage of both gas and stool through the intestine. Pain, bloating, and nausea are relieved, and the patient can resume eating and drinking normally. In patients awaiting surgery, a normal result allows the surgery to be scheduled nonemergently, thus decreasing the risk of **colostomy** as part of the surgical outcome. Success is achieved between 93 and 95% of the time in colonic stent placement.

## Morbidity and mortality rates

Complications of colonic stent placement include dislodging of the stent from its original location (has occurred in about 10-12% of patients), passage of the stent in stool, obstruction of the stent's lumen with impacted stool or expanding tumor, perforation (occurs in about 4% of patients) of the intestine, bleeding, abdominal pain, rectal spasms, embolism.

## Resources

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# Colonoscopy

## Definition

Colonoscopy is an endoscopic medical procedure that uses a colonoscope, a long, flexible, thin, lighted tube-like instrument containing a tiny video camera, that allows a visual examination of the lining of the colon (large intestine) and rectum.

## Purpose

A colonoscopy is generally recommended when the patient complains of rectal bleeding, has a change in bowel habits, and/or has other unexplained abdominal symptoms. The test is frequently used to look for colorectal cancer, especially when polyps or tumor-like growths have been detected by a **barium enema** examination and other diagnostic imaging tests. Polyps can be removed through the colonoscope, and samples of tissue (biopsies) can be taken to detect the presence of cancerous cells. In addition, colonoscopy can also be used to remove foreign bodies from the colon, control hemorrhaging, and excise tumors.

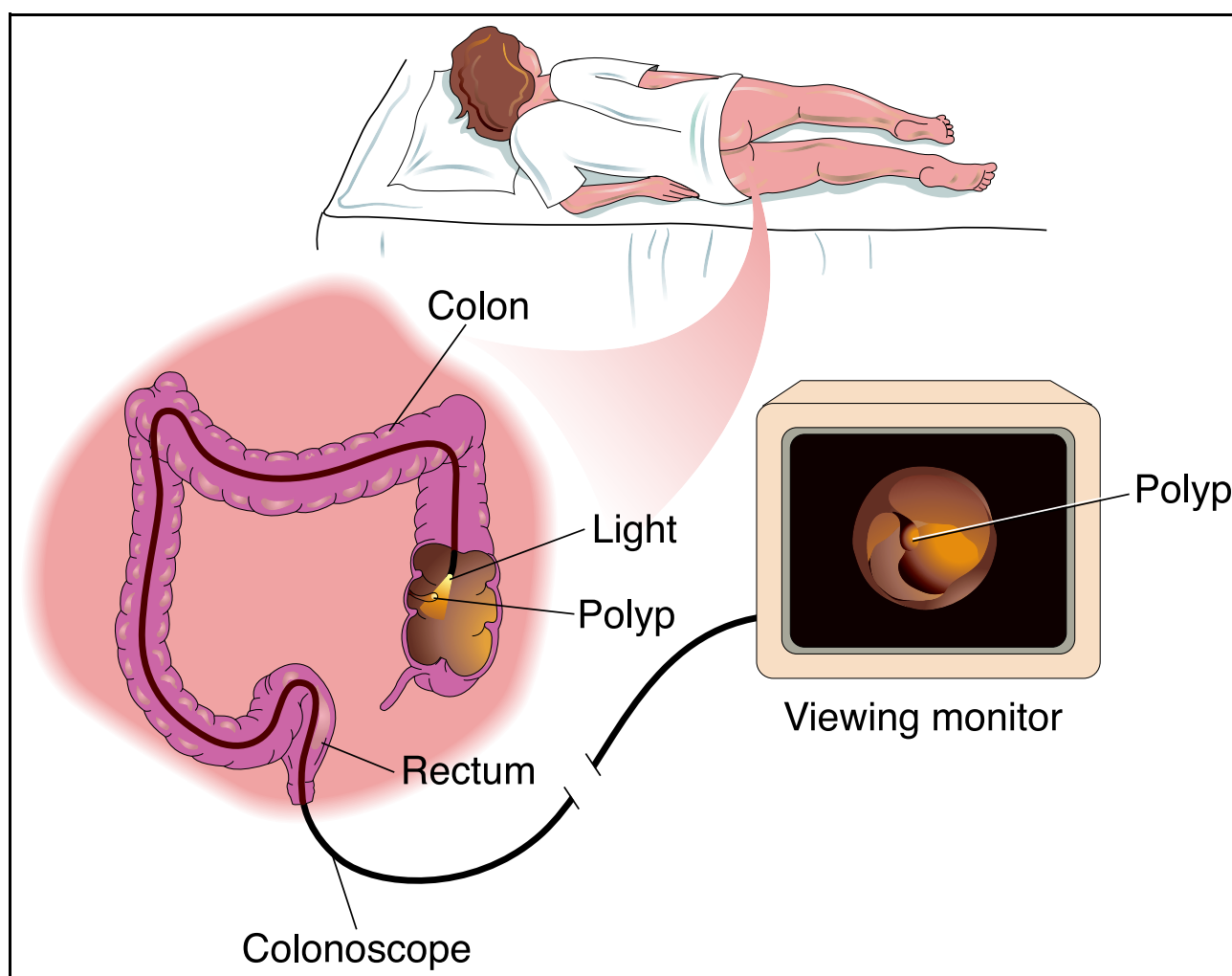
A colonoscopy allows the physician to visualize the lining of the entire colon and, therefore, it also enables physicians to check for bowel diseases such as ulcerative colitis and Crohn's disease. Colonoscopy is being used increasingly as a screening tool in asymptomatic patients. It is recommended as a screening test in all people 50 years or older and is an essential tool for monitoring patients who have a past history of polyps or colon cancer.

## Description

Colonoscopy can be performed either in a physician's office or in an endoscopic procedure room of a hospital or freestanding clinic. For otherwise healthy patients, colonoscopy is usually performed by a gastroenterologist or surgeon in an office or clinic setting. When performed on patients with other medical conditions that could cause complications or that require hospitalization, it is usually performed in the endoscopy department of a hospital, where more intensive physiologic monitoring and/or **general anesthesia** can be better provided.

An intravenous line is usually inserted into a vein in the patient's arm to administer a sedative and a painkiller. During the colonoscopy, patients lie on their sides with their knees drawn up towards the abdomen. The doctor begins the procedure by inserting a lubricated, gloved finger into the anus to check for any abnormal masses or blockage. A thin, well-lubricated colonoscope is then inserted into the anus and gently advanced through the colon. The lining of the large intestine is examined through the colonoscope. The physician views images on a television monitor, and the procedure can be documented using a video recorder. Still images can be recorded and saved on a computer disk or printed. Occasionally, air may be pumped through the colonoscope to help clear the path or open the colon. If excessive secretions, stool, or blood obstructs the viewing, they are suctioned out through the scope. The doctor may press on the abdomen or ask the patient to change position in order to advance the scope through the colon.

The entire length of the large intestine can be examined in this manner. If suspicious growths are present, tiny biopsy forceps or brushes are inserted through the colon and tissue samples (biopsies) are obtained. Small polyps or inflamed tissue also can be removed using tiny instruments passed through the scope. For removing tumors or performing other types of surgery on the colon during colonoscopy, an electrosurgical device or laser system may be used in conjunction with the colonoscope. To stop bleeding in the colon, a laser, heater probe, or electrical probe is



**Colonoscopy** is a procedure where a long and flexible tubular instrument called a colonoscope is inserted into the patient's anus in order to view the lining of the colon and rectum. It is performed to test for colorectal cancer and other bowel diseases, and enables the physician to collect tissue samples for laboratory analysis. (Illustration by Electronic Illustrators Group. Cengage Learning, Gale.)

used, or special medicines are injected through the scope. After the procedure, the colonoscope is slowly withdrawn and the instilled air is allowed to escape. The anal area is then cleansed with tissues. Tissue samples taken by biopsy are sent to a clinical laboratory, where they are analyzed by a pathologist.

The procedure may take anywhere from 30 minutes to two hours depending on how easy it is to advance the scope through the colon. Colonoscopy can be a long and uncomfortable procedure, and the bowel-cleansing preparation may be tiring and can produce diarrhea and cramping. During the colonoscopy, the sedative and the pain medications will keep the patient drowsy and relaxed. Some patients complain of minor discomfort and pressure from the colonoscope; however, the

sedative and pain medication usually cause most patients to dose off during the procedure.

### Preparation

Patients who regularly take **aspirin**, **nonsteroidal anti-inflammatory drugs** (NSAIDs), blood thinners, or insulin should be sure to inform the physician at the time the colonoscopy is scheduled. The physician also should be notified if the patient has allergies to any medications or anesthetics, bleeding problems, or is pregnant. The doctor should be informed of all the medications the patient is taking and if he or she has had a barium enema x-ray examination recently. If the patient has had heart valves replaced, the doctor should be informed so that appropriate **antibiotics**



## KEY TERMS

**Barium enema**—An X-ray test of the bowel performed after giving the patient an enema of a white chalky substance (barium) that outlines the colon and the rectum.

**Biopsy**—A procedure in which a sample of suspicious tissue is removed and examined by a pathologist for cancer or other disease.

**Colonoscope**—A thin, flexible, hollow, lighted tube that is inserted through the anus and rectum to the colon to enable the physician to view the entire lining of the colon.

**Computed tomography (CT) scan**—A radiologic imaging technique that uses computer processing to generate an image of the tissue density; also called computerized axial tomography (CAT) and computerized transaxial tomography (CTAT).

**Crohn's disease**—A chronic inflammatory disease that generally starts in the gastrointestinal tract and causes the immune system to attack one's own body.

**Diverticulosis**—A condition that involves the development of sacs that bulge through the large intestine's muscular walls, but are not inflamed. It may cause bleeding, stomach distress, and excess gas.

**Electrosurgical device**—A medical device that uses electrical current to cauterize or coagulate tissue

during surgical procedures; often used in conjunction with laparoscopy.

**Magnetic resonance imaging (MRI)**—A test that provides pictures of organs and structures inside the body using radio waves. In many cases, an MRI provides information that cannot be obtained from X-ray tests.

**Pathologist**—A doctor who specializes in the diagnosis of disease by studying cells and tissues under a microscope.

**Polyps**—An abnormal growth that develops on the inside of a hollow organ such as the colon.

**Sigmoidoscopy**—A process of passing a long, hollow tubular instrument through the anus in order to permit inspection, diagnosis, treatment, and imaging, especially of the sigmoid flexure.

**Ulcerative colitis**—A chronic condition in which recurrent ulcers are found in the colon. It is manifested clinically by abdominal cramping and rectal bleeding.

**Virtual colonoscopy**—Two new techniques that provide views of the colon to screen for colon polyps and cancer. The images are produced by computerized manipulations rather than direct observation through the colonoscope; one technique uses the X-ray images from a CT scan, and the other uses magnetic images from an MRI scan.

can be administered to prevent infection. Patients with severe active colitis, extremely dilated colon (toxic megacolon), or severely inflamed bowel may not be candidates for colonoscopy. Patients requiring continuous ambulatory peritoneal dialysis are generally not candidates for colonoscopy due to a higher risk of developing internal bleeding. The risks associated with the procedure are explained to the patient beforehand, and the patient is asked to sign a consent form.

The colon must be thoroughly cleansed before performing colonoscopy. Consequently, for about two days before the procedure, considerable preparation is necessary to clear the colon of all stool. The patient is asked to refrain from eating any solid food for 24–48 hours before the test. Only clear liquid such as juices, broth, and gelatin are allowed. Red or purple juices should be avoided, since they can cause coloring of the colon that may be misinterpreted as blood during the colonoscopy. The patient is advised to drink plenty of water to avoid dehydration. A day before the

colonoscopy, the patient is prescribed liquid, tablet, and/or suppository **laxatives** by the physician. In addition, commercial enemas may be prescribed. The patient is given specific instructions on how and when to use the laxatives and/or enemas. This preparatory emptying of the colon assures that the colonoscope will not be obstructed and that the physician will be able to clearly see the colon lining.

On the morning of the colonoscopy, the patient is not to eat or drink anything. Unless otherwise instructed by the physician, the patient should continue to take all current medications. Vitamins with iron, iron supplements, or iron preparations should be discontinued for a few weeks before the colonoscopy because iron residue in the colon can inhibit viewing during the procedure. These preparatory procedures are extremely important to ensure a thoroughly clean colon for examination.

After the procedure, the patient is kept under observation until the medications' effects wear off.

The patient has to be driven home and can generally resume a normal diet and usual activities unless otherwise instructed. The patient is advised to drink plenty of fluids to replace those lost by laxatives and fasting.

For a few hours after the procedure, the patient may feel groggy. There may be some abdominal cramping and a considerable amount of gas may be passed. If a biopsy was performed or a polyp was removed, there may be small amounts of blood in the stool for a few days. If the patient experiences severe abdominal pain or has persistent and heavy bleeding, this information should be brought to the physician's attention immediately.

### Risks

The procedure is practically free of complications and risks. Rarely, (two in 1,000 cases) a perforation (hole) may occur in the intestinal wall. Heavy bleeding due to the removal of the polyp or from the biopsy site occurs infrequently (one in 1,000 cases). Some patients may have adverse reactions to the sedatives administered during the colonoscopy, but severe reactions are very rare. Infections due to a colonoscopy are also extremely rare. Patients with artificial or abnormal heart valves are usually given antibiotics before and after the procedure to prevent an infection.

### Normal results

The results are normal if the lining of the colon is a pale reddish pink and there are no abnormal masses visible. In this case, the patient probably will not have to undergo another colonoscopy for several years.

Abnormal results indicate polyps or other suspicious masses in the lining of the colon. Many polyps can be removed during the procedure, and tissue samples can be taken by biopsy. If cancerous cells are detected in the tissue samples, then a diagnosis of colon cancer is made. A pathologist analyzes the tumor cells further to estimate the tumor's aggressiveness and the extent of the disease. This is crucial before deciding on the mode of treatment for the disease. Abnormal findings could also be due to inflammatory bowel diseases such as ulcerative colitis or Crohn's disease. A condition called diverticulosis, which causes many small finger-like pouches to protrude from the colon wall, may also contribute to an abnormal result in the colonoscopy.

### Morbidity and mortality rates

Colorectal cancer is the second leading cause of cancer deaths in the United States. In 2007, The American Cancer Society estimated that 52,180 people died

from the disease. The World Health Organization (WHO) estimates that about 500,000 people worldwide die from colorectal cancer each year. Although colonoscopy screening can find precancerous growths (polyps), which lead to colorectal cancer, screening rates in the United States remain low. Removing polyps before they become cancerous can prevent the disease and potentially reduce deaths. Scientific evidence indicates that more than one-third of deaths from colorectal cancer could be avoided if people aged 50 years and older were screened regularly.

### Alternatives

Individuals with a strong family history of colorectal cancer may wish to undergo genetic screening to detect a genetic alteration that may identify people who are more likely to develop the disease and who would benefit from earlier and more frequent screening. Only about 5% of colorectal cancers are inherited, so genetic testing provides limited benefits for most of the population.

Virtual colonoscopy is a new non-invasive technique for screening for colon polyps and cancer. The colon is cleaned out using potent laxatives just as it is for a standard colonoscopy. Instead of obtaining pictures through the insertion of a colonoscope, virtual colonoscopy uses X-ray images from a computerized tomography (CT) scan or **magnetic resonance imaging** (MRI) to create through computer manipulation two- and three-dimensional pictures of the colon.

Virtual colonoscopy offers several advantages. The procedure is non-invasive. It does not require patients to be sedated or put under anesthesia and is a good option for individuals who cannot or will not undergo standard colonoscopy. The procedure can be performed in less than one minute, compared with about 30–60 minutes plus recovery time required for standard colonoscopy. Another benefit of the **CT scan** is that it can find polyps that occasionally are missed by colonoscopy because the polyps lie behind folds within the colon.

Disadvantages of virtual colonoscopy include:

- It has difficulty finding small polyps (<0.2 in [5 mm] in size) that are easily seen in a colonoscopy.
- It is less able to find flat polyps compared to a colonoscopy.
- Small pieces of stool can look like polyps on the CT scan and lead to a diagnosis of polyp when there is none.
- It is not possible to remove suspect polyps or take a biopsy. If polyps are found by virtual colonoscopy, a standard colonoscopy must be done to remove the polyps. As a result, the individual must undergo two procedures.

## Resources

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### ORGANIZATIONS

- American College of Gastroenterology, P.O. Box 342260, Bethesda, MD, 20827 2260, (301) 263 9000, <http://www.acg.gi.org>.
- Colorectal Cancer Network (CCNetwork), P.O. Box 182, Kensington, MD, 20895 0182, (301) 879 1500, [http://clickonium.com/colorectal\\_cancer.net/html/](http://clickonium.com/colorectal_cancer.net/html/).
- International Foundation for Functional Gastrointestinal Disorders (IFFGD), P.O. Box 170864, Milwaukee, WI, 53217, (414) 964 1799, (888) 964 2001, <http://www.iffgd.org>.
- National Digestive Diseases Information Clearinghouse (NDDIC), 2 Information Way, Bethesda, MD, 20892 3570, (800) 891 5389, <http://digestive.niddk.nih.gov>.
- Society of American Gastrointestinal Endoscopic Surgeons (SAGES), 11300 West Olympic Blvd., Suite 600, Los Angeles, CA, 90064, (310) 437 0544, <http://www.sages.org>.

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## Colorectal surgery

### Definition

Colorectal surgery repairs damage to the colon, rectum, and anus through a variety of procedures that may have little or great long-term consequence to the

patient. It may also involve surgery to the pelvic floor to repair hernias.

### Purpose

Colorectal surgery is performed to repair damage to the colon, rectum, and anus, caused by diseases of the lower digestive tract, such as cancer, **diverticulitis**, and inflammatory bowel disease (ulcerative colitis and Crohn's disease). Injury, obstruction, and ischemia (compromised blood supply) may require bowel surgery. Masses and scar tissue can grow within the rectum, causing blockages that prevent normal elimination of feces. Other diseases such as diverticulitis and ulcerative colitis can cause perforations in the rectum. Surgical removal of the damaged area or areas can return normal bowel function.

### Demographics

Colorectal cancer affects 140,000 people annually, causing 60,000 deaths. Polypectomy (the removal of polyps in the colon), usually performed during a routine diagnostic test (colonoscopy or flexible **sigmoidoscopy**), has been a factor in the declining incidence of this cancer. However, incidence of the disease, as reported in the Journal of the National Cancer Institute in 2001, differed among ethnic groups, with Hispanics having 10.2 cases per 100,000 people, to African Americans having 22.8 cases per 100,000. Surgery is the optimal treatment for colorectal cancer, resulting in cure in 80% of patients. Recurrence due to surgical failure is low, from 4% to 8%, when surgery is meticulously performed.

Crohn's disease and ulcerative colitis, both chronic inflammatory diseases of the colon, together affect approximately 1,000,000 young adults. Surgery is recommended when medication fails patients with ulcerative colitis. Usually, surgery is drastic, removing the colon and rectum and creating an interior or exterior pouch to collect body wastes. Nearly three-fourths of all Crohn's patients face surgery to remove a diseased section of the intestine or rectum.

Diverticulosis, the growth of pouches in the walls of the intestine, occurs in nearly half of all Americans by the time they reach age 60 and in practically everyone over 80. Sometimes these diverticuli become infected and diverticulitis occurs. Diverticulitis may also require surgery to remove part of the colon if there have been recurrent episodes with complications or perforations.

### Description

Colorectal surgery is a necessary treatment option for colorectal cancer, ulcerative colitis, Crohn's disease,

## KEY TERMS

**Adjuvant therapy**—Treatment that is added to increase the effectiveness of surgery, usually chemotherapy or radiation used to kill any cancer cells that might be remaining.

**Anastomosis**—The surgical connection of two sections of tubes, ducts, or vessels.

**Diverticuli**—Pouches in the intestinal wall usually created from a diet low in fiber.

**Embolism**—Blockage of a blood vessel by any small piece of material traveling in the blood; the emboli may be caused by germs, air, blood clots, or fat.

**Enema**—Insertion of a tube into the rectum to infuse fluid into the bowel and encourage a bowel movement. Ordinary enemas contain tap water, mixtures of soap and water, glycerine and water, or other materials.

**Intestine**—Commonly called the bowels, divided into the small and large intestine. They extend from the stomach to the anus.

**Ischemia**—A compromise in blood supply delivered to body tissues that causes tissue damage or death.

**Ostomy**—A surgical procedure that creates an opening from the inside of the body to the outside, usually to remove body wastes (feces or urine).

**Sigmoid colon**—The last third of the intestinal tract that is attached to the rectum.

and some cases of diverticulitis, often resulting in major reconstruction of the intestinal tract. Other bowel conditions that may require surgery to a lesser extent are hemorrhoids, anal fissures (tears in the lining of the anus), rectal prolapse, and bowel incontinence. Most of these surgeries repair tears, remove blockages, or tighten sphincter muscles. Patients with anal fissures, for example, experience immediate relief, with more than 90% of them never having the problem recur.

Some colorectal surgeons also treat pelvic floor disorders such as perineal hernia and rectocele (a bulging of the rectum toward the vagina).

### *Types of surgery*

There are a variety of procedures a colorectal surgeon may use to treat intestinal disorders. Until 1990, all colorectal surgery was performed by making large incisions in the abdomen, opening up the

intestinal cavity, and making the repair. Most of these repairs involved resection (cutting out the diseased or damaged portion) and anastomosis (attaching the cut ends of the intestine together). Some were tucks to tighten sphincter muscles or repair fissures, and others cut out hemorrhoids. Some colorectal surgeons perform a strictureplasty, a new procedure that widens the intestine instead of making it shorter; this is used with patients with extensive Crohn's disease.

Often colorectal surgery involves creating an ostomy, which is an opening from the inside of the body to the outside, usually to remove body wastes (feces or urine). There are several types of ostomy surgeries that colorectal surgeons do. A **colostomy** is a surgical procedure that brings a portion of the large intestine through the abdominal wall, creating an opening, or stoma, to carry feces out of the body to a pouch. An **ileostomy** removes the entire colon, the rectum, and the anus. The lower end of the small intestine (the ileum) becomes the stoma.

For all ostomies, a pouch will generally be placed around the stoma on the patient's abdomen during surgery. During the hospital stay, the patient and his or her caregivers will be educated on care of the stoma and the ostomy pouch. Determination of appropriate pouching supplies and a schedule of how often to change the pouch should be established. Regular assessment and meticulous care of the skin surrounding the stoma is important to maintain an adequate surface on which to attach the pouch. Some patients with colostomies are able to routinely irrigate the stoma, resulting in regulation of bowel function; rather than needing to wear a pouch, these patients may need only a dressing or cap over their stoma. Often, an enterostomal therapist will visit the patient in the hospital or at home after discharge to help the patient with stoma care.

Most colostomies and ileostomies are permanent. Temporary colostomies are created to divert stool from injured or diseased portions of the large intestine, allowing rest and healing. Although colorectal cancer is the most common indication for a permanent colostomy, only about 10–15% of patients with this diagnosis require a colostomy.

A new procedure called an **ileoanal anastomosis** creates an internal reservoir that is sewn to the anus and acts as an artificial rectum. It usually is not used with Crohn's disease patients because their disease often recurs.

Laparoscopic surgery is being used with many diseases of the intestinal tract, including initial cancers. For this surgery, the colon and rectal surgeon



inserts a laparoscope (an instrument that has a tiny video camera attached) through a small incision in the abdomen. Other small incisions are made through which the surgeon inserts **surgical instruments**. This surgery often results in fewer complications, a shorter stay in the hospital, less postoperative pain, a quicker return to normal activities, and less scarring. It is not recommended for patients who have had extensive prior abdominal surgery, large tumors, previous cancer, or serious heart problems.

### Diagnosis/Preparation

Some disease or conditions may require a minimally invasive surgery. Other diseases such as inflammatory bowel disease and colorectal cancer may require an ostomy, a more drastic procedure. Determining whether this surgery is necessary is a decision the physician makes based on a number of factors, including patient history, the amount of pain the patient is experiencing, and the results of several diagnostic tests. Due to the lifestyle impact of ostomy surgery, surgeons make that decision with careful input from the patient. Sometimes, though, an immediate decision may be necessary in emergency situations involving injuries or puncture wounds in the abdomen, or intestinal perforations related to diverticular disease, ulcers, or cancer, which can be life-threatening.

#### Diagnostic tests

**Colonoscopy**, flexible sigmoidoscopy, and a lower GI (gastrointestinal) series help determine the condition of the intestinal tract. These tests can identify masses and perforations on bowel walls.

A lower GI series is a series of x rays of the colon and rectum, which can identify ulcers, cysts, polyps, diverticuli (pouches in the intestine), and cancer. The patient is given a **barium enema**; the barium coats the intestinal tract, making any signs of disease easier to see on x rays.

Flexible sigmoidoscopy, a flexible tube with a miniature camera, is inserted into the rectum so the physician can examine the lining of the rectum and the sigmoid colon, the last third of the intestinal tract. The sigmoidoscope can also remove polyps or tissue for biopsy.

A colonoscopy is a similar procedure to the flexible sigmoidoscopy, except the flexible tube looks at the entire intestinal tract. For the patient's comfort, a sedative is given.

**Magnetic resonance imaging (MRI)**, used both prior to and during surgery, allows physicians to determine the precise margins for resections of the

colon, so that they can eliminate all of the diseased tissue. MRI can also identify patients who could most benefit from adjuvant therapy such as chemotherapy or radiation.

#### Preoperative preparation

The doctor will outline the procedure, possible side effects, and what the patient may experience after surgery. As with any surgical procedure, the patient will be required to sign a consent form. Blood and urine studies, along with various x rays and an electrocardiograph (EKG), may be ordered. If necessary, an enterostomal therapist will be contacted to mark an appropriate place on the abdomen for the stoma and offer preoperative education on ostomy management.

In order to empty and cleanse the bowel, the patient may be placed on a restricted diet for several days prior to surgery. A liquid diet may be ordered for at least the day before surgery, with nothing by mouth after midnight. A series of enemas and/or oral preparations (GoLytely, Colyte, or senna) may be ordered to empty the bowel of stool. Oral anti-infectives (neomycin, erythromycin, or kanamycin sulfate) may be ordered to decrease bacteria in the intestine and help prevent postoperative infection.

#### Aftercare

**Postoperative care** involves monitoring blood pressure, pulse, respiration, and temperature. Breathing tends to be shallow because of the effect of the anesthesia and the patient's reluctance to breathe deeply and experience pain that is caused by the abdominal incision. The patient is instructed how to support the operative site during deep breathing and coughing, and given pain medication as necessary. Fluid intake and output is measured, and the operative site is observed for color and amount of wound drainage.

The patient is usually helped out of bed the evening of the surgery and allowed to sit in a chair. Most patients are discharged in two to four days.

The nasogastric tube will remain in place, attached to low, intermittent suction until bowel activity resumes. For the first 24–48 hours after surgery, the ostomy will drain bloody mucus. Fluids and electrolytes are given intravenously until the patient's diet can gradually be resumed, beginning with liquids only, then adding solids. Usually within 72 hours, passage of gas and stool through the stoma begins. Initially the stool is liquid, gradually thickening as the patient begins to take solid foods. The patient is usually out of bed in eight to 24 hours after surgery and discharged in two to four days.

## Risks

Potential risks of colorectal surgery are those of any major surgery and usually occur while the patient is still in the hospital. The patient's general health prior to surgery will also be an indication of the potential for risk. Of special concern are cardiac problems and stressed immune systems.

Psychological complications may result from ostomy surgery because of the fear of the social stigma attached to wearing a colostomy bag. Patients may also be depressed and have feelings of low self-worth because of the change in their lifestyle and their appearance. Some patients may feel ugly and sexually unattractive and may worry that their spouse or significant other will no longer find them appealing. Counseling and education regarding surgery and the inherent lifestyle changes are often necessary.

## Normal results

Complete healing is expected without complications. The period of time required for recovery from the surgery may vary, depending on the patient's overall health prior to surgery. Dietary changes may be encouraged to prevent future disorders or to manage a current disease.

## Morbidity and mortality rates

Mortality has been decreased from nearly 28% to under 6% through the use of prophylactic **antibiotics** prescribed before and after surgery. Strong indicators of survival outcome or increased complications from surgery for elderly patients are underlying medical conditions. Therefore, the underlying medical conditions of at-risk patients should be controlled prior to a colorectal surgery.

Even among higher risk patients, mortality is about 16%. This rate is greatly reduced (between 0.8% and 3.8%) when the ostomies and resections for cancer are performed by a board-certified colon and rectal surgeon.

The physician and the nursing staff monitor the patient's **vital signs** and the surgical incision, alert for:

- excessive bleeding
- wound infection
- thrombophlebitis (inflammation and blood clot in the veins in the legs)
- pneumonia
- pulmonary embolism (blood clot or air bubble in the lungs' blood supply)
- cardiac stress due to allergic reaction to the general anesthetic

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Colorectal surgery is performed by general surgeons and board-certified colon and rectal surgeons as in-patient surgeries under general anesthesia.

Symptoms that the patient should report, especially after discharge, include:

- increased pain, swelling, redness, drainage, or bleeding in the surgical area
- flu-like symptoms such as headache, muscle aches, dizziness, or fever
- increased abdominal pain or swelling, constipation, nausea or vomiting, or black, tarry stools

Stomal complications can also occur. They include:

- Death (necrosis) of stomal tissue. Caused by inadequate blood supply, this complication is usually visible 12–24 hours after the operation and may require additional surgery.
- Retraction (stoma is flush with the abdomen surface or has moved below it). Caused by insufficient stomal length, this complication may be managed by use of special pouching supplies; elective revision of the stoma is also an option.
- Prolapse (stoma increases length above the surface of the abdomen). Most often this results from an overly large opening in the abdominal wall or inadequate fixation of the bowel to the abdominal wall; surgical correction is required when blood supply is compromised.
- Stenosis (narrowing at the opening of the stoma). Often this is associated with infection around the stoma or scarring. Mild stenosis can be removed under local anesthesia; severe stenosis may require surgery for reshaping the stoma.
- Parastomal hernia (bulge in the abdominal wall, caused by a section of bowel, next to the stoma). This occurs due to placement of the stoma where the abdominal wall is weak or an overly large opening in the abdominal wall is created. The use of an ostomy support belt and special pouching supplies may be adequate. If severe, the defect in the abdominal wall should be repaired and the stoma moved to another location.

## QUESTIONS TO ASK THE DOCTOR

- Am I a good candidate for laparoscopic surgery?
- What tests will you require?
- What drugs will be given for pain after the surgery?
- What will I need to do to prepare for surgery?
- What will my recovery time be and what restrictions will I have?
- How many of these procedures have you performed?
- What are my risks for this surgery?

### Alternatives

When a colostomy is deemed necessary, there are usually no alternatives to the surgery, though there can be alternatives in the type of surgery involved and adjuvant therapies related to the disease.

### Resources

#### BOOKS

- Johnston, Lorraine. *Colon & Rectal Cancer: A Comprehensive Guide for Patients and Families*. Sebastopol, CA: O'Reilly, 2000.
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#### ORGANIZATIONS

- American Board of Colon and Rectal Surgery (ABCRS). 20600 Eureka Road, Suite 713, Taylor, MI 48180. (734) 282-9400. [www.fascrs.org](http://www.fascrs.org).
- Mayo Clinic. 200 First St. S.W., Rochester, MN 55905. (507) 284-2511. [www.mayoclinic.org](http://www.mayoclinic.org).

United Ostomy Association, Inc. (UOA). 19772 MacArthur Blvd., Suite 200, Irvine, CA 92612-2405. (800) 826-0826. <http://www.uoa.org>.

Wound Ostomy and Continence Nurses Society. 2755 Bristol Street, Suite 110, Costa Mesa, CA 92626. (714) 476-0268. <http://www.wocn.org>.

#### OTHER

National Digestive Diseases Information Clearinghouse. *Ileostomy, Colostomy, and Ileanal Reservoir Surgery*. (February 1, 2000): 1.

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## Colostomy

### Definition

A colostomy is a surgical procedure that brings a portion of the large intestine through the abdominal wall to carry feces out of the body.

### Purpose

A colostomy is a means to treat various disorders of the large intestine, including cancer, obstruction, inflammatory bowel disease, ruptured diverticulum, ischemia (compromised blood supply), or traumatic injury. Temporary colostomies are created to divert stool from injured or diseased portions of the large intestine, allowing rest and healing. Permanent colostomies are performed when the distal bowel (at the farthest distance) must be removed or is blocked and inoperable. Although colorectal cancer is the most common indication for a permanent colostomy, only about 10–15% of patients with this diagnosis require a colostomy.

### Demographics

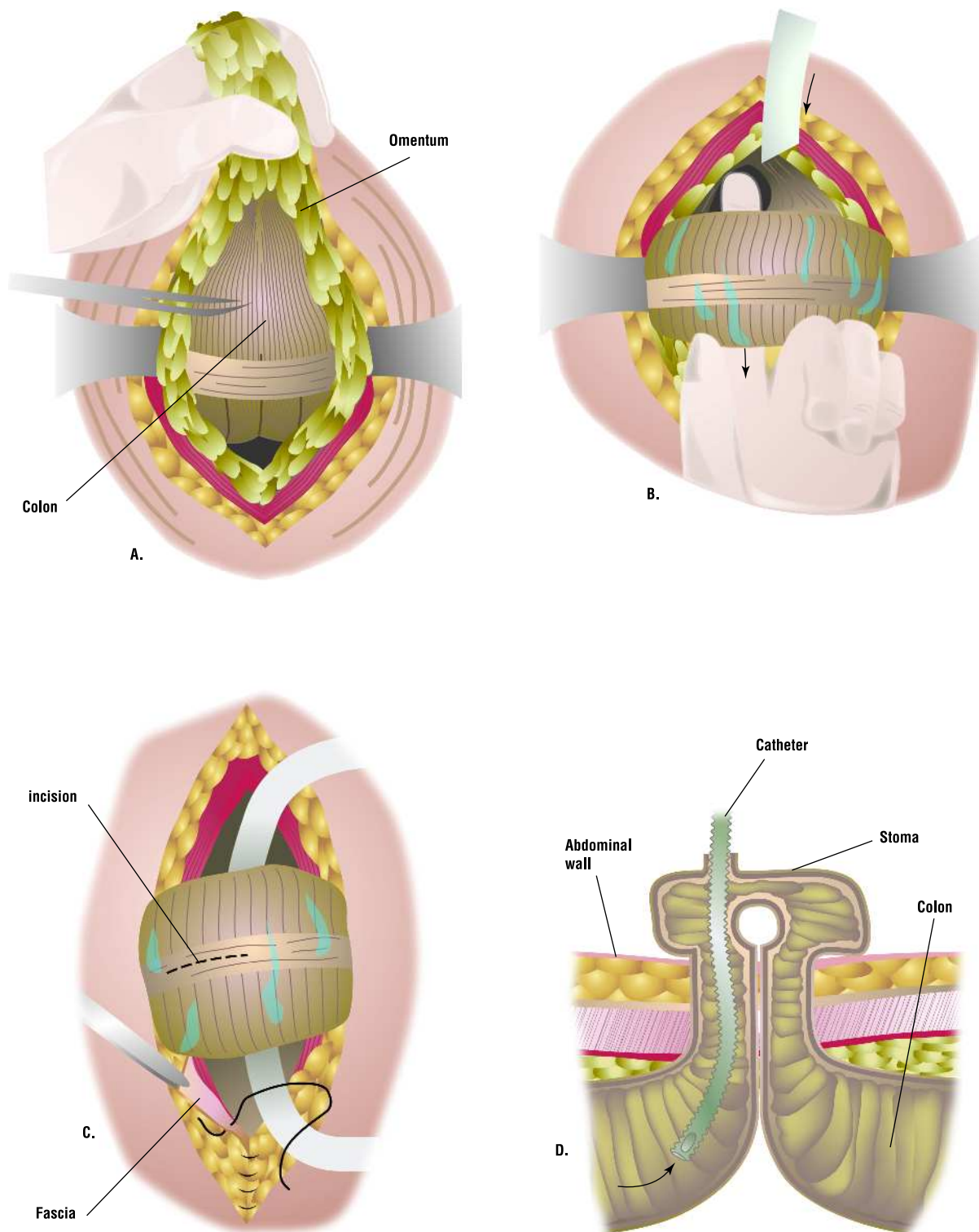
Estimates of all ostomy surgeries (those involving any opening from the abdomen for the removal of either feces or urine) range from 42,000 to 65,000 each year; about half are temporary. Emergency surgeries for bowel obstruction and/or perforation comprise 10–15% of all colorectal surgeries; a portion of these result in colostomy.

### Description

Surgery will result in one of three types of colostomies:

- End colostomy. The functioning end of the intestine (the section of bowel that remains connected to the

## Colostomy



To perform a colostomy, the surgeon enters the abdomen and locates the colon, or large intestine (A). A loop of the colon is pulled through the abdominal incision (B); then the colon is cut to allow the insertion of a catheter (C). The skin and tissues are closed around the new opening, called a stoma (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)



upper gastrointestinal tract) is brought out onto the surface of the abdomen, forming the stoma (artificial opening) by cuffing the intestine back on itself and suturing the end to the skin. The surface of the stoma is actually the lining of the intestine, usually appearing moist and pink. The distal portion of bowel (now connected only to the rectum) may be removed, or sutured closed and left in the abdomen. An end colostomy is usually a permanent ostomy, resulting from trauma, cancer, or another pathological condition.

- **Double-barrel colostomy.** This involves the creation of two separate stomas on the abdominal wall. The proximal (nearest) stoma is the functional end that is connected to the upper gastrointestinal tract and will drain stool; the distal stoma, connected to the rectum and also called a mucous fistula, drains small amounts of mucus material. This is most often a temporary colostomy performed to rest an area of bowel, and to be later closed.
- **Loop colostomy.** This surgery brings a loop of bowel through an incision in the abdominal wall. The loop is held in place outside the abdomen by a plastic rod slipped beneath it. An incision is made in the bowel to allow the passage of stool through the loop colostomy. The supporting rod is removed approximately seven to 10 days after surgery, when healing has occurred that will prevent the loop of bowel from retracting into the abdomen. A loop colostomy is most often performed for creation of a temporary stoma to divert stool away from an area of intestine that has been blocked or ruptured.

### Diagnosis/Preparation

A number of diseases and injuries may require a colostomy. Among the diseases are inflammatory bowel disease and colorectal cancer. Determining whether this surgery is necessary is a decision the physician makes based on a number of factors, including patient history, amount of pain, and the results of tests such as **colonoscopy** and lower G.I. (gastrointestinal) series. Due to lifestyle impact of the surgery, the decision is made after careful consultation with the patient. However, an immediate decision may be made in emergency situations involving injuries or puncture wounds in the abdomen or intestinal perforations related to diverticular disease, ulcers, or life-threatening cancer.

As with any surgical procedure, the patient will be required to sign a consent form after the procedure is explained thoroughly. Blood and urine studies, along with various x rays and an electrocardiograph (EKG), may be ordered as the doctor deems necessary. If possible, the patient should visit an enterostomal

## KEY TERMS

**Diverticulum**—Pouches that project off the wall of the intestine.

**Embolism**—Blockage of a blood vessel by any small piece of material traveling in the blood; the emboli may be caused by germs, air, blood clots, or fat.

**Enema**—Insertion of a tube into the rectum to infuse fluid into the bowel and encourage a bowel movement. Ordinary enemas contain tap water, mixtures of soap and water, glycerine and water, or other materials.

**Intestine**—Commonly called the bowels, divided into the small and large intestine. They extend from the stomach to the anus.

**Ischemia**—A compromise in blood supply delivered to body tissues that causes tissue damage or death.

**Ostomy**—A surgical procedure that creates an opening from the inside of the body to the outside, usually to remove body wastes (feces or urine).

therapist, who will mark an appropriate place on the abdomen for the stoma and offer preoperative education on ostomy management.

In order to empty and cleanse the bowel, the patient may be placed on a low-residue diet for several days prior to surgery. A liquid diet may be ordered for at least the day before surgery, with nothing by mouth after midnight. A series of enemas and/or oral preparations (GoLytely or Colyte) may be ordered to empty the bowel of stool. Oral anti-infectives (neomycin, erythromycin, or kanamycin sulfate) may be ordered to decrease bacteria in the intestine and help prevent postoperative infection. A nasogastric tube is inserted from the nose to the stomach on the day of surgery or during surgery to remove gastric secretions and prevent nausea and vomiting. A urinary catheter (a thin plastic tube) may also be inserted to keep the bladder empty during surgery, giving more space in the surgical field and decreasing chances of accidental injury.

### Aftercare

**Postoperative care** for the patient with a new colostomy, as with those who have had any major surgery, involves monitoring of blood pressure, pulse, respirations, and temperature. Breathing tends to be shallow because of the effect of anesthesia and

the patient's reluctance to breathe deeply and experience pain that is caused by the abdominal incision. The patient is instructed how to support the operative site during deep breathing and coughing, and given pain medication as necessary. Fluid intake and output is measured, and the operative site is observed for color and amount of wound drainage. The nasogastric tube will remain in place, attached to low, intermittent suction until bowel activity resumes. For the first 24–48 hours after surgery, the colostomy will drain bloody mucus. Fluids and electrolytes are infused intravenously until the patient's diet can gradually be resumed, beginning with liquids. Usually within 72 hours, passage of gas and stool through the stoma begins. Initially, the stool is liquid, gradually thickening as the patient begins to take solid foods. The patient is usually out of bed in eight to 24 hours after surgery and discharged in two to four days.

A colostomy pouch will generally have been placed on the patient's abdomen around the stoma during surgery. During the hospital stay, the patient and his or her caregivers will be educated on how to care for the colostomy. Determination of appropriate pouching supplies and a schedule of how often to change the pouch should be established. Regular assessment and meticulous care of the skin surrounding the stoma is important to maintain an adequate surface on which to attach the pouch. Some patients with colostomies are able to routinely irrigate the stoma, resulting in regulation of bowel function; rather than needing to wear a pouch, these patients may only need a dressing or cap over their stoma. Often, an enterostomal therapist will visit the patient in the hospital or at home after discharge to help the patient with stoma care.

Dietary counseling will be necessary for the patient to maintain normal bowel function and to avoid constipation, impaction, and other discomforts.

### Risks

Potential complications of colostomy surgery include:

- excessive bleeding
- surgical wound infection
- thrombophlebitis (inflammation and blood clot to veins in the legs)
- pneumonia
- pulmonary embolism (blood clot or air bubble in the lungs' blood supply)

Psychological complications may result from colostomy surgery because of the fear of the perceived

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

General surgeons and colon and rectal surgeons perform colostomies as inpatient surgeries, under general anesthesia.

social stigma attached to wearing a colostomy bag. Patients may also be depressed and have feelings of low self-worth because of the change in their lifestyle and their appearance. Some patients may feel ugly and sexually unattractive and may worry that their spouse or significant other will no longer find them appealing. Counseling and education regarding surgery and the inherent lifestyle changes are often necessary.

### Normal results

Complete healing is expected without complications. The period of time required for recovery from the surgery may vary depending on the patient's overall health prior to surgery and the patient's willingness to participate in stoma care. The colostomy patient without other medical complications should be able to resume all daily activities once recovered from the surgery. Adjustments in diet and daily personal care will need to be made.

### Morbidity and mortality rates

Complications after colostomy surgery can occur. The doctor should be made aware of any of the following problems after surgery:

- increased pain, swelling, redness, drainage, or bleeding in the surgical area
- headache, muscle aches, dizziness, or fever
- increased abdominal pain or swelling, constipation, nausea or vomiting, or black, tarry stools

Stomal complications can also occur. They include:

- Death (necrosis) of stomal tissue. Caused by inadequate blood supply, this complication is usually visible 12–24 hours after the operation and may require additional surgery.
- Retraction (stoma is flush with the abdomen surface or has moved below it). Caused by insufficient stomal length, this complication may be managed by use of special pouching supplies. Elective revision of the stoma is also an option.

## QUESTIONS TO ASK THE DOCTOR

- What kinds of preoperative tests will be required?
- What drugs will be given for pain after the surgery?
- What will I need to do to prepare for surgery?
- Is there an enterostomal therapist I can talk to before the surgery?
- What will my recovery time be and what restrictions will I have?
- Is there an ostomy support group at the hospital that I can attend?

- Prolapse (stoma increases length above the surface of the abdomen). Most often this results from an overly large opening in the abdominal wall or inadequate fixation of the bowel to the abdominal wall. Surgical correction is required when blood supply is compromised.
- Stenosis (narrowing at the opening of the stoma). Often this is associated with infection around the stoma or scarring. Mild stenosis can be removed under local anesthesia; severe stenosis may require surgery for reshaping the stoma.
- Parastomal hernia (bowel causing bulge in the abdominal wall next to the stoma). This occurs due to placement of the stoma where the abdominal wall is weak or an overly large opening in the abdominal wall was made. The use of an ostomy support belt and special pouching supplies may be adequate. If severe, the defect in the abdominal wall should be repaired and the stoma moved to another location.

Mortality rates for colostomy patients vary according to the patient's general health upon admittance to the hospital. Even among higher risk patients, mortality is about 16%. This rate is greatly reduced (between 0.8% and 3.8%) when the colostomy is performed by a board-certified colon and rectal surgeon.

### Alternatives

When a colostomy is deemed necessary, there are usually no alternatives to the surgery, though there can be alternatives in the type of surgery involved and adjuvant therapies related to the disease. For example, laparoscopic surgery is being used with many diseases of the intestinal tract, including initial cancers. For this surgery, the colon and rectal surgeon

inserts a laparoscope (an instrument that has a tiny video camera attached) through a small incision in the abdomen. Other small incisions are made for the surgeon to insert laparoscopic instruments to use in creating the colostomy. This surgery often results in a shorter stay in the hospital, less postoperative pain, a quicker return to normal activities, and far less scarring. It is not recommended for patients who have had extensive prior abdominal surgery, large tumors, previous cancer, or serious heart problems.

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- Hampton, Beverly, and Ruth Bryant. *Ostomies and Continent Diversions*. St. Louis: Mosby Year Book, Inc., 1992.
- Monahan, Frances. *Medical Surgical Nursing*. Philadelphia: W. B. Saunders Co., 1998.

#### ORGANIZATIONS

- United Ostomy Association, Inc. (UOA). 19772 MacArthur Blvd., Suite 200, Irvine, CA 92612 2405. (800) 826 0826. <http://www.uoa.org>.
- Wound Ostomy and Continence Nurses Society. 2755 Bristol Street, Suite 110, Costa Mesa, CA 92626. (714) 476 0268. <http://www.wocn.org>.

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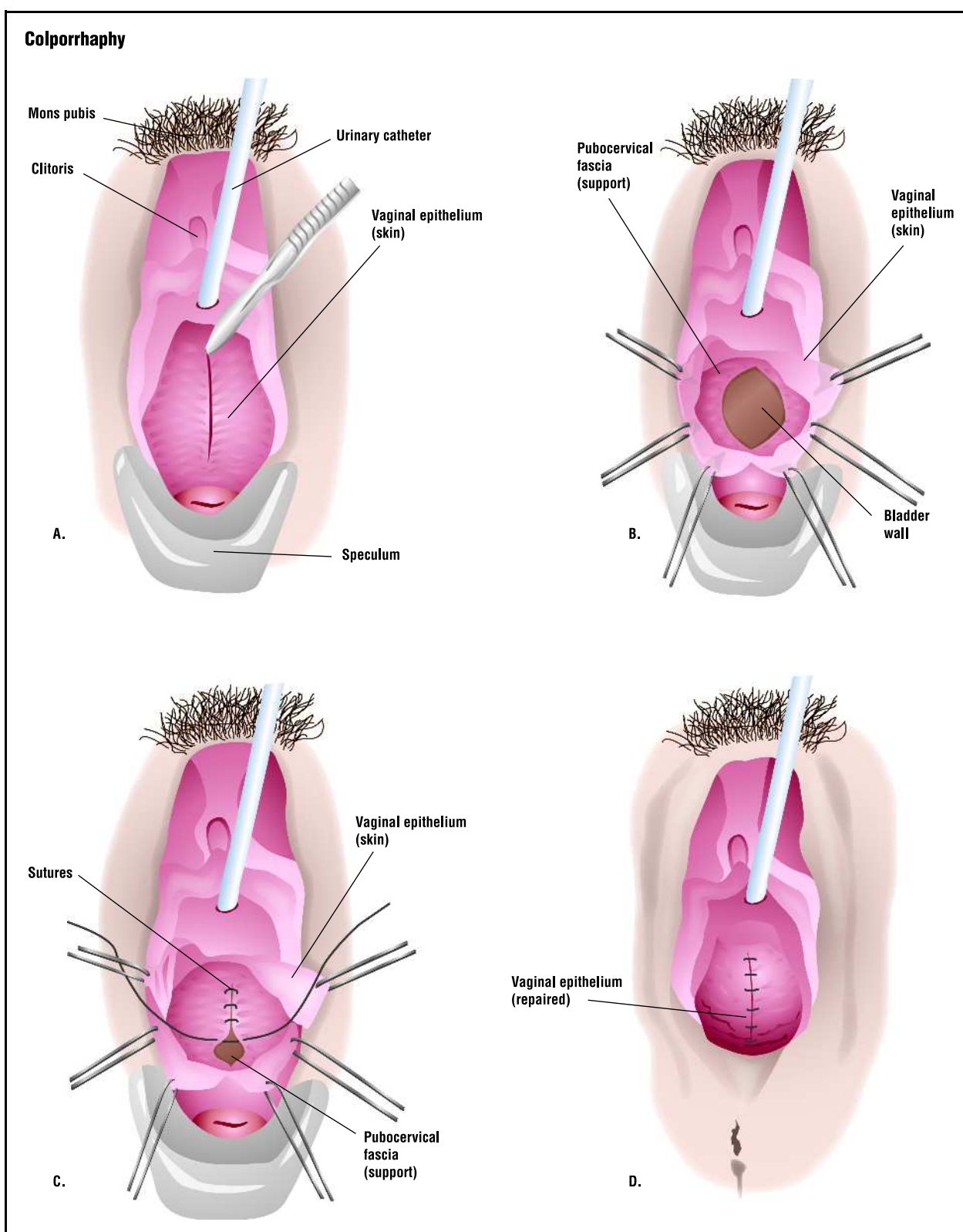
## Colporrhaphy

### Definition

Colporrhaphy is the surgical repair of a defect in the vaginal wall, including a cystocele (when the bladder protrudes into the vagina) and a rectocele (when the rectum protrudes into the vagina).

### Purpose

A prolapse occurs when an organ falls or sinks out of its normal anatomical place. The pelvic organs normally have tissue (muscle, ligaments, etc.) holding them in place. Certain factors, however, may cause those tissues to weaken, leading to prolapse of the organs. A cystocele is defined as the protrusion or



In this anterior colporrhaphy, a speculum is used to hold open the vagina, and the cystocele is visualized (A). The wall of the vagina is cut open to reveal an opening in the supporting structures, or fascia (B). The defect is closed (C), and the vaginal skin is repaired (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)



prolapse of the bladder into the vagina; a urethrocele is the prolapse of the urethra into the vagina. These are caused by a defect in the pubocervical fascia (fibrous tissue that separates the bladder and vagina). A rectocele occurs when the rectum prolapses into the vagina, caused by a defect in the rectovaginal fascia (fibrous tissue that separates the rectum and vagina). When a part of the small intestine prolapses into the vagina, it is called an enterocele. Uterine prolapse occurs when the uterus protrudes downward into the vagina.

Factors that are linked to pelvic organ prolapse include age, repeated childbirth, hormone deficiency, ongoing physical activity, and prior **hysterectomy**. Symptoms of pelvic organ prolapse include stress incontinence (inadvertent leakage of urine with physical activity), a vaginal bulge, painful sexual intercourse, back pain, and difficult urination or bowel movements.

### Demographics

Approximately 50% of women report occasional urinary incontinence, with 10% reporting regular incontinence. This percentage increases with age; daily incontinence is experienced by 20% of women over the age of 75. According to a recent study, approximately 16% of women ages 45 to 55 experience mild pelvic organ prolapse, while only 3% experience prolapse severe enough to warrant surgical repair.

### Description

Colporrhaphy may be performed on the anterior (front) and/or posterior (back) walls of the vagina. An anterior colporrhaphy treats a cystocele or urethrocele, while a posterior colporrhaphy treats a rectocele. Surgery is generally not performed unless the symptoms of the prolapse have begun to interfere with daily life.

The patient is first given general, regional, or **local anesthesia**. A speculum is inserted into the vagina to hold it open during the procedure. An incision is made into the vaginal skin and the defect in the underlying fascia is identified. The vaginal skin is separated from the fascia and the defect is folded over and sutured (stitched). Any excess vaginal skin is removed and the incision is closed with **stitches**.

### Diagnosis/Preparation

**Physical examination** is most often used to diagnose prolapse of the pelvic organs. A speculum is inserted into the vagina, and the patient is asked to

## KEY TERMS

**Enema**—The injection of fluid into the rectum to stimulate a bowel movement.

**Fascia**—Fibrous tissue that separates and supports organs and other structures in the body.

**Foley catheter**—A thin tube that is inserted into the urethra (the tube that runs from the bladder to the outside of the body) to allow the drainage of urine.

**Hysterectomy**—The surgical removal of the uterus.

**Perineum**—The area between the vulva and anus in females, or the scrotum and anus in males.

**Vaginal speculum**—An instrument that is inserted into the vagina that expands and allows for examination of the vagina and cervix.

strain or sit in an upright position. The physician then inspects the anterior, posterior, upper (apex), and side (lateral) walls of the vagina for prolapse or bulging. In some cases, a physical examination cannot sufficiently diagnose pelvic prolapse. For example, cystogram may be used to determine the extent of a cystocele; the bladder is filled by urinary catheter with contrast medium and then x-rayed.

The patient will be asked to refrain from eating or drinking after midnight on the day of the procedure. The physician may request that an enema be administered the night before the procedure if posterior colporrhaphy will be performed.

### Aftercare

A Foley catheter may remain for one to two days after surgery. The patient will be given a liquid diet until normal bowel function returns. The patient will be instructed to avoid activities for several weeks that will cause strain on the surgical site, including lifting, coughing, long periods of standing, sneezing, straining with bowel movements, and sexual intercourse.

### Risks

Risks of colporrhaphy include potential complications associated with anesthesia, infection, bleeding, injury to other pelvic structures, dyspareunia (painful intercourse), recurrent prolapse, and failure to correct the defect. A fistula is a rare complication of colporrhaphy in which an opening develops between the vagina and bladder or the vagina and rectum.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Colporrhaphy is usually performed in a hospital operating room by a gynecologist or urologist. A gynecologist is a medical doctor who specializes in the areas of women's general and reproductive health, pregnancy, and labor and childbirth. A urologist is a medical doctor who specializes in the diagnosis and treatment of diseases of the urinary tract and genital organs.

### Normal results

A woman will usually be able to resume normal activities, including sexual intercourse, about four weeks after the procedure. After successful colporrhaphy, the symptoms associated with cystocele or rectocele will recede, although a separate procedure may be needed to treat stress incontinence. Anterior colporrhaphy is approximately 66% successful at restoring urinary continence.

### Morbidity and mortality rates

There is approximately a 1% risk of serious complications associated with colporrhaphy; the procedure is generally viewed to be safe with a very low rate of overall complications.

### Alternatives

Surgery is generally reserved for more severe cases of pelvic organ prolapse. Milder cases may be treated by a number of medical interventions. The physician may recommend that the patient do Kegel exercises, a series of contractions and relaxations of the muscles in the perineal area. These exercises are thought to strengthen the pelvic floor and may help prevent urinary incontinence. One study showed a decrease of 62% in the amount of urine leakage among women ages 35 to 75 who performed Kegel exercises regularly for 16 weeks.

A pessary, a device that is inserted into the vagina to help support the pelvic organs, may be recommended. Pessaries come in different shapes and sizes and must be fitted to the patient by a physician. Hormone replacement therapy may also be prescribed if the woman has gone through menopause; hormones may improve the quality of the supporting tissues in the pelvis.

## QUESTIONS TO ASK THE DOCTOR

- Why is colporrhaphy recommended in my case?
- What non-surgical options are available to treat pelvic organ prolapse?
- How long after surgery may I resume normal activity?

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Stephanie Dionne Sherk

## Colposcopy

### Definition

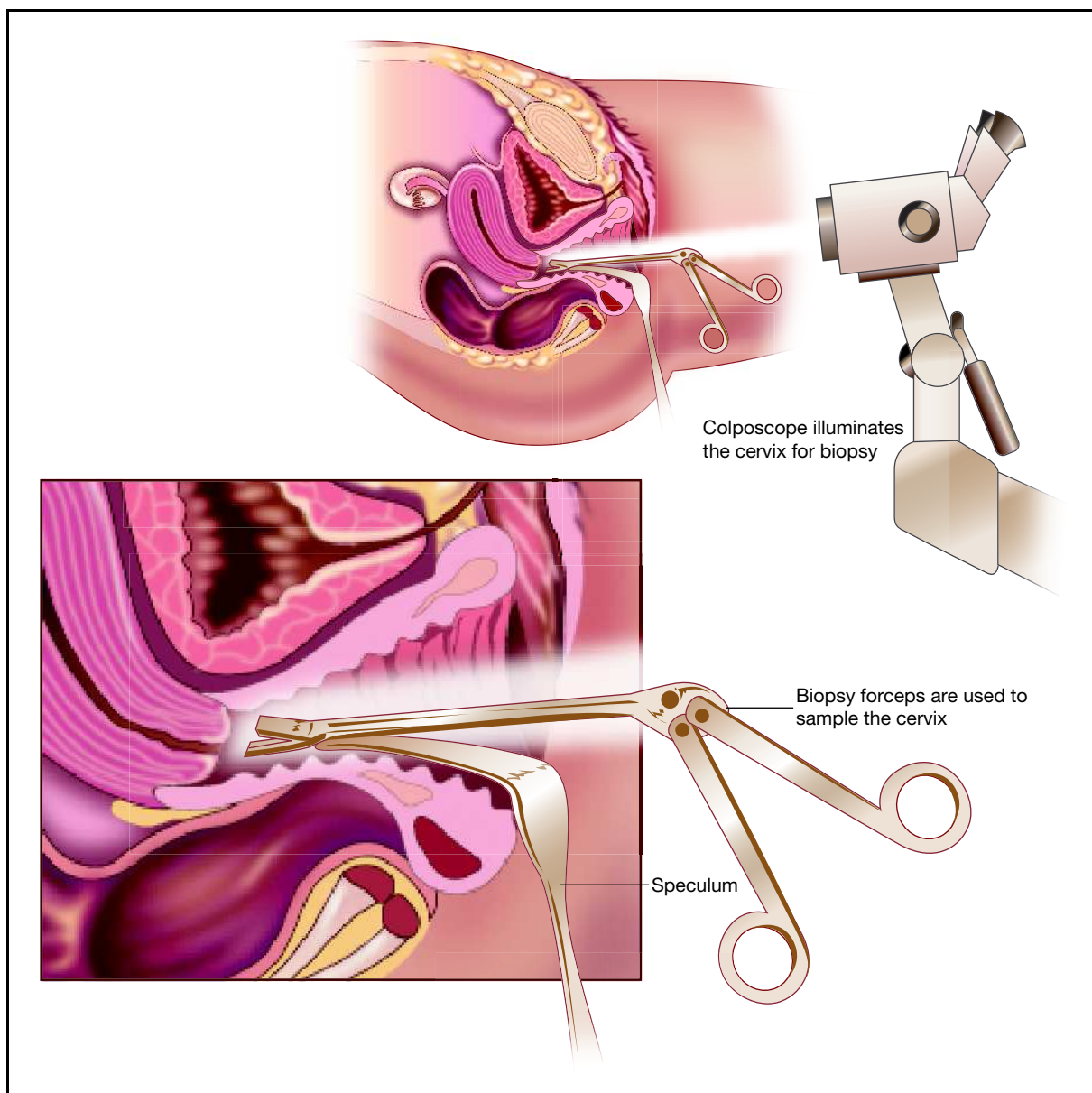
Colposcopy is a procedure that allows a physician to examine a woman's cervix and vagina using a special microscope called a colposcope. Colposcopy is used to check for precancerous or abnormal areas.

### Purpose

Colposcopy is used to identify or rule out the existence of any precancerous conditions in the cervical

tissue. If a Papanicolaou (Pap) test shows abnormal cell growth, colposcopy is usually the first follow-up test performed. The physician will attempt to find the area that produced the abnormal cells and remove a sample of it for further study (biopsy) and diagnosis.

Colposcopy may also be performed if the cervix looks abnormal during a routine examination. It may be suggested for women with genital warts and for diethylstilbestrol (DES) daughters (women whose mothers took the anti-miscarriage drug DES when pregnant with them). Colposcopy is used in the emergency department to examine victims of sexual assault



(Illustration by Electronic Illustrators Group.)

and abuse and document any physical evidence of vaginal injury.

## Demographics

Cervical cancer affects millions of women worldwide. In the United States, the routine use of Pap tests has substantially decreased the rate of this cancer. With the introduction of a vaccine against the family of viruses associated with cervical cancer, the rate in the developed world is expected to continue to fall. Cervical cancer continues to be a major health problem for women in the developing world. Even in the United States, it is estimated that about one-third of women fail to follow up with colposcopy after an abnormal Pap test. Minority women, teenagers, and those of low socioeconomic status are the least likely to follow up.

## Description

Colposcopy is usually performed in a physician's office and is similar to a regular gynecologic exam. An instrument called a speculum is inserted to hold the vagina open, and the gynecologist looks at the cervix and vagina using a colposcope, a low-power microscope designed to magnify the cervix 10–40 times its normal size. Most colposcopes are connected to a video monitor that displays the area of interest. Photographs are taken during the examination to document abnormal areas.

The cervix and vagina are swabbed with dilute acetic acid (vinegar). The solution highlights abnormal areas by turning them white (instead of a normal pink color). Abnormal areas can also be identified by looking for a characteristic pattern made by abnormal blood vessels.

If any abnormal areas are seen, the doctor takes a biopsy of the tissue, a common procedure that takes about 15 minutes. Several samples might be taken, depending on the size of the abnormal area. A biopsy may cause temporary discomfort and cramping, which usually go away within a few minutes. If the abnormal area appears to extend inside the cervical canal, a scraping of the canal may also be done. The biopsy results are usually available within a week.

If the tissue sample indicates abnormal growth (dysplasia) or is precancerous, and if the entire abnormal area can be seen, the doctor may destroy the tissue using one of several procedures, including ones that use high heat (diathermy), extreme cold (cryosurgery), or lasers. Another procedure, called loop electrosurgical excision (LEEP), uses low-voltage, high-frequency radio waves to excise tissue. If any of the abnormal tissue is within the cervical canal, a **cone biopsy**

KEY TERMS	
<b>Biopsy</b>	Removal of a sample of abnormal tissue for more extensive examination under a microscope.
<b>Cervix</b>	Narrow, lower end of the uterus forming the opening to the vagina.
<b>Cryosurgery</b>	Freezing and destroying abnormal cells.
<b>Diathermy</b>	Also called electrocautery, this is a procedure that heats and destroys abnormal cells.
<b>Diethylstilbestrol (DES)</b>	A synthetic form of estrogen that was widely prescribed to women from 1940 to 1970 to prevent complications during pregnancy, and linked to several serious birth defects and disorders of the reproductive system in daughters of women who took DES.
<b>Dysplasia</b>	Abnormal cellular changes that may become cancerous.
<b>Human papillomavirus (HPV)</b>	A family of viruses that cause common warts of the hands and feet, as well as lesions in the genital and vaginal area. More than 50 types of HPV have been identified, some of which are linked to cancerous and precancerous conditions, including cancer of the cervix. A vaccine is now available against some of these viruses.
<b>Loop electrosurgical excision (LEEP)</b>	A procedure that can help diagnose and treat cervical abnormalities using a thin wire loop that emits a low-voltage high-frequency radio wave that can excise tissue.
<b>Monsel's solution</b>	A solution used to stop bleeding.
<b>Pap test</b>	The common term for the Papanicolaou test, a simple smear method of removing cervical cells to screen for abnormalities that indicate cancer or a precancerous condition.
<b>Speculum</b>	A retractor used to separate the walls of the vagina to make visual examination easier.

(removal of a conical section of the cervix for inspection) will be needed.

## Diagnosis/Preparation

Women who are pregnant or who suspect that they are pregnant must tell their doctor before the procedure begins. Pregnant women may undergo colposcopy if they have an abnormal Pap test; special precautions, however, must be taken during biopsy of the cervix. Patients who are taking blood-thinning



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Colposcopy may be performed by a gynecologist or other qualified health care provider in an outpatient setting. A gynecologist specializes in the areas of women's general health, pregnancy, labor and childbirth, prenatal testing, and genetics. In cases of sexual assault, a nurse practitioner, or registered nurse may perform the procedure. If a biopsy is performed, a pathologist examines the tissue samples under a powerful microscope in the laboratory and sends the results to the health care provider who, in turn, informs the patient of the results.

medications such as warfarin (Coumadin) should tell their doctor before the procedure.

Patients should be instructed not to douche, use tampons, or have sexual intercourse for 24 hours before colposcopy. Patients should empty their bladder and bowels before colposcopy for comfort. Colposcopy does not require any anesthetic medication because pain is minimal. If a biopsy is done, there may be mild cramps or a sharp pinching when the tissue is removed. To lessen this pain, the doctor may recommend ibuprofen (Motrin, Advil) taken the night before and the morning of the procedure (no later than 30 minutes before the appointment). Patients who are pregnant or allergic to **aspirin** or ibuprofen can instead take **acetaminophen** (Tylenol).

### Aftercare

If a biopsy was done, there may be a dark vaginal discharge afterwards. After the sample is removed, the doctor applies Monsel's solution to the area to stop the bleeding. When this mixes with blood, it creates a black fluid that looks like coffee grounds. This fluid may be present for a several days after the procedure. It is also normal to have some blood spotting after colposcopy. Pain-relieving medication can be taken to lessen any post-procedural cramping.

Patients should not use tampons, douche, or have sex for at least a week after the procedure or until the doctor says it is safe because of the risk of infection.

### Risks

Colposcopy is a very safe procedure. Patients may have bleeding or infection after biopsy. Bleeding is usually controlled with a topical medication prescribed

## QUESTIONS TO ASK THE DOCTOR

- Why is colposcopy recommended in my case?
- Will a biopsy be performed?
- How long will the procedure take?
- When will I find out the results?
- What will happen if the results are positive for cancer or another abnormality?

by the physician or health care provider. If colposcopy is performed on a pregnant patient, there is a risk of premature labor.

A patient should call her doctor right away if she notices any of the following symptoms:

- heavy vaginal bleeding (more than one sanitary pad an hour);
- fever, chills, or an unpleasant vaginal odor; or
- lower abdominal pain.

### Normal results

If visual inspection shows that the surface of the cervix is smooth and pink, this is considered normal. Areas that look abnormal may actually be normal variations; a biopsy will indicate whether the tissue is normal or abnormal.

Abnormal conditions that can be detected using colposcopy and biopsy include precancerous tissue changes (cervical dysplasia), cancer, and cervical warts caused by human papillomavirus.

### Morbidity and mortality rates

Complications associated with colposcopy are extremely rare. There is a risk that the procedure will miss precancerous or cancerous tissues and thus prolong treatment until the cancer has become advanced. The American Cancer Society estimated that 11,150 new cases of cervical cancer were diagnosed in 2007 and 3,670 deaths could be attributed to the disease.

### Alternatives

While the Pap test is an effective screening test for abnormal cell growth of the cervix, it is an inadequate diagnostic alternative to colposcopy because of the potential for false negative results (10–50%). In some instances, a repeat Pap test may be recommended before performing colposcopy (e.g., in the case of inflammation or no previous abnormal Pap test).

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American Society for Colposcopy and Cervical Pathology, 152 West Washington Street, Hagerstown, MD, 21740, (301) 733 3640, (800) 787 7227, <http://www.asccp.org>.

Association of Women’s Health, Obstetric, and Neonatal Nurses, 2000 L St., NW, Suite 740, Washington, DC, 20036, (202) 261 2400, (800) 673 8499, <http://www.awhonn.org>.

DES Action USA, 158 S. Stanwood Rd., Columbus, OH, 43209, (800) 337 9288, <http://www.desaction.org>.

Society of Gynecologic Oncologists, 230 West Monroe Street, Suite 710, Chicago, IL, 60606, (312) 235 4060, <http://www.sgo.org>.

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## Colpotomy

### Definition

A colpotomy, also known as a vaginotomy, is a procedure by which an incision is made in the vagina.

### Purpose

A colpotomy is performed either to visualize pelvic structures or to perform surgery on the fallopian tubes or ovaries.

### Role of colpotomy in gynecologic surgery

Several gynecologic surgery protocols require a colpotomy as part of the overall surgical procedure.

It is performed whenever the surgeon needs to access the vagina. Several of these surgeries include:

- Tubal sterilization. Sterilization is a procedure that can be performed using either abdominal or vaginal procedures. When a vaginal procedure is selected by the surgeon, he performs a colpotomy and may also insert a culdoscope to locate the tubes (culdoscopy), and close them off.
- Removal of myomas. Myomas are fibroid tumors of the muscle tissue of the uterus and they are sometimes removed vaginally by colpotomy.
- Removal of pelvic cysts and masses. In one treatment variant, patients may undergo a laparoscopy followed by a colpotomy for the vaginal extraction of the pelvic cyst or mass.
- Hysterectomy. One technique used to surgically remove the uterus combines three steps, an initial laparoscopic stage, followed by a vaginal stage, and a final laparoscopic stage. The colpotomy is performed during the second step to deliver the uterus into the vagina.
- Dysmenorrhea. Separation of the uterosacral ligaments via colpotomy is an approach that has been used for the relief of dysmenorrhea (painful menstruation).
- Complications in pregnancy and childbirth. Colpotomy may be used in the management of difficult pregnancies and childbirths.

### Demographics

According to Professor V. Base-Smith at the University of Cincinnati College of Nursing, removal of the uterus is the second most commonly performed surgical procedure in the United States after cesarean delivery. Analysis of the demographics show that:

- 650,000 hysterectomies are performed annually, expected to reach approximately 834,000 by 2005.
- 6.1–8.6 per 1,000 women undergo hysterectomy per year.
- In the United States, the Northeast has the lowest hysterectomy rate, while the South has the highest rate.
- African-American women experience hysterectomy more frequently than European-American women.

The ratio of abdominal to vaginally performed hysterectomies is three to one, meaning that colpotomy is performed in one out of four **hysterectomy** procedures.

Female sterilization is a common contraception method. About 20,000 female sterilizations are carried out each year in Canada and nearly 10% of North

## KEY TERMS

**Anesthesia**—A combination of drugs administered by a variety of techniques by trained professionals that provide sedation, amnesia, analgesia, and immobility adequate for the accomplishment of the surgical procedure with minimal discomfort, and without injury, to the patient.

**Antiseptic**—Substance preventing or stopping the growth of microorganisms.

**Cul-de-sac**—The closed end of a pouch.

**Culdoscopy**—Procedure by which a surgeon performs a colpotomy and inserts a culdoscope, an instrument with a light on the end, through the incision.

**Culdocentesis**—Removal of material from the pouch of Douglas, a deep peritoneal recess between the uterus and the upper vaginal wall, by means of puncture of the vaginal wall.

**Cyst**—A closed sac having a distinct membrane and developing abnormally in a body cavity or structure.

**Dysmenorrhea**—Painful menstruation.

**Fallopian tubes**—The pair of anatomical tubes that carry the egg from the ovary to the uterus.

**Forceps**—An instrument for grasping, holding firmly, or exerting traction upon objects especially for delicate operations.

**Hysterectomy**—Surgical removal of the uterus.

**Laparoscopy**—Visual examination of the inside of the abdomen by means of a laparoscope or surgery performed using a laparoscope.

**Myoma**—A tumor consisting of muscle tissue.

**Ovary**—One of the two essential female reproductive organs that produce eggs and sex hormones.

**Pelvic**—Located near the pelvis, the skeletal structure comprised of four bones that encloses the pelvic cavity.

**Sterilization**—To make sterile, meaning to deprive of the power of reproducing.

**Uterus**—The womb, an organ in females for containing and nourishing the young during development before to birth.

**Vagina**—A canal in the female body that leads from the cervix to the external orifice opening to the outside of the body.

**Vulva**—The external parts of the female genital organs that include the mons pubis, labia majora, labia minora, clitoris, vestibule of the vagina, bulb of the vestibule, and Bartholin's glands.

American women 30 years or older have been sterilized in a procedure that involved colpotomy.

### Description

The patient is placed in a supine position on the operating table with her legs in stirrups and the incision site is prepared. An antiseptic solution, such as chlorhexidine, is applied to the skin using highly disinfected forceps and gauze swabs. The patient is covered with surgical drapes with the window positioned directly over the incision site. Throughout the procedure, the **vital signs** of the patient are monitored (blood pressure, pulse, respiratory rate) as well as her level of consciousness and blood loss. **Pain management** depends on the surgery that requires the colpotomy, and may involve local, regional, or **general anesthesia**. The incision is only made as large as necessary for the requirements of the overall surgery.

For example, when a decision has been made to remove a myoma by colpotomy, the procedure may proceed as follows:

- A small myoma screw is inserted into the myoma and a grasper with locking mechanism is placed on the lower edge of the wound.
- The myoma is directed toward the cul-de-sac using the myoma screw.
- A colpotomy is performed.
- The myoma is grasped and removed vaginally. During this part of the procedure, the surgeon examines whether the myoma extends into the uterine cavity.
- If it does, the uterus is guided to the colpotomy site. T-clamps are placed on the edges of the wounds and the fundus of the uterus is delivered, via the colpotomy incision, into the vagina.
- The uterus is sutured in three layers (endometrial, myometrial and serosal).
- The repaired uterus is returned to the abdominal cavity.
- The colpotomy incision is sutured.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A colpotomy is performed by a gynecological surgeon either in an outpatient clinic or in a hospital setting, depending on the overall surgical procedure of which the colpotomy is a part.

### Preparation

The procedure is explained to the patient within the broader context of the surgery that includes the colpotomy. Preoperative preparation includes whatever is required for the overall surgical procedure that will be performed.

### Aftercare

Aftercare for colpotomy is associated with the overall surgery that required the colpotomy.

For example, if a colpotomy is performed for **tubal ligation** (female sterilization), the procedure takes only 15–30 minutes and women usually go home the same day. It may take a few days at home to recover. Sexual intercourse is usually postponed until the colpotomy incision is completely healed, and as advised by the doctor. The healing process usually requires several weeks and there are no visible scars. In the case of a colpotomy performed for myoma removal, aftercare is more elaborate with the patient's vital signs monitored in the **recovery room** until she regains consciousness.

### Risks

Complications such as bleeding, infection, or reaction to the anesthetic, may occur as with any type of gynecological surgery.

### Normal results

Colpotomy results are considered normal when the incision performed allows the surgeon to meet the goal of the overall surgical protocol.

### Morbidity and mortality rates

Colpotomy morbidity rates are not reported. This is because the procedure represents one surgical process in an operation that involves other surgical procedures. In the case of colpotomy performed in the context of tubal sterilization, morbidity with tubal

## QUESTIONS TO ASK THE DOCTOR

- Why is a colpotomy required?
- What are the risks involved?
- How many such procedures do you perform in a year?
- How soon can I have sexual intercourse again?
- Is the procedure painful?

ligation is 5%; mortality is less than four in 100,000 cases.

As for hysterectomies, a higher morbidity and mortality rate is associated with abdominal than with vaginal hysterectomy surgery, the latter procedure being the only one to involve colpotomy.

### Alternatives

In the case of colpotomy used for tubal ligation procedures, **laparoscopy** or laparotomy procedures are currently the preferred technique, since fewer and fewer U.S. surgeons are trained to use colpotomy as an approach for sterilization.

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13021 East Florence Avenue, Santa Fe Springs, CA 90670 4505. (800) 554 2245. [www.aagl.com/](http://www.aagl.com/).

American College of Obstetricians and Gynecologists. 409 12th Street, SW, Washington, DC 20024 2188. E mail: [resources@acog.org](mailto:resources@acog.org). [www.acog.org/](http://www.acog.org/).

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Computer monitor displaying a complete blood count with differential. (Thomas Photography LLC / Alamy)

# Complete blood count

## Definition

A complete blood count (CBC) provides important information about the types and numbers of cells in the blood; in particular, information about red blood cells, white blood cells and platelets.

## Purpose

The purpose of a CBC is to help physicians to diagnose conditions related to abnormalities in the blood such as infections and anemia.

## Description

A complete blood count usually includes the following elements:

- Red blood cell count (also called RBC or erythrocyte count)

- Red blood cell indices - mean corpuscular volume (MCV, mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC)
- Hemoglobin (also called Hgb)
- Hematocrit (also called HCT)
- White blood cell count (also called WBC or leukocyte count)
- Platelet count (also called thrombocyte count)

Red blood cells (erythrocytes) transport oxygen between the lungs and cells throughout the rest of the body. They also transport carbon dioxide back to the lungs so it can be exhaled. A low red cell count may be due to anemia and cells in the body may not be getting the oxygen that they need. A red blood cell count that is abnormally high may be due to an uncommon condition called polycythemia.

White blood cells (leukocytes) protect the body against infection. When an infection develops, white blood cells attack and destroy the pathogen (bacteria,

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

- A complete blood count is typically ordered by a family doctor, internist or surgeon but any physician may order one.
- A blood sample is usually obtained by a nurse, phlebotomist or medical technologist.
- The blood sample is tested or processed by a medical technologist.
- Results are usually reviewed, returned to the person being tested and interpreted by the physician initially ordering the complete blood count.

virus, or other organism) causing it. White blood cells are larger than red blood cells but fewer in number. When a person has a bacterial infection, the number of white cells increases very quickly. The number of white blood cells is sometimes used to pinpoint an infection or to see how the body is reacting to cancer treatment.

Platelets (thrombocytes) are the smallest type of blood cell. They are essential to the process of blood clotting. When bleeding occurs, platelets swell, clump together, and form a sticky plug that helps to stop the bleeding. If the platelet count is too low, uncontrolled bleeding may occur. If the platelet count is too high, there is a chance of a blood clot forming in a blood vessel. Platelets may contribute to the process of hardening of the arteries (atherosclerosis).

There are three **red blood cell indices**: mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC). They are measured by a laboratory instrument machine that calculates their values from other measurements in a complete blood count. The mean corpuscular volume reflects the average size of red blood cells. The mean corpuscular hemoglobin value reflects the quantity of hemoglobin in an average red blood cell. The mean corpuscular hemoglobin concentration reflects the concentration of hemoglobin in an average red blood cell. These numbers are used in diagnosing different types of anemia.

The hemoglobin value reflects the amount of hemoglobin in blood and is a good measure of the ability of a person's blood stream to carry oxygen throughout the

## QUESTIONS TO ASK YOUR DOCTOR

- Why is a complete blood count needed?
- What do the results indicate for my health?
- What treatment options do I have?

body. A hemoglobin molecule comprises much of the volume of red blood cells. It carries oxygen and gives red blood cells their normal color.

The **hematocrit** value reflects the amount of space (volume) that red blood cells occupy in the blood. The value is given as a percentage of red blood cells in a volume of blood. For example, a hematocrit of 46 means that 46% of the blood's volume is comprised of red blood cells. Males and females have different normal hematocrit values.

Normal values for the elements of a complete blood count include the following:

- Red blood cell (erythrocyte) count: 4.2–5.9 million
- White blood cell (leukocyte) count: 4,300–10,800
- Platelet (thrombocyte) count: 150,000–400,000
- Mean corpuscular volume (MCV): 86–98
- Mean corpuscular hemoglobin (MCH): 27–32
- Mean corpuscular hemoglobin concentration (MCHC): 32–36%
- Hemoglobin (Hgb): 13–18 for men and 12–16 for women
- Hematocrit (HCT): 45–52% for men and 37–48% for women

A complete blood count can be ordered at any time.

### Precautions

Precautions are generally not needed for a complete blood count.

At the time of drawing blood, the only precaution needed is to clean the venipuncture site with alcohol.

### Side effects

The most common side effects of a complete blood count are minor bleeding (hematoma) or bruising at the site of venipuncture.

## KEY TERMS

**Hematoma**—A collection of blood that has entered a closed space.

**Phlebotomist**—Health care professional trained to obtain samples of blood.

## Interactions

There are no interactions for a complete blood count.

## Resources

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Computerized axial tomography see **CT scans**

## Cone biopsy

### Definition

A cone biopsy is a surgical procedure in which a cone-shaped tissue sample from the cervix is removed for examination. Also called cervical conization, a cone biopsy is done to diagnose cervical cancer or to remove cancerous or precancerous tissue.

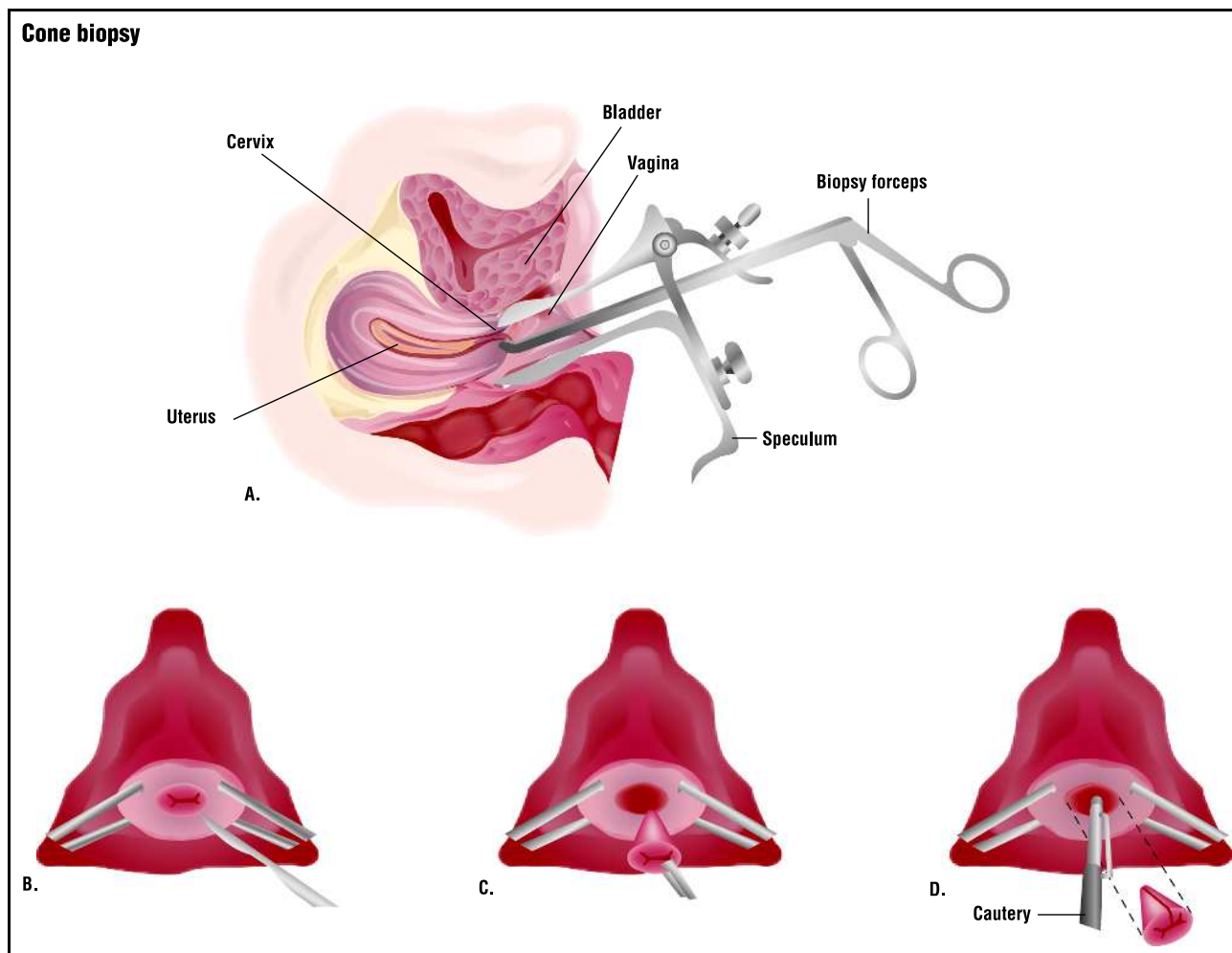
### Purpose

The cervix is the neck-shaped opening at the lower part of the uterus. The American Cancer Society estimated that in 2007, approximately 11,150 women would be diagnosed with cancer of the cervix, and 3,670 women would die of the disease. When cervical cancer is detected and treated in its early stages, however, the long-term rate of survival is almost 100%.

A cone biopsy is performed to diagnose cancer of the cervix or to detect precancerous changes. The procedure is often recommended if a Pap test indicates the presence of abnormal cells. In some cases, a cone biopsy may be used as a conservative treatment for cervical cancer for women who wish to avoid a **hysterectomy** (surgical removal of the uterus).

### Demographics

The risk of developing cervical cancer increases with age through a woman's 20s and 30s; the risk



In a cone biopsy, the patient lies on her back, and a speculum is inserted into the vagina (A). The cervix is visualized, and a cone-shaped piece of the cervix is removed (B and C). A cauterizing tool is used to stop any bleeding (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

remains about the same for women over the age of 40. Minority women and women of low socioeconomic status have higher rates of cervical cancer and an increased mortality rate. According to the Centers for Disease Control and Prevention (CDC), African-American, Asian-American, and Hispanic women have a higher-than-average incidence of the disease, while African-American and Hispanic women have a higher rate of cervical cancer-related **death**.

### Description

The procedure is performed with the patient lying on her back with her legs in stirrups. **General anesthesia** is commonly used, although regional (spinal or epidural) or **local anesthesia** may also be used. A

speculum is inserted into the vagina to hold it open during surgery.

There are several different methods that may be used to perform a cone biopsy. Cold-knife conization is the removal of a cone-shaped wedge of tissue with a scalpel. The tissue may also be removed using a carbon dioxide laser, a procedure called laser conization. A loop electrosurgical excision procedure (LEEP) uses low-voltage, high-frequency radio waves to excise the tissue. Some surgeons choose to cover the open cervical tissue with flaps of tissue stitched into place.

The tissue sample will then be examined under a microscope for the presence of cancerous cells. If abnormal cells are found around the edge of the biopsy, then further surgery will be required to excise any remaining cancer. If there is evidence of invasive



## KEY TERMS

**Fallopian tubes**—The structures that carry a mature egg from the ovaries to the uterus.

**Ovaries**—Egg-shaped structures located on each side of the uterus.

**Pap test**—The common term for the Papanicolaou test, a simple smear method of examining stained cells to detect cancer of the cervix.

**Vaginal speculum**—An instrument that is inserted into the vagina that expands and allows for examination of the vagina and cervix.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A cone biopsy is usually performed by a gynecologist who specializes in the areas of women's general and reproductive health, pregnancy, labor and delivery, and prenatal testing. Tissue samples are analyzed by a pathologist who specializes in the diagnosis of diseases from microscopic analysis of cells and tissues. The procedure is generally done on an outpatient basis in a hospital or doctor's office.

cancer (i.e., the cancer has spread to surrounding tissues), then other treatments, such as more extensive surgery, chemotherapy, and/or radiation, may be recommended.

## Diagnosis/Preparation

A number of tests may be performed prior to cone biopsy to determine if precancerous or cancerous cells exist. A Pap test involves scraping the cervix for a sample of cells and then staining and examining the cells for any abnormalities. **Colposcopy** is a procedure that allows a physician to examine a woman's cervix and vagina using a special microscope called a colposcope. A cervical biopsy involves the extraction of a smaller tissue sample and is less invasive than a cone biopsy. Based on the results of these tests, a cone biopsy may be indicated if moderate to severe cell abnormalities are found.

As cone biopsy is commonly performed under general anesthesia, the patient is usually instructed to refrain from eating and drinking after midnight on the day of surgery.

## Aftercare

After the procedure, the patient may experience some cramping, discomfort, or mild to moderate bleeding. The biopsy site may take up to six weeks to completely heal. The patient will be instructed to avoid intercourse, tampons, and douches for at least three weeks following the procedure.

## Risks

Bleeding during and after cone biopsy is the most common complication. Rarely, uncontrolled bleeding during the procedure may result in an emergency hysterectomy. Other potential complications include

reaction to the anesthesia, infection of the biopsy site, injury to the uterus or other tissues, cervical stenosis (when the cervical canal narrows or becomes closed), and failure to remove all cancerous tissue. If too much tissue is removed during a cone biopsy so that the internal opening of the cervix to the uterus (called the internal os) is affected, a woman may have difficulty carrying a pregnancy to term, increasing her risk of miscarriage or premature birth.

## Normal results

Numerous studies have indicated that cone biopsy is successful in excising all cancerous tissue in 90% of patients with cervical cancer.

## Morbidity and mortality rates

Between 2 and 8% of women who undergo a cone biopsy will experience bleeding for up to two weeks. One study found that cervical stenosis occurs at a rate of 3–8%, depending on the method of conization.

## Alternatives

**Cryotherapy** (freezing and destroying of abnormal cells) or laser vaporization (using a laser to destroy abnormal cells) may be used to treat early-stage cancer. A hysterectomy may be necessary to remove more invasive cancer. In a subtotal hysterectomy, only the uterus is removed. In a radical hysterectomy, the uterus, cervix, ovaries, fallopian tubes, lymph nodes, and lymph channels are removed. The type of hysterectomy performed depends on how far the cancer has spread. In all cases, menstruation stops and a woman loses the ability to bear children.

## QUESTIONS TO ASK THE DOCTOR

- Why is a cone biopsy recommended in my case?
- How will the sample be removed?
- How long will the procedure take?
- When will I find out the results?
- What will happen if the results are positive for cancer or another abnormality?

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Confidentiality see **Patient confidentiality**

Congenital glaucoma surgery see  
**Goniotomy**

Conization see **Cone biopsy**

Conscious sedation see **Sedation, conscious**

Continent ileostomy see **Ileoanal reservoir surgery**

Corneal keratoplasty see **Corneal transplantation**

## Corneal transplantation

### Definition

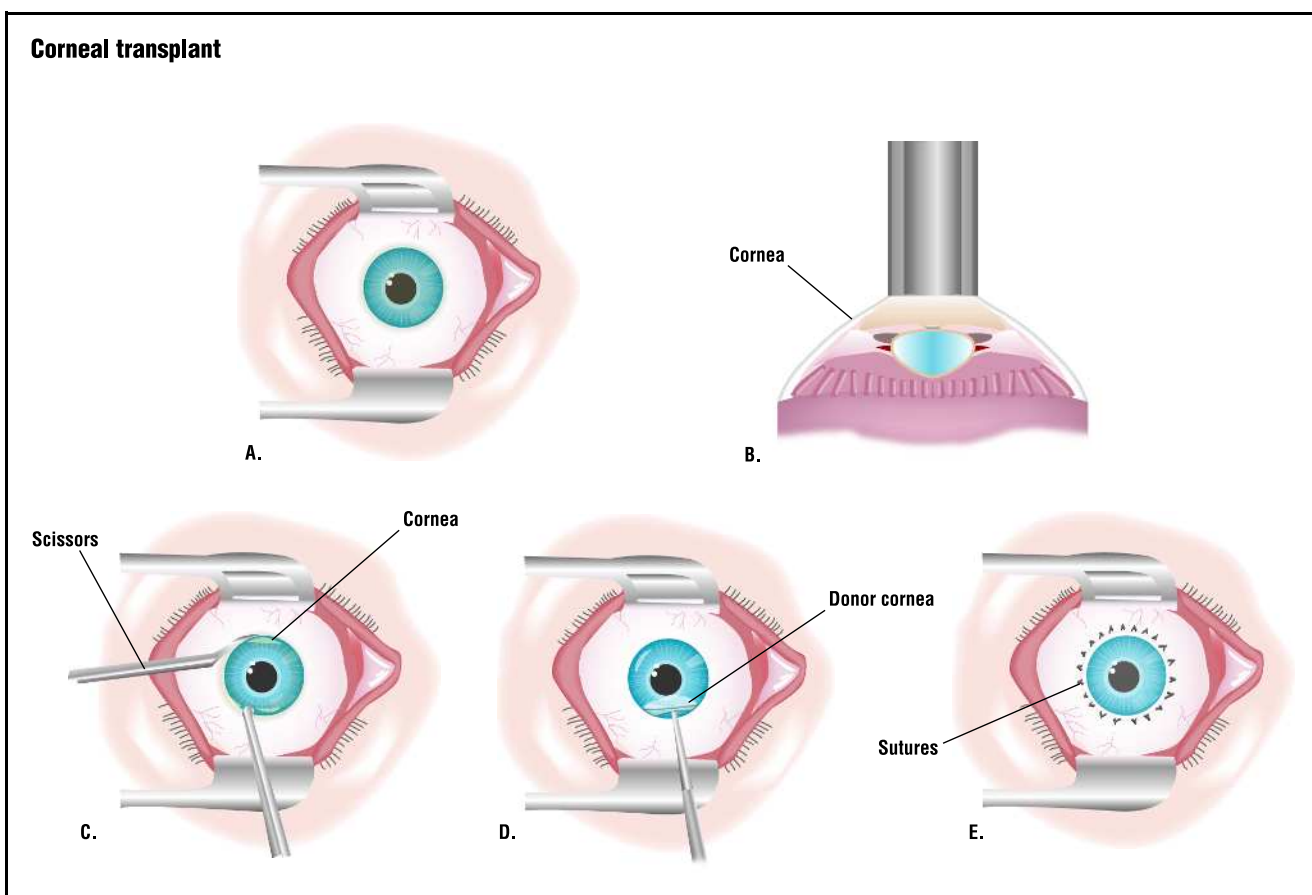
In corneal transplant, also known as keratoplasty, a patient's damaged cornea is replaced by the cornea from the eye of a human cadaver. This is the most common type of human **transplant surgery** and has the highest success rate. Eye banks acquire and store eyes from donors to supply the need for transplant corneas.

### Purpose

Corneal transplant is used when vision is lost because the cornea has been damaged by disease or traumatic injury, and there are no other viable options. Some of the conditions that might require corneal transplant include the bulging outward of the cornea (keratoconus), a malfunction of the cornea's inner layer (Fuchs' dystrophy), and painful corneal swelling (pseudophakic bullous keratopathy). Other conditions that might make a corneal transplant necessary are tissue growth on the cornea (pterygium) and Stevens-Johnson syndrome, a skin disorder that can affect the eyes. Some of these conditions cause cloudiness of the cornea; others alter its natural curvature, which also can reduce vision quality.

Injury to the cornea can occur because of chemical burns, mechanical trauma, or infection by viruses, bacteria, fungi, or protozoa. The herpes virus produces one of the more common infections leading to corneal transplant.

Corneal transplants are used only when damage to the cornea is too severe to be treated with corrective lenses. Occasionally, corneal transplant is combined with other eye surgery, such as cataract surgery, to solve multiple eye problems with one procedure.



In a corneal transplant, the eye is held open with a speculum (A). A laser is used to make an initial cut in the existing cornea (B). The surgeon uses scissors to remove it (C), and a donor cornea is placed (D). It is stitched with very fine sutures (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

### Demographics

The Eye Bank Association of America reported that corneal transplant recipients range in age from nine days to 103 years. In 2005, 31,952 corneal transplants were performed in the United States. The cost is usually covered in part by **Medicare** and health insurers, although the patient might be required to incur part of the cost for the procedure. All eye tissue is donated. It is illegal to buy or sell human tissue.

### Description

The cornea is the transparent layer of tissue at the front of the eye. It is composed almost entirely of a special type of collagen. It normally contains no blood vessels, but because it contains nerve endings, cornea damage can be very painful.

In a corneal transplant, a disc of tissue is removed from the center of the eye and replaced by a

corresponding disc from a donor eye. The circular incision is made using an instrument called a trephine, which resembles a cookie cutter. In one form of corneal transplant, penetrating keratoplasty (PK), the disc removed is the entire thickness of the cornea and so is the replacement disc.

The donor cornea is attached with extremely fine sutures. Surgery can be performed under **local anesthesia** that is confined to one area of the body, with the patient awake, or under **general anesthesia** that places the entire body of the patient in a state of unconsciousness. Corneal transplantation surgery takes about an hour to perform.

Over 90% of all corneal transplants in the United States are PK. In lamellar keratoplasty (LK), only the outer layer of the cornea is removed and replaced. LK has many advantages, including early suture removal and decreased infection risk. It is not as widely used as PK, however, because it is more time consuming and requires much greater technical ability by the surgeon.

## KEY TERMS

**Cadaver**—The human body after death.

**Cataract**—A condition of cloudiness of the lens of the eye.

**Cornea**—The transparent layer of tissue at the very front of the eye.

**Corticosteroids**—Synthetic hormones widely used to fight inflammation.

**Epikeratophakia**—A procedure in which the donor cornea is attached directly onto the host cornea.

**Epithelial cells**—Cells that form a thin surface coating on the outside of a body structure.

**Fibrous connective tissue**—Dense tissue found in various parts of the body containing very few living cells.

**Fuchs' dystrophy**—A hereditary disease of the inner layer of the cornea.

**Glaucoma**—A vision defect caused when excessive fluid pressure within the eye damages the optic nerve.

**Histocompatibility antigens**—Proteins scattered throughout body tissues that are unique for almost every individual.

**Keratoconus**—An eye condition in which the cornea bulges outward, interfering with normal vision; usually both eyes are affected.

**Pseudophakic bullous keratopathy (PBK)**—Painful swelling of the cornea occasionally occurring after surgery to implant an artificial lens in place of a lens affected by cataract.

**Retinal detachment**—A serious vision disorder in which the light-detecting layer of cells inside the eye (retina) is separated from its normal support tissue and no longer functions properly.

**Trephine**—A small surgical instrument that is rotated to cut a circular incision.

A less common but related procedure called epikeratophakia involves suturing the donor cornea directly onto the surface of the existing host cornea. The only tissue removed from the host is the extremely thin epithelial cell layer on the outside of the host cornea. There is no permanent damage to the host cornea, and this procedure can be reversed. This procedure is mostly performed on children. In adults, the use of contact lenses can usually achieve the same goals.

## Diagnosis/Preparation

Surgeons may discuss the need for corneal transplants after other viable options to remedy corneal trauma or disease have been discussed. No special preparation for corneal transplant is needed. Some ophthalmologists may request that the patient have a complete **physical examination** before surgery. Any active eye infection or eye inflammation usually needs to be brought under control before surgery. The patient may be asked to skip breakfast on the day of surgery.

## Aftercare

Corneal transplant is often performed on an outpatient basis, although some patients need brief hospitalization after surgery. The patient will wear an eye patch at least overnight. An eye shield or glasses must be worn to protect the eye until the surgical wound has healed. The patient should avoid getting water in the eye while showering or bathing. Eye drops will be prescribed for the patient to use for several weeks after surgery. Some patients require medication for at least a year. These drops include **antibiotics** to prevent infection, as well as **corticosteroids** to reduce inflammation and prevent graft rejection.

For the first few days after surgery, the eye may feel scratchy and irritated. Vision will be somewhat blurry for as long as several months.

Sutures are often left in place for six months, and occasionally for as long as two years. Some surgeons may prescribe rigid contact lenses to reduce corneal astigmatism that follows corneal transplant.

## Risks

Corneal transplants are highly successful, with over 90% of the operations in United States achieving restoration of sight. However, there is always some risk associated with any surgery. Complications that can occur include infection, glaucoma, retinal detachment, cataract formation, and rejection.

Graft rejection occurs in 5–30% of patients, a complication possible with any procedure involving tissue transplantation from another person (allograft). Allograft rejection results from a reaction of the patient's immune system to the donor tissue. Cell surface proteins called histocompatibility antigens trigger this reaction. These antigens are often associated with vascular tissue (blood vessels) within the graft tissue. Because the cornea normally contains no blood vessels, it experiences a very low rate of rejection. Generally, blood typing and tissue typing are not needed in



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Corneal transplants are performed by an ophthalmologist, who is a corneal specialist and is expert at transplants and corneal diseases. Patients might be referred to a corneal specialist by their ophthalmologist or optometrist.

Surgery is performed in a hospital setting, usually on an outpatient basis. Some surgeons may also perform the procedure at an ambulatory surgery center designed for outpatient procedures. It is recommended that the patient have someone available to take him or her home, because patients are often groggy after the procedure.

corneal transplants, and no close match between donor and recipient is required. However, the Collaborative Corneal Transplantation Study found that patients at high risk for rejection could benefit from receiving corneas from a donor with a matching blood type.

Symptoms of rejection include persistent discomfort, sensitivity to light, redness, or a change in vision. If a rejection reaction does occur, it can usually be blocked by steroid treatment. Rejection reactions may become noticeable within weeks after surgery, but may not occur until 10 or even 20 years after the transplant. When full rejection does occur, the surgery will usually need to be repeated.

Although the cornea is not normally vascular, some corneal diseases cause vascularization (the growth of blood vessels) into the cornea. In patients with these conditions, careful testing of both donor and recipient is performed just as in transplantation of other organs and tissues such as hearts, kidneys, and bone marrow. In such patients, repeated surgery is sometimes necessary in order to achieve a successful transplant.

### Normal results

Patients can expect restored vision after the healing process is complete. In some patients, this might take as long as a year. Patients with keratoconus, corneal scars, early bullous keratopathy, or corneal stromal dystrophies have the highest rate of transplant success. Corneal transplants for keratoconus patients have a success rate of more than 90%.

## QUESTIONS TO ASK THE DOCTOR

- Are there any alternatives that might restore my vision?
- What is the chance of rejection?
- How am I matched with the donor corneas?
- What is the screening process for donors?
- What physical restrictions will I have during the healing process?
- What are the chances of eye injury causing rejection?
- If the transplant is successful, how long will it be until vision is restored?
- Will I ever have to have another transplant?

### Morbidity and mortality rates

While there is risk involved with any surgery, corneal transplants are relatively safe. In 2001, there was some concern about cornea donors transmitting Creutzfeldt-Jakob disease, a fatal neurological disease, after questions of infection arose in Europe. A study showed the risk of transmission in the United States was small, as was any infection risk from cornea donors. Currently, cornea donors are screened using medical standards of the Eye Bank Association of America. These guidelines restrict donors who died from unknown causes, or suffered from immune deficiency diseases, hepatitis, and other infectious diseases.

Transplant recipients may have to receive another transplant if the first is unsuccessful or if, after a number of years, the disease returns.

### Alternatives

An increasingly popular alternative to corneal transplants is phototherapeutic keratectomy (PTK). This technique is now used to treat corneal scars and dystrophies, and some infections. Surgeons use an excimer laser and a computer to vaporize diseased tissue, leaving a smooth surface. New tissue begins growing immediately, and recovery takes only a few days. Patients must be carefully selected, however, and success is greatest if damage is restricted to the cornea's top layer.

Intrastromal corneal rings are implantable devices that could be used for some keratoconus patients. The rings are implanted and the procedure is reversible.

However, not much is known about long-term stability. Some companies also are developing synthetic corneas that are implanted using synthetic penetrating keratoplasty. This procedure may become more widely used for high-risk patients and those with severe chemical burns.

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## Coronary artery bypass graft surgery

### Definition

Coronary artery bypass graft surgery (CABG) is a procedure in which one or more blocked coronary arteries are bypassed by a blood vessel graft to restore normal blood flow to the heart. These grafts usually come from the patient's own arteries and veins located in the leg, arm, or chest.

### Purpose

Coronary artery bypass graft surgery, also called coronary artery bypass surgery and bypass operation, is performed to restore blood flow to the heart. This relieves chest pain and ischemia, improves the patient's quality of life, and, in some cases, prolongs the patient's life. The goals of the procedure are to relieve symptoms of coronary artery disease, enable the patient to resume a normal lifestyle, and lower the risk of a heart attack or other heart problems.

According to the American Heart Association, appropriate candidates for coronary artery bypass graft surgery include patients who:

- have blockages in at least two or three major coronary arteries, especially if the blockages are in arteries that feed the heart's left ventricle or are in the left anterior descending artery;
- have angina so severe that even mild exertion causes chest pain;
- have poor left ventricular function; and
- cannot tolerate percutaneous transluminal coronary angioplasty and do not respond well to drug therapy.

## KEY TERMS

**Angina**—Also called angina pectoris, chest pain or discomfort that occurs when diseased blood vessels restrict blood flow to the heart.

**Angiotensin-converting enzyme (ACE) inhibitor**—A drug that lowers blood pressure by interfering with the breakdown of a protein-like substance involved in blood pressure regulation.

**Aorta**—The main artery that carries blood from the heart to the rest of the body. The aorta is the largest artery in the body.

**Artery**—A vessel that carries oxygen-rich blood to the body.

**Atherectomy**—A non-surgical technique for treating diseased arteries with a rotating device that cuts or shaves away obstructing material inside the artery.

**Atrium (plural Atria)**—The right or left upper chamber of the heart.

**Beta blocker**—An anti-hypertensive drug that limits the activity of epinephrine, a hormone that increases blood pressure.

**Brachytherapy**—The use of radiation during angioplasty to prevent the artery from narrowing again (a process called restenosis).

**Calcium channel blocker**—A drug that lowers blood pressure by regulating calcium-related electrical activity in the heart.

**Cardiac rehabilitation**—A structured program of education and activity offered by hospitals and other organizations.

**Coronary artery disease**—Also called atherosclerosis, it is a build-up of fatty matter and debris in the coronary artery wall that causes narrowing of the artery.

**Echocardiogram**—An imaging procedure used to create a picture of the heart's movement, valves, and chambers.

**Graft**—To implant living tissue surgically.

**Homocysteine**—An amino acid normally found in small amounts in the blood.

**Ischemia**—Decreased blood flow to an organ, usually caused by constriction or obstruction of an artery.

**Lipoproteins**—Substances that carry fat through the blood vessels for use or storage in other parts of the body.

**Mammary artery**—A chest wall artery that descends from the aorta and is commonly used for bypass grafts.

**Radial artery**—An artery located in the arm and used for bypass grafts.

**Rotablation**—A non-surgical technique for treating diseased arteries.

**Saphenous vein**—A long vein in the thigh or calf commonly used for bypass grafts.

**Stent**—A device made of expandable, metal mesh that is placed (by using a balloon catheter) at the site of a narrowing artery; the stent stays in place to keep the artery open.

**Sternum**—Also called the breastbone, the sternum is the bone in the chest that is separated during open heart surgery.

**Stress test**—A test used to determine how the heart responds to stress.

**Vein**—A blood vessel that returns oxygen-depleted blood from various parts of the body to the heart.

**Ventricle**—A lower pumping chambers of the heart. There are two ventricles, right and left. The right ventricle pumps oxygen-poor blood to the lungs to be re-oxygenated. The left ventricle pumps oxygen-rich blood to the body.

## Demographics

The American Heart Association estimated that in the United States in 2005, 469,000 coronary artery bypass procedures were performed on 261,000 individual patients. More than twice as many of these surgeries were performed on men than women. Fifteen thousand of these procedures were performed on people 15–44, 188,000 on people between ages 45 and 64, and the remainder on people age 65 and older.

## Description

Coronary artery bypass graft surgery builds a detour around one or more blocked coronary arteries with a graft from a healthy vein or artery. The graft goes around the clogged artery (or arteries) to create new pathways for oxygen-rich blood to flow to the heart.

## Procedure

After **general anesthesia** is administered, the surgeon removes the veins or prepares the arteries for

grafting. The surgeon decides which grafts to use based on the location of the blockage, the amount of blockage, and the size of the patient's coronary arteries. If the saphenous vein is to be used for the graft, a series of incisions are made in the patient's thigh or calf. If the radial artery is to be used for the graft, incisions are made in the patient's forearm. More commonly, a segment of the internal mammary artery is used for the graft, and the incisions are made in the chest wall. The internal mammary arteries are often used because they have shown the best long-term results. The removal of veins or arteries for grafting does not deprive the area from which they are removed of adequate blood flow.

In traditional coronary artery bypass surgery, the surgeon makes an incision down the center of the patient's chest, cuts through the breastbone, and retracts the rib cage open to expose the heart. The patient is connected to a heart-lung bypass machine, also called a cardiopulmonary bypass pump, that takes over for the heart and lungs during the surgery. During this "on-pump" procedure, the heart-lung machine removes carbon dioxide from the blood and replaces it with oxygen. A tube is inserted into the aorta to carry the oxygenated blood from the bypass machine to the aorta for circulation to the body. The heart-lung machine allows heart contractions to be stopped, so the surgeon can operate on a still heart. Aortic clamps are used to restrict blood flow to the area of the heart where grafts will be placed so the heart is blood-free during the surgery. The clamps remain until the grafts are in place.

Some patients may be candidates for minimally invasive coronary artery bypass surgery or for off-pump bypass surgery. During minimally invasive surgery, smaller chest and graft removal incisions are used, promoting a quicker recovery and less risk of infection. Off-pump bypass surgery, also called beating heart surgery, is a surgical technique performed while the heart is still contracting (beating). The surgeon uses advanced equipment to stabilize portions of the heart and bypass the blocked artery while the rest of the heart keeps pumping and circulating blood through the body.

After the grafts are prepared, a small opening is made in the diseased coronary artery just below the blockage. Blood will be redirected through this opening once the graft is sewn in place. If a leg or arm vein is used, one end is connected to the coronary artery and the other to the aorta. If a mammary artery is used, one end is connected to the coronary artery while the other is already attached to the aorta and remains in place. The procedure is repeated on as many coronary

arteries as necessary. On average, three or four coronary arteries are bypassed during surgery. Blood flow is checked to assure the graft supplies adequate blood to the heart.

If the procedure was done "on-pump," electric shocks start the heart pumping again after the grafts have been completed. The heart-lung machine is turned off and the blood slowly returns to normal **body temperature**. After implanting pacing wires and inserting a chest tube to drain fluid, the surgeon closes the chest cavity. Sometimes a temporary pacemaker is attached to the pacing wires to regulate the heart rhythm until the patient's condition improves. After surgery, the patient is transferred to an **intensive care unit (ICU)** for close monitoring.

## Diagnosis/Preparation

### Diagnosis

The diagnosis of coronary artery disease is made after the patient's medical history is carefully reviewed, a physical exam is performed, and the patient's symptoms are evaluated. Tests used to diagnose coronary artery disease include:

- electrocardiogram;
- stress tests;
- cardiac catheterization;
- imaging tests such as a chest X-ray, echocardiography, or computed tomography (CT) scan; and
- blood tests to measure blood cholesterol, triglycerides, and other substances.

### Preparation

The patient should quit smoking or using tobacco products before the surgery, and the patient needs to make the commitment to be a nonsmoker after the surgery. There are many **smoking cessation** programs available through hospital or community groups. A health care provider can provide more information about ways quit smoking.

Coronary artery bypass graft surgery should ideally be postponed for three months after a heart attack. Whenever possible, patients should be medically stable before the surgery. If the patient develops a cold, fever, or sore throat within a few days before the surgery, he or she should notify the surgeon's office.

During a preoperative appointment, usually scheduled one to two weeks before surgery, the patient will receive information about what to expect during the surgery and the recovery period. The patient will usually meet the cardiologist, anesthesiologist, nurse



clinicians, and surgeon during this appointment or just before the procedure.

The evening before the surgery, the patient showers with antiseptic soap provided by the surgeon's office. After midnight, the patient should not eat or drink anything.

The patient is usually admitted to the hospital day the surgery is scheduled. The patient should bring a list of current medications, allergies, and appropriate medical records upon **admission to the hospital**.

Before the surgery, the patient is given a blood-thinning drug (usually heparin) that helps to prevent blood clots. A sedative is given the morning of surgery. The chest and the area from where the graft will be taken are shaved.

Coronary **angiography** will have been previously performed to show the surgeon where the arteries are blocked and where the grafts might best be positioned. Heart monitoring is initiated. The patient is given general anesthesia before the procedure.

The length of the procedure depends upon the number of arteries being bypassed, but it generally takes from three to five hours or sometimes longer.

## Aftercare

### *Recovery in the hospital*

The patient recovers in a surgical intensive care unit for one to two days after the surgery. The patient will be connected to chest and breathing tubes, a mechanical ventilator, a heart monitor, and other monitoring equipment. A urinary catheter will be in place to drain urine. The breathing tube and ventilator are usually removed about six hours after surgery, but the other tubes remain in place as long as the patient is in the intensive care unit.

Drugs are prescribed to control pain and infection and to prevent unwanted blood clotting. Daily doses of **aspirin** are started within 6–24 hours after the procedure.

The patient is closely monitored during the recovery period. **Vital signs** and other parameters such as heart sounds, oxygen, and carbon dioxide levels in arterial blood are checked frequently. The chest tube is checked to ensure that it is draining properly. The patient may be fed intravenously for the first day or two.

Chest physiotherapy is started after the ventilator and breathing tubes are removed. The therapy includes coughing, turning frequently, and taking deep breaths. Sometimes oxygen is delivered via a mask to help loosen and clear secretions from the lungs. Other

exercises will be encouraged to improve the patient's circulation and prevent complications due to prolonged bed rest.

If there are no complications, the patient begins to resume a normal routine on the second day, including eating regular food, sitting up, and walking around a bit. Before being discharged from the hospital, the patient usually spends a few days under observation in a non-surgical unit. During this time, counseling is usually provided on eating right and starting a light **exercise** program to keep the heart healthy. The average hospital stay after coronary artery bypass graft surgery is five to seven days.

### *Recovery at home*

**INCISION AND SKIN CARE.** The incision should be kept clean and dry. When the skin is healed, the incision should be washed with soapy water. The scar should not be bumped, scratched, or otherwise disturbed. Ointments, lotions, and **dressings** should not be applied to the incision unless specific instructions have been given to do so.

**DISCOMFORT.** While the incision scar heals, which takes one to two months, it may be sore. Itching, tightness, or numbness along the incision are common. Muscle or incision discomfort may occur in the chest during activity.

Swelling or aching may occur in the legs if the saphenous vein was used for the graft. Special support stockings may be needed to decrease leg swelling after surgery. While sitting, the patient should not cross the legs and the feet should be elevated. Walking daily, even if the legs are swollen, will help improve circulation and reduce swelling.

**LIFESTYLE CHANGES.** The patient needs to make several lifestyle changes after surgery, including:

- quitting smoking. Smoking causes damage to the bypass grafts and other blood vessels, increases the patient's blood pressure and heart rate, and decreases the amount of oxygen available in the blood.
- managing weight. Maintaining a healthy weight, by watching portion sizes and exercising, is important. Being overweight increases the work of the heart.
- participating in an exercise program. The exercise program is usually tailored for the patient, who will be encouraged to participate in a cardiac rehabilitation program supervised by exercise professionals.
- making dietary changes. Patients should eat a lot of fruits, vegetables, whole grains, and non-fat or low-fat dairy products, and reduce fat intake to less than 30% of all calories.

- taking medications as prescribed. Aspirin and other heart medications may be prescribed, and the patient may need to take these medications for life.
- following up with health care providers. The patient must schedule follow-up visits to determine how effective the surgery was, to confirm that progressive exercise is safe, and to monitor his or her recovery and control risk factors.

## Risks

Coronary artery bypass graft surgery is major surgery and patients may experience any of the normal complications associated with major surgery and anesthesia, such as the risk of bleeding, pneumonia, or infection. Other possible complications include:

- graft closure or blockage;
- development of blockages in other arteries;
- damage to the aorta;
- long-term development of atherosclerotic disease of saphenous vein grafts;
- abnormal heart rhythms;
- high or low blood pressure;
- recurrence of angina;
- blood clots that can lead to a stroke or heart attack;
- kidney failure;
- depression or severe mood swings; and
- possible short-term memory loss, difficulty thinking clearly, and problems concentrating for long periods (these effects generally subside within six months after surgery).

There is a higher risk for complications in patients who:

- are heavy smokers;
- have a history of lung, kidney, or metabolic diseases;
- have diabetes;
- have had a recent heart attack; or
- have a history of angina, ventricular arrhythmias, congestive heart failure, cerebrovascular disease, or mitral regurgitation.

## Normal results

Full recovery from coronary artery bypass graft surgery takes two to three months and is a gradual process. Upon release from the hospital, the patient will feel weak because of the extended bed rest in the hospital. Within a few weeks, the patient should begin to feel stronger.

Most patients are able to drive in three to eight weeks, after receiving approval from their physician.

Sexual activity can generally be resumed in three to four weeks, depending on the patient's rate of recovery.

It takes about six to eight weeks for the sternum to heal. During this time, the patient should not perform activities that cause pressure or weight on the breastbone or tension on the arms and chest. Pushing and pulling heavy objects (as in mowing the lawn) should be avoided and lifting objects more than 20 lbs (9 kg) is not permitted. The patient should not hold his or her arms above shoulder level for a long period, such as when doing household chores. The patient should try not to stand in one place for longer than 15 minutes. Stair climbing is permitted unless other instructions have been given. Within four to six weeks, people with sedentary office jobs can return to work. People with physical jobs, such as construction work or jobs requiring heavy lifting, must wait longer (up to 12 weeks) or may have to change careers.

About 90% of patients experience significant improvements after coronary artery bypass graft surgery. Patients experience full relief from chest pain and resume their normal activities in about 70% of the cases; the remaining 20% experience partial relief.

Coronary artery bypass surgery does not prevent coronary artery disease from recurring. For most people, the graft remains open for about 10–15 years. Therefore, lifestyle changes are strongly recommended and medications are prescribed to reduce the risk for the return of coronary artery disease. About 40% of patients have a new blockage within 10 years after surgery and require a second bypass, change in medication, or an interventional procedure.

## Morbidity and mortality rates

The risk of **death** while in the hospital during and after coronary artery bypass graft surgery is 2–1%, although the rate varies among individual hospitals and surgeons. In 5–10% of coronary artery bypass graft surgeries, the bypass graft stops supplying blood to the bypassed artery within one year. Younger people who are healthy except for the heart disease achieve good results with bypass surgery. Patients who have poorer results from coronary artery bypass graft surgery include those over the age of 70, those who have poor left ventricular function, are undergoing a repeat surgery or other procedures concurrently, and those who continue smoking, do not treat high cholesterol or other coronary risk factors, or have another debilitating disease.

Over the long term, symptoms recur in only about 3–4% of patients per year. Five years after coronary artery bypass graft surgery, survival expectancy is

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The surgery team for coronary artery bypass graft surgery includes the cardiovascular surgeon, assisting surgeons, a cardiovascular anesthesiologist, a perfusion technologist (who operates the heart-lung machine), and specially trained nurses. The surgery is performed in a hospital.

90%, at 10 years it is about 85%, at 15 years it is about 55%, and at 20 years it is about 40%.

Angina recurs in about 40% of patients after 10 years. In most cases, it is less severe than before the surgery and can be controlled with drug therapy. In patients who have had vein grafts, 40% of the grafts are severely obstructed 10 years after the procedure. Repeat coronary artery bypass graft surgery may be necessary, and is usually less successful than the first surgery.

### Alternatives

All patients with coronary artery disease can help improve their condition by making lifestyle changes such as quitting smoking, losing weight if they are overweight, eating healthy foods, reducing blood cholesterol, exercising regularly, and controlling diabetes and high blood pressure.

All patients with coronary artery disease should be prescribed medications to treat their condition. Antiplatelet medications such as aspirin or clopidogrel (Plavix) are usually recommended. Other medications used to treat angina may include beta blockers, nitrates, and angiotensin-converting enzyme (ACE) inhibitors. Medications may also be prescribed to lower lipoprotein levels, since elevated lipoprotein levels have been associated with an increased risk of cardiovascular problems.

Treatment with vitamin E is not recommended because it does not lower the rate of cardiovascular events in people with coronary artery disease. Antioxidants such as vitamin C and beta-carotene show some signs of helping reduce coronary artery disease, but not enough rigorously documented information about their effects is available and they are not recommended for routine use. Treatment with folic acid and vitamins B<sub>6</sub> and B<sub>12</sub> lowers homocysteine levels (reducing the risk for cardiovascular problems), but more studies are needed to determine if lowered homocysteine

## QUESTIONS TO ASK THE DOCTOR

- Why is this surgery being performed?
- Am I a candidate for minimally invasive coronary artery bypass surgery?
- Which technique will be used during the surgery, the “on-pump” or “off-pump” technique?
- Who will be performing the surgery? How many years of experience does this surgeon have? How many other coronary artery bypass graft surgeries has this surgeon performed?
- Should I take my medications the day of the surgery?
- How long will I have to stay in the hospital after the surgery?
- After I go home from the hospital, how long will it take me to recover from surgery?
- What should I do if I experience chest discomfort or other symptoms similar to those I felt before surgery?
- What types of symptoms should I report to my doctor?
- How should I care for my incision?
- What types of medications will I have to take after surgery?
- When will I be able to resume my normal activities?
- If I have had the surgery once, can I have it again to correct future blockages?
- Are there any medications, foods, or activities I should avoid to prevent my symptoms from recurring?
- What lifestyle changes (including diet, weight management, exercise, and activity changes) are recommended after the procedure to improve my heart health?
- How often do I need to see my doctor for follow-up visits after the surgery?

levels correlate with a reduced rate of cardiovascular problems in treated patients.

Less invasive, nonsurgical interventional procedures, such as balloon **angioplasty**, stent placement, rotoblation, atherectomy, or brachytherapy, can be performed to open a blocked artery. These procedures may be the appropriate treatment for some patients before coronary artery bypass graft surgery is considered.

**Enhanced external counterpulsation (EECP)** may be a treatment option for patients who are not candidates for interventional procedures or coronary artery bypass graft surgery. During EECP, a set of cuffs is wrapped around the patient's calves, thighs, and buttocks. These cuffs gently but firmly compress the blood vessels in the lower limbs to increase blood flow to the heart. The inflation and deflation of the cuffs are electronically synchronized with the heart-beat and blood pressure using **electrocardiography** and blood pressure monitors. EECP may encourage blood vessels to open small channels to eventually bypass blocked vessels and improve blood flow to the heart. Not all patients are candidates for this procedure, and treatments, lasting one to two hours, must be repeated about five times a week for up to seven weeks.

## Resources

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American College of Cardiology, Heart House 2400 N Street, NW, Washington, DC, 20037, (800) 253 4636, <http://www.acc.org>.

American Heart Association, 7272 Greenville Ave., Dallas, TX, 75231, (800) 242 8721, <http://www.americanheart.org>.

The Cleveland Clinic Heart & Vascular Institute, 9500 Euclid Avenue, F25, Cleveland, OH, 44195, (866) 289 6911, <http://www.clevelandclinic.org/heartcenter>.

National Heart, Lung, and Blood Institute, P.O. Box 30105, Bethesda, MD, 20824 0105, (301) 592 8573, <http://www.nhlbi.nih.gov>.

Texas Heart Institute, Heart Information Service, P.O. Box 20345, Houston, TX, 77225 0345, (800) 292 2221, <http://www.texasheartinstitute.org/>.

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## Coronary stenting

### Definition

A coronary stent is an artificial support device placed in the coronary artery to keep the vessel open after treatment for coronary artery disease. Also called atherosclerosis, coronary artery disease is a build-up of fatty matter and debris on the walls of the arteries. Over time, this buildup narrows the arteries and reduces blood supply to the heart.

The stent is usually a stainless steel mesh tube that is available in various sizes to match the size of the artery and hold it open after the blockage in the artery has been treated.

### Purpose

The coronary stent is used to keep coronary arteries expanded, usually following a balloon **angioplasty** or other interventional procedure. Balloon angioplasty (also called percutaneous transluminal coronary angioplasty, or PTCA) and other interventional procedures are performed to open narrowed coronary arteries and improve blood flow to the heart. By forming a rigid support, the stent can prevent the vessel from reclosing (a process called restenosis) and reduce the need for coronary bypass surgery.

### Demographics

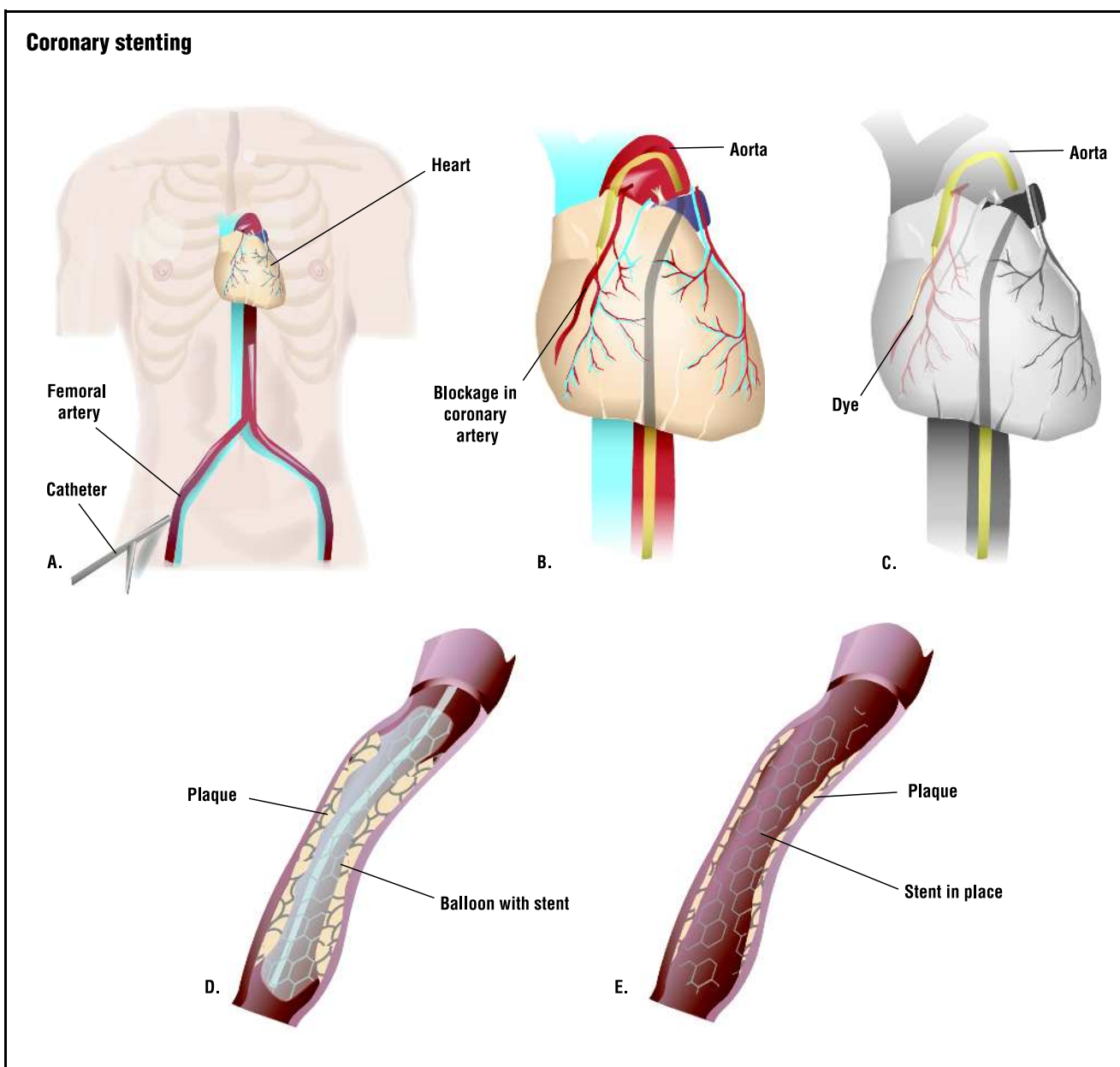
According to the American Heart Association, 1,271,000 angioplasties were performed in the United States in 2005. There were 874,000 men and 397,000 women who had angioplasties in 2005. Stent placement is part of the majority of interventional procedures.

### Description

Coronary stenting usually follows balloon angioplasty. After the patient receives a local anesthetic to numb the area, a **cardiac catheterization** procedure is performed in which a long, narrow tube (catheter) is passed through a sheath placed within a small incision in the femoral artery in the upper thigh. Sometimes, the catheter is placed in an artery in the arm.

A catheter with a small balloon at the tip is guided to the point of narrowing in the coronary artery. Contrast material is injected through the catheter so the physician can view the site where the artery is narrowed on a special monitor. When the balloon catheter is positioned at the location of the blockage in the coronary artery, it is slowly inflated to widen that





During coronary stenting, a catheter is fed into the femoral artery of the upper leg (A). The catheter is fed up to coronary arteries to an area of blockage (B). A dye is released, allowing visualization of the blockage (C). A stent is placed on the balloon-tipped catheter. The balloon is inflated, opening the artery (D). The stent holds the artery open after the catheter is removed (E).  
*(Illustration by GGS Information Services. Cengage Learning, Gale.)*

artery and compress the blockage or fatty area into the artery wall and stretch the artery open.

The stent is inserted into the artery with the balloon-tip catheter. The stent is flat when inserted so that it can travel through the artery. When the stent is correctly positioned in the coronary artery, the balloon is inflated, expanding the stent against the walls of the coronary artery. The balloon catheter

is deflated and removed, leaving the stent permanently in place to hold the coronary artery open.

A cardiac **angiography** will follow to ensure that the stent is keeping the artery open.

In April 2003, the first drug-coated stent brand, the Cordis CYPHER, was approved for use by the U.S. Food and Drug Administration. Coated stents, also called drug-eluting stents, are stents that have

## KEY TERMS

**Angina**—Also called angina pectoris, chest pain or discomfort that occurs when diseased blood vessels restrict blood flow to the heart.

**Anticoagulant**—A medication, also called a blood thinner, that prevents blood from clotting.

**Atherectomy**—A non-surgical technique for treating diseased arteries with a rotating device that cuts or shaves away obstructing material inside the artery.

**Brachytherapy**—The use of radiation during angioplasty to prevent the artery from narrowing again (a process called restenosis).

**Cardiac angiography**—A procedure used to visualize blood vessels of the heart.

**Catheter**—A long, thin flexible tube that can be inserted into the body; in this case, it is threaded to the heart.

**Echocardiogram**—An imaging procedure used to create a picture of the heart's movement, valves, and chambers.

**Electrocardiogram (ECG, EKG)**—A test that records the electrical activity of the heart.

**Homocysteine**—An amino acid normally found in small amounts in the blood.

**Restenosis**—The narrowing of a blood vessel after it has been opened, usually by balloon angioplasty.

**Stress test**—A test used to determine how the heart responds to stress.

**Thrombosis**—The development of a blood clot in the vessels, which may clog a blood vessel and stop the flow of blood.

- electrocardiogram;
- stress tests;
- cardiac catheterization;
- imaging tests such as a chest X-ray, echocardiography, or computed tomography (CT); and
- blood tests to measure blood cholesterol, triglycerides, and other substances.

### Preparation

The patient should quit smoking or using tobacco products before the procedure, and should make the commitment to be a nonsmoker after the surgery. Most communities have a variety of free **smoking cessation** programs available. The patient can ask a health-care provider for more information about quitting smoking.

The patient is usually instructed to take **aspirin** or another blood-thinning medication for several days before the procedure. Aspirin can help decrease the possibility of blood clots forming at the stent.

It is advisable for the patient to arrange for transportation home because drowsiness may last several hours and driving is not permitted after the procedure.

After midnight the night before the procedure, the patient should not eat or drink anything.

The patient usually goes to the hospital the same day the procedure is scheduled, and should bring a list of current medications, allergies, and appropriate medical records upon **admission to the hospital**.

An intravenous needle will be inserted into a vein in the arm to deliver medications and fluids during the procedure. The catheter insertion site may be shaved. A sedative is given to make the patient drowsy and relaxed, but the patient will not be completely asleep during the procedure.

### Aftercare

The procedure generally takes from 90 minutes to two hours to perform, but the preparation and recovery time add several hours to the overall procedure time. Although patients often go home the same day or the evening of the procedure, they should plan to stay at the hospital most of the day.

### Recovery in the hospital

The patient is instructed to stay flat in bed without bending the legs so that the artery can heal from the insertion of the catheter. A stitch or collagen plug may be placed at the site of the catheter insertion to seal the wound and firm pressure may be applied to the area. A

been coated with drugs that help to ensure the blood vessel does not reclose. Some clinical studies have found that these drug coated stents can reduce the rate of blood vessel reclosing from about one third down to as low as 3%.

## Diagnosis/Preparation

### Diagnosis

The diagnosis of coronary artery disease is made after the patient's medical history is carefully reviewed, a physical exam is performed and the patient's symptoms are evaluated. Tests used to diagnose coronary artery disease include:

flat position is required for two to six hours after the procedure. A health-care provider will help the patient get out of bed for the first time when the doctor approves it. The patient will be allowed to eat after he or she is able to get out of bed.

The patient is closely monitored during the recovery period. **Vital signs** and other parameters such as the heart's rhythm and electrical activity as well as oxygen and carbon dioxide levels in arterial blood are checked frequently. A catheter may be placed to drain urine during the recovery period.

A blood thinner may be given to the patient intravenously for the first few hours after the procedure to prevent clotting.

### *Recovery at home*

Medications are prescribed to control pain. Minor chest discomfort is common after the procedure; however, the patient should notify the health-care provider if severe chest, arm, or back discomfort is experienced. Some bleeding and bruising near the catheter insertion site are also common after the procedure. Severe bleeding should be reported to a health-care provider immediately. If bleeding occurs, the patient should dial 911 and lay down immediately. The dressing covering the area should be removed and firm pressure should be applied to the area until help arrives.

Ointments, lotions, and **dressings** should not be applied to the catheter insertion site unless specific instructions have been given.

Medications are prescribed to prevent unwanted blood clotting. Daily doses of aspirin or other anticoagulant medications are started after the procedure and are continued after the patient goes home.

The patient should not have any **magnetic resonance imaging** (MRI) tests for six months after the procedure, because the magnetic field may move the stent.

**LIFESTYLE CHANGES.** The patient needs to make several lifestyle changes after surgery, including:

- Quitting smoking. Smoking causes damage to blood vessels, increases the patient's blood pressure and heart rate, and decreases the amount of oxygen available in the blood.
- Managing weight. Maintaining a healthy weight by watching portion sizes and exercising is important. Being overweight increases the work of the heart.
- Participating in an exercise program. The exercise program is usually tailored for the patient, who will be encouraged to participate in a cardiac rehabilitation program supervised by exercise professionals.

- Making dietary changes. Patients should eat a lot of fruits, vegetables, grains, and non-fat or low-fat dairy products, and reduce fats to less than 30% of all calories. A diet low in cholesterol and vitamin K (to prevent interference with the anticoagulant medication) may be recommended.
- Taking medications as prescribed. Aspirin and other heart medications may be prescribed, and the patient may need to take these medications for life.
- Managing other health conditions such as diabetes or high blood pressure. Taking medications as prescribed and following the doctor's guidelines are very important ways for the patient to manage his or her health.
- Following up with health-care providers. The patient needs to regularly see the physician to monitor his or her recovery and control risk factors. Routine stress testing is a part of the follow-up treatment to detect restenosis that may occur without symptoms.

### **Risks**

Although coronary stents greatly reduce the risk of restenosis following balloon angioplasty, there is still some risk that the stented artery may close.

Serious complications are uncommon, but may include infection, damage to the heart or blood vessels, and blood clots. Anticlotting medication is given after stent placement to prevent the risk of blood clots. Less serious complications include bleeding, swelling, or bruising where the catheter was placed.

### **Normal results**

The patient usually goes home the day or evening of the procedure, but sometimes an overnight stay in the hospital is necessary so monitoring can be continued. Patients should have someone to take them home after the procedure; driving is not recommended for at least 24 hours after the procedure.

Fatigue and weakness are common after the procedure. The patient should limit activities for the first two days after the procedure and can gradually resume normal activities by the end of the week.

For the first week after the procedure, pushing and pulling heavy objects (as in mowing the lawn) should be avoided, and lifting objects more than 20 lbs (9 kg) is not permitted. Stair climbing is permitted unless other instructions have been given.

Balloon angioplasty and the placement of a stent does not prevent coronary artery disease from recurring; therefore, lifestyle changes are strongly recommended and medications are prescribed to further reduce this risk.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A team of specialized heart doctors (cardiologists), nurses, and technicians trained in stent placement perform this procedure. Stent placement usually takes place in the hospital setting in a special lab called the catheterization laboratory. It may also be performed in an intensive care unit, emergency room (such as for treatment of a heart attack), or other special procedure room.

### Morbidity and mortality rates

**Death** is extremely rare as a result of the stent placement procedure. There is some risk of embolism, a blockage in an artery in the brain caused by a clot or loosened debris. Embolism can cause stroke.

Sometimes a blockage returns to the treated coronary artery (restenosis). If restenosis occurs, it usually happens within the first six months after the procedure. If the patient has previously experienced restenosis, there is an increased risk that it will recur. Repeat blockages can be treated with other interventional procedures; **coronary artery bypass graft surgery** may be needed.

### Alternatives

All patients with coronary artery disease can help improve their condition by making lifestyle changes such as quitting smoking, losing weight if they are overweight, eating healthy foods, reducing blood cholesterol, exercising regularly, and controlling diabetes and high blood pressure.

All patients with coronary artery disease should be prescribed medications to treat their condition. Antiplatelet medications such as aspirin or clopidogrel (Plavix) are usually recommended. Medications may also be prescribed to lower lipoprotein levels, since elevated lipoprotein levels have been associated with an increased risk of cardiovascular problems.

Treatment with vitamin E is not recommended because it does not lower the rate of cardiovascular events in people with coronary artery disease. Although antioxidants such as vitamin C, beta-carotene, and probucol show promising results, they are not recommended for routine use. Treatment with folic acid and vitamins B<sub>6</sub> and B<sub>12</sub> lowers homocysteine levels (reducing the risk for cardiovascular problems), but more

## QUESTIONS TO ASK THE DOCTOR

- Why is this procedure being performed?
- Should I take my medications the day of the procedure?
- Can I eat or drink the day of the procedure? If not, how long before the procedure should I stop eating or drinking?
- When can I drive after the procedure?
- What should I wear the day of the procedure?
- Will I be awake during the procedure?
- Will I have to stay in the hospital after the procedure?
- When can I resume my normal activities?
- When will I find out the results?
- What if the procedure was not successful?
- If I have had the procedure once, can I have it again to treat coronary artery disease?
- Will I have any pain or discomfort after the procedure? If so, how can I relieve this pain or discomfort?
- Are there any medications, foods, or activities I should avoid to prevent my symptoms from recurring?

studies are needed to determine if lowered homocysteine levels correlate with a reduced rate of cardiovascular problems in treated patients.

Other interventional procedures used to open a blocked artery include rotoblation, brachytherapy, and atherectomy.

Coronary artery bypass graft surgery is a treatment option that is considered when medications and interventional therapies do not adequately treat coronary artery disease. During coronary artery bypass graft surgery, a blood vessel graft to restore normal blood flow to the heart is used to bypass one or more blocked coronary arteries. These grafts usually come from the patient's own arteries and veins located in the leg, arm, or chest.

**Enhanced external counterpulsation (EECP)** may be a treatment option for patients who are not candidates for interventional procedures or coronary artery bypass graft surgery. During EECP, a set of cuffs is wrapped around the patient's calves, thighs, and buttocks. These cuffs gently but firmly compress the blood vessels in the lower limbs to increase blood flow to the heart. The inflation and deflation of the cuffs are



electronically synchronized with the heartbeat and blood pressure using **electrocardiography** and blood pressure monitors. EECF may encourage blood vessels to open small channels to eventually bypass blocked vessels and improve blood flow to the heart. Not all patients are candidates for this procedure, and treatments, lasting one to two hours, must be repeated about five times a week for up to seven weeks.

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- American College of Cardiology, Heart House 2400 N. Street NW, Washington, DC, 20037, (800) 253 4636, <http://www.acc.org>.
- American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242 8721, <http://www.americanheart.org>.
- Cleveland Clinic Heart Center, 9500 Euclid Avenue, Cleveland, OH, 44195, (800) 223 2273, <http://www.clevelandclinic.org/heartcenter>.
- National Heart, Lung and Blood Institute, National Institutes of Health, P.O. Box 30105, Bethesda, MD, 20824 0105, [NHLBIinfo@nhlbi.nih.gov](mailto:NHLBIinfo@nhlbi.nih.gov), <http://www.nhlbi.nih.gov>.

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## Corpus callosotomy

### Definition

Corpus callosotomy is a treatment for epilepsy, in which a group of fibers connecting the two sides of the brain, called the corpus callosum, is cut.

### Purpose

Corpus callosotomy is used to treat epilepsy that is unresponsive to drug treatments. A person with epilepsy may be considered a good candidate for one type of epilepsy surgery or another if he or she has seizures that are not adequately controlled by drug therapy, and has tried at least two (perhaps more, depending on the treatment center's guidelines) different anti-epileptic drugs.

The seizures of epilepsy are due to unregulated spreading of electrical activity from one part of the brain to other parts. In many people with epilepsy, this activity begins from a well-defined focal point, which can be identified by electrical testing. Surgical treatment of focal-origin seizures involves removal of the brain region containing the focal point, usually in a procedure called temporal lobectomy. In other people, no focal point is found, or there may be too many to remove individually. These patients are most likely to receive corpus callosotomy.

The purpose of a corpus callosotomy is to prevent spreading of seizure activity from one half of the brain to the other. The brain is divided into two halves, or hemispheres, that are connected by a thick bundle of nerve fibers, the corpus callosum. When these fibers are cut, a seizure that begins in one hemisphere is less likely to spread to the other. This can reduce the frequency of seizures significantly.

The initial surgery may cut the forward two-thirds of the corpus callosum, leaving the rest intact. If this does not provide sufficient seizure control, the remaining portion may be cut.

### Demographics

Corpus callosotomy is most often performed for children with "drop attacks," or atonic seizures, in which a sudden loss of muscle tone causes the child to fall to the floor. It is also performed in people with uncontrolled generalized tonic-clonic, or grand mal, seizures, or with massive jerking movements. Of the 20,000 to 70,000 people in the United States considered candidates for any type of epilepsy surgery, approximately 5,000 receive surgery per year. Between 1985 and 1990, more than 800 corpus callosotomies were performed, and the number has increased since then. Corpus callosotomy is performed by a special neurosurgical team, at a regional epilepsy treatment center.

### Description

During corpus callosotomy, the patient is under **general anesthesia**, lying on the back. The head is fixed in place with blunt pins attached to a rigid

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Corpus callosotomy is performed by a neurosurgeon in a hospital operating room.

structure. The head is shaved either before or during the procedure.

Incisions are made in the top of the skull to remove a flap of bone, exposing the brain. The outer covering is cut, and the two hemispheres are pulled slightly apart to expose the corpus callosum. The fibers of the corpus callosum are cut, taking care to avoid nearby arteries and ventricles (fluid-filled cavities in the brain).

Once the cut is made and any bleeding is controlled, the brain covering, bone, and scalp are closed and stitched.

### Diagnosis/Preparation

The candidate for any type of epilepsy surgery will have had a wide range of tests prior to surgery. These include **electroencephalography** (EEG), in which electrodes are placed on the scalp, on the brain surface, or within the brain to record electrical activity. EEG is used to attempt to locate the focal point(s) of the seizure activity.

Several neuroimaging procedures are used to obtain images of the brain. These may reveal structural abnormalities that the neurosurgeon must be aware of. These procedures may include **magnetic resonance imaging** (MRI), x rays, computed tomography (CT) scans, or **positron emission tomography** (PET) imaging.

Neuropsychological tests may be done to provide a baseline against which the results of the surgery are measured. A Wada test may also be performed. In this test, a drug is injected into the artery leading to one half of the brain, putting it to sleep, allowing the neurologist to determine where language and other functions in the brain are localized, which may be useful for predicting the result of the surgery.

### Aftercare

The patient remains in the hospital for about a week, possibly more depending on any complications that have occurred during surgery and on the health of the patient. There may be some discomfort afterwards. Tylenol with codeine may be prescribed for pain. Bending over should

## QUESTIONS TO ASK THE DOCTOR

- Are there any drugs that we haven't tried that may be effective?
- How long until I can return to school or work?
- Am I a candidate for any other epilepsy surgery?

be avoided if possible, as it may lead to headache in the week or so after the procedure. Ice packs may be useful for pain and itchiness of the sutures on the head. Another several weeks of convalescence at home are required before the patient can resume normal activities. Heavy lifting or straining may continue to cause headaches or nausea, and should be avoided until the doctor approves. A diet rich in fiber can help avoid constipation, which may occur following surgery. Patients remain on anti-seizure medication at least for the short term, and may continue to require medication.

### Risks

There is a slight risk of infection or hemorrhage from the surgery, usually less than 1%. Disconnection of the two hemispheres of the brain can cause some neuropsychological impairments such as decreased spontaneity of speech (it may be difficult to bring the right words into one's mind) and decreased use of the non-dominant hand. These problems usually improve over time. Complete cutting of the corpus callosotomy produces more long-lasting, but very subtle deficits in connecting words with images. These are usually not significant, or even noticed, by the patient.

### Normal results

Patients typically experience a marked reduction in number and severity of seizures, with a small percentage of people becoming seizure free. Drop attacks may be eliminated completely in approximately 70% of patients. Other types of seizure are also reduced by 50% or more from corpus callosotomy surgery.

### Morbidity and mortality rates

Serious morbidity or mortality occurs in 1% or less of patients. Combined major and minor complication rates are approximately 20%.

### Alternatives

Newer anti-seizure medications have partially replaced corpus callosotomy. Focal epilepsy is treated

with focal surgery such as temporal lobectomy or **hemispherectomy**. Vagus nerve stimulation is an alternative for some patients.

## Resources

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Richard Robinson

## Corticosteroids

### Definition

Corticosteroids are a group of natural and synthetic analogs (chemical cousins) of the hormones secreted by the pituitary gland, also known as the hypothalamic-anterior pituitary-adrenocortical (HPA) axis. These analogs include glucocorticoids, which are anti-inflammatory agents with a large number of other functions; mineralocorticoids, which control salt and water balance primarily through action on the kidneys; and corticotropins, which control secretion of hormones by the pituitary gland. First introduced in 1949 for the treatment of rheumatoid arthritis, corticosteroids are widely used in the twenty-first century to treat conditions as varied as asthma, lung infections in AIDS patients, bacterial meningitis, and cancer-related pain.

### Purpose

Glucocorticoids have multiple effects, and are used for a large number of conditions. They affect glucose (sugar) utilization and fat metabolism, bone development, and are potent anti-inflammatory agents. They may be used for replacement of natural hormones in patients with pituitary deficiency (Addison's disease), as well as for a wide number of other conditions including arthritis, asthma, anemia, various cancers, eye disease (uveitis), inflammatory bowel disease, and skin inflammations. Additional uses include inhibition of nausea and vomiting after chemotherapy, treatment of septic shock, treatment of spinal cord injuries, and treatment of hirsutism (excessive hair growth). The choice of drug will vary with the condition.

Cortisone and hydrocortisone, which have both glucocorticoid and mineralocorticoid effects, are the drugs of choice for replacement therapy of natural

hormone deficiency. Synthetic compounds, which have greater anti-inflammatory effects and less effect on salt and water balance, are usually preferred for other purposes. These compounds include dexamethasone, which is almost exclusively glucocorticoid in its actions, as well as prednisone, prednisolone, betamethasone, triamcinolone, and others. Glucocorticoids are formulated in oral dosage forms, topical creams and ointments, oral and nasal inhalations, rectal foams, and ear and eye drops.

Mineralocorticoids control the retention of sodium in the kidneys. In mineralocorticoid deficiency, there is excessive loss of sodium through the kidneys, with resulting water loss. Fludrocortisone (Florinef) is the only drug available for treatment of mineralocorticoid deficiency, and is available only in an oral form.

Corticotropin (ACTH, adrenocorticotrophic hormone) stimulates the pituitary gland to release cortisone. A deficiency of corticotrophic hormone will have the same effects as a deficiency of cortisone. The hormone, which is available under the brand names Acthar and Actrel, is used for diagnostic testing to determine the cause of a glucocorticoid deficiency. It is rarely used for replacement therapy, however, since direct administration of glucocorticoids may be easier and offers better control over dosages.

### Recommended dosage

Dosage of glucocorticoids varies with the specific drug, the route of administration, the condition being treated, and the patient's individual metabolism.

Fludrocortisone, for use in replacement therapy, is normally dosed at 0.1 mg/day. Some patients require higher doses. It should normally be taken in conjunction with cortisone or hydrocortisone.

ACTH, when used for diagnostic purposes, is given as 10–25 units by intravenous solution over eight hours. A long-acting form, which may be used for replacement therapy, is given by subcutaneous (SC) or intramuscular (IM) injection at a dose of 40–80 units every 24–72 hours.

### Precautions

The most significant risk associated with administration of glucocorticoids is suppression of natural corticosteroid secretion. When the artificial hormones are administered, they suppress the secretion of ACTH, which in turn reduces the secretion of the natural hormones. The extent of suppression varies with dose, drug potency, duration of treatment, and individual patient response. While suppression is seen primarily with drugs

## KEY TERMS

**Addison's disease**—A rare endocrine disorder in which the adrenal gland does not produce enough steroid hormones.

**Addisonian crisis**—A medical emergency resulting from severe adrenal insufficiency. It can be caused by sudden withdrawal from oral glucocorticoid medications, as well as from damage to the adrenal gland itself. Untreated Addisonian crisis can be fatal.

**Cortisol**—A corticosteroid hormone produced by the adrenal gland.

**Cushing's syndrome**—A condition resulting from excess cortisol in the body, characterized by high blood pressure, a round “moon” face, excessive sweating, thinning of the skin and easy bruising, and the growth of fat pads around the shoulders and back of the neck. It was first described in 1932 by Harvey Cushing, an eminent American surgeon.

**Hallucination**—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

**Hirsutism**—Excessive or increased growth of facial or body hair in women resembling the male pattern of hair distribution.

**Hormone**—A substance that is produced in one part of the body, then travels through the bloodstream to another part of the body where it has its effect.

**Hypertension**—High blood pressure.

**Hypotension**—Low blood pressure.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

**Ointment**—A thick spreadable substance that contains medicine and is meant to be used on the outside of the body.

**Pregnancy category**—A system of classifying drugs according to their established risks for use during pregnancy. The classifications are categories A, B, C, D, and X.

administered systemically, it can also occur with topical drugs such as creams and ointments, or drugs administered by inhalation. Abrupt cessation of corticosteroids may result in acute adrenal crisis (Addisonian crisis) which is marked by dehydration with severe vomiting and diarrhea, sudden sharp pain in the abdomen, lower back, or legs, hypotension, convulsions, mental confusion, and loss of consciousness. Acute adrenal crisis is potentially fatal.

Chronic overdose of glucocorticoids leads to Cushingoid syndrome, which is clinically identical to Cushing's syndrome. The only difference is that in Cushingoid, the excessive steroids are from drug therapy rather than excessive glandular secretion of cortisol. Symptoms vary, but most people have upper body obesity, a rounded “moon” face, increased fat around the neck, and thinning arms and legs. In its later stages, this condition leads to weakening of bones and muscles with rib and spinal column fractures.

The short-term adverse effects of corticosteroids are generally mild, and include indigestion, increased appetite, insomnia, and nervousness. There are also a very large number of infrequent adverse reactions, the most significant of which is drug-induced paranoia. Delirium, depression, menstrual irregularity, and increased hair growth are also possible.

Long-term use of topical glucocorticoids can result in thinning of the skin or permanent damage to the retina of the eye. Oral steroid inhalations may cause fungal overgrowth in the oral cavity. Patients must be instructed to rinse their mouths carefully after each dose.

Corticosteroids are included in pregnancy category C. The pregnancy category system classifies drugs according to their established risks for use during pregnancy. Corticosteroids have caused congenital malformations in animal studies, including cleft palate. Breastfeeding while taking these medications should be avoided.

Because fludrocortisone has glucocorticoid activity as well as mineralocorticoid action, the same hazards and precautions apply to fludrocortisone as to the glucocorticoids. Overdose of fludrocortisone may also cause edema (swelling), hypertension, and congestive heart failure.

Corticotropin has all the same risks as the glucocorticoids. Prolonged use may cause reduced response to the stimulatory effects of corticotropin.

### Warnings

Patients with the following conditions should use corticosteroids with caution:

- osteoporosis or any other bone disease
- current or past tuberculosis
- glaucoma or cataracts
- infections of any type (virus, bacteria, fungus, amoeba)
- sores in the nose or recent nose surgery (if using nasal spray forms of corticosteroids)
- an underactive or overactive thyroid gland



- liver disease
- stomach or intestine problems
- diabetes
- heart disease
- high blood pressure
- high cholesterol
- kidney disease or kidney stones
- myasthenia gravis
- systemic lupus erythematosus (SLE)
- emotional problems
- skin conditions that cause the skin to be thinner and bruise more easily

### Interactions

Corticosteroids interact with many other drugs a patient might take; they reduce the effectiveness of vaccination in some patients. Patients taking **barbiturates** as sleep medications may need higher doses of corticosteroids. Smoking reduces the effectiveness of inhaled corticosteroids. Patients should inform their doctor about all other medications (both prescription and over-the-counter) they take, and discuss possible interactions.

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- Arthritis Foundation. 1330 West Peachtree Street, Suite 100, Atlanta, GA 30309. (800) 283–7800 or (404) 872–7100. <http://www.arthritis.org/index.php> (accessed March 11, 2008).
- Asthma and Allergy Foundation of America. 1125 15th Street NW, Suite 502, Washington, DC 20005. Telephone: (800) 727–8462. Web site: <http://www.aafa.org> (accessed March 11, 2008).
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Cosmetic surgery see **Plastic, reconstructive, and cosmetic surgery**

Cotrel-Dubousset spinal instrumentation see **Spinal instrumentation**

CPR see **Cardiopulmonary resuscitation**

## Craniofacial reconstruction

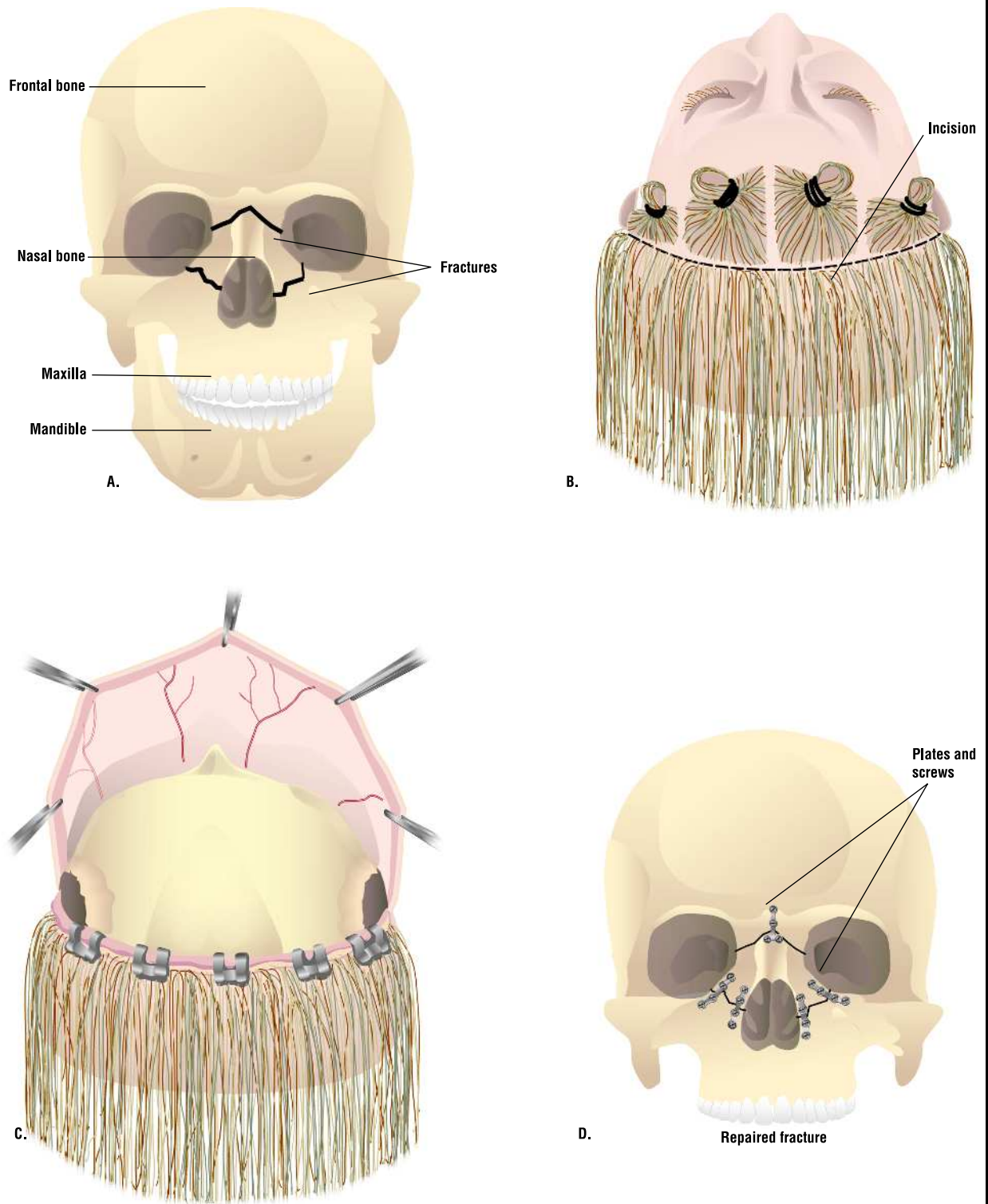
### Definition

Craniofacial reconstruction refers to a group of procedures used to repair or reshape the face and skull of a living person, or to create a replica of the head and face of a dead or missing person. The word "craniofacial" is a combination of "cranium," which is the medical word for the upper portion of the skull, and facial. Craniofacial reconstruction is sometimes called orbital-craniofacial surgery; "orbital" refers to the name of the bony cavity in the face that surrounds the eyeball.

### Purpose

Craniofacial reconstruction has several different purposes depending on the group of patients or

## Craniofacial reconstruction



To repair severe fractures around the nasal bone (A), an incision is made into the patient's skin at the top of the head (B). The skin is pulled off the face to expose the fracture (C), which then can be repaired with plates and screws (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Cleft palate**—A birth defect in which the roof of the mouth is open because the two sides of the palate failed to join together during fetal development.

**Congenital**—Present at the time of birth.

**Craniosynostosis**—Premature closing of the sutures joining the skull bones.

**Cranium**—The large, rounded upper part of the skull that encloses the brain.

**Down syndrome**—A congenital disorder caused by a mutation of human chromosome 21 in which there are three chromosomes (trisomy) instead of the usual pair.

**Flap**—A piece of tissue used for grafting that has kept its own blood supply.

**Forensic**—Referring to legal or courtroom proceedings.

**Frontal bone**—The part of the skull that lies behind the forehead.

**Le Fort fracture**—A term that refers to a system for classifying fractures of the facial bones into three groups according to the region affected.

**Mandible**—The horseshoe-shaped bone that forms the lower jaw.

**Maxilla**—The facial bone that forms the upper jaw and holds the upper teeth.

**Microsurgery**—Surgery performed under a microscope on nerves and other very small structures with the help of special instruments.

**Orbit**—The bony cavity in the face that surrounds and protects the eyeball.

**Suture**—A type of body joint that is found only in the skull; the surfaces of the bones in the skull are held together by a thin layer of fibrous connective tissue.

**Treacher Collins syndrome**—A disorder that affects facial development and hearing, thought to be caused by a gene mutation on human chromosome 5; sometimes called mandibulofacial dysostosis.

**Zygoma**—The cheek bone in the front of the face below the eye socket, it is connected to the frontal bone of the forehead and the maxilla (upper jaw); sometimes called the os zygomaticum or zygomatic bone.

persons in question. In children, craniofacial reconstruction is done to repair abnormalities in the shape of the child's skull and facial features resulting from birth defects or genetic disorders. It is also done to repair traumatic injuries resulting from accidents or child abuse. Craniofacial reconstruction in children requires special techniques and planning because the surgeon must allow for future growth of the child's facial bones and skull.

In adults, craniofacial reconstruction is most commonly done following head or facial trauma, but it is also performed on cancer patients who have lost part of the bony structures or soft tissue of the face following tumor surgery. In both adults and children, the reconstruction is intended to restore the functioning of the patient's mouth, jaw, and sensory organs as well as improve his or her appearance. Craniofacial reconstruction is a complicated procedure because the surgeon is operating on a part of the body that contains the brain and upper part of the spinal cord, the eyes, and other sensory organs, and the opening of the patient's airway—all within a small space.

The third major application of craniofacial reconstruction is in forensic medicine and anthropology. Forensic is a term that refers to legal matters. Physicians who specialize in forensic science study the remains of

people who have died to establish not only the cause of **death** but in some cases, the identity of the dead person. Craniofacial reconstruction is one approach to this identification. Anthropologists, the scientists who study the origins and cultural development of humans, make use of craniofacial reconstruction to understand what prehistoric people looked like and to compare them with present-day humans.

## Demographics

### *Birth defects and genetic disorders*

About 7%, or 227,500, of the children born each year in the United States are affected by birth defects of the head and face. According to the American Society of Plastic Surgeons, 37,732 procedures were performed to repair birth defects in 2001, an increase of 2% over the number of surgeries in 2000.

The demographics of specific birth defects affecting the head and face vary; some are considered rare disorders. Figures for some of the disorders most likely to be treated surgically include:

- **Cleft palate.** Cleft lip or palate is the fourth most common birth defect affecting American children, one in every 700 newborns. The male-female ratio is two to one in children of all races. Asian-American

children have a higher than average incidence of cleft palate, while African-American children have a lower than average incidence.

- **Down syndrome.** Down syndrome is the most common congenital disorder caused by a chromosomal abnormality; it occurs in one in every 900 infants. Children with Down syndrome have facial characteristics that typically include slanted eyes, a flattened nasal bridge, small rounded ears, and a large protruding tongue. There are about 350,000 people in the United States with Down syndrome.
- **Treacher Collins syndrome.** This congenital disorder is caused by a mutation on human chromosome 5 that can arise spontaneously or be inherited from the parents. The craniofacial abnormalities in Treacher Collins include an abnormally small jaw and airway that can cause breathing problems; the ears may also be malformed or missing. Treacher Collins syndrome affects one in every 10,000 infants.
- **Apert and Crouzon syndromes.** These two disorders are sometimes grouped together because they are both characterized by craniosynostosis, which is the medical term for premature closing of the sutures (seams) in the bones at the top of the skull. Children with these syndromes have misshapen heads and a sunken-in appearance to the face. They also have breathing problems and malpositioning of the teeth caused by deformed facial bones. Apert syndrome is very rare, affecting only one child in every 150,000. Crouzon syndrome occurs in one out of every 25,000 infants.

### *Traumatic injuries*

Traumatic injuries to the face and head can include blunt trauma, lacerations (tears), and burns. Heat, chemicals, or electricity may cause burns. According to the American Burn Institute, there are 1.1 million burn injuries each year in the United States that are serious enough to require medical treatment. In 2001, 16,879 adults needed **plastic surgery** to repair burn injuries, while 24,298 required maxillofacial surgery for injuries to the face and jaw.

Prior to the early 1980s, when more rigorous seat belt laws were passed, most severe facial injuries in the United States resulted from automobile accidents. As of 2003, however, 70% of facial injuries treated in urban hospitals are caused by assaults; at least 10% of fractured facial bones in women are the result of domestic violence. Falls cause a significant number of facial injuries in small children and the elderly. Another common source of facial trauma in children is animal bites.

### *Cancer patients*

Cancers of the head and neck affect about 55,000 Americans each year; about 13,000 of these patients die. These cancers include cancers of the skin of the face, the esophagus, the larynx (voice box), the mouth, and the nasal passages. Most of these cancers are preventable because they result from prolonged exposure to either sunlight (facial skin) or tobacco (mouth, throat, nose, and larynx). Men are two to four times as likely to develop cancers of the mouth and throat as women.

## **Description**

### *General background*

Craniofacial reconstruction dates back to the late nineteenth century, when doctors in Germany and France first used it to produce more accurate images of the faces of certain famous people who had died before the invention of photography. Early craniofacial reconstructions included those of Bach, Dante, Kant, and Raphael. The technique was then applied to reconstructing the appearance of prehistoric humans for museums and research institutions. An important contribution to the field was the publication in 1901 of three major papers on the classification of facial fractures by René Le Fort, a French surgeon. Le Fort identified the lines of weakness in the facial bones where fractures are most likely to occur. Traumatic injuries of the facial bones are still classified as Le Fort I, II, and III fractures. A Le Fort I fracture runs across the maxilla, or upper jaw; a Le Fort II fracture is pyramidal in shape, breaking the cheekbone below the orbit (eye socket) and running across the bridge of the nose; a Le Fort III fracture separates the frontal bone behind the forehead from the zygoma (cheekbone) as well as breaking the nasal bridge. A Le Fort III fracture is sometimes called a craniofacial separation.

In the 1920s, British physicians pioneered the application of facial reconstruction to unsolved criminal cases and to treating World War I veterans who had been disfigured in combat. Prior to the invention of the computer, craniofacial reconstruction was done either by applying soft clay to the skull (or a cast of the skull) to recreate the person's features, or by making a two-dimensional drawing over a photograph or x-ray picture of the skull. It was difficult for surgeons operating on mutilated patients to predict the outcome of the operation from these two-dimensional sketches.

The first attempts at craniofacial reconstruction in children with congenital abnormalities were made in the late 1940s by Sir Harold Gillies, a British plastic surgeon who had treated disfigured World War II veterans. More recent advances in craniofacial reconstruction



include improved understanding of the soft tissues of the face and better surgical techniques for repairing injuries to these tissues; the invention of surgical plastics that can be used instead of bone grafts to fill in missing pieces of bone; new techniques for fixing the facial bones in place during the healing process; and computerized imaging programs that help the surgeon analyze the patient's facial abnormality or injury. Some of these programs allow doctors to download data directly from x rays, computed tomography (CT) scans, or other diagnostic imaging programs in order to plan the operation and have a clearer picture of the results. In the case of children, computer imaging can be used to estimate the future growth lines of a child's skull and facial bones as well as his or her present condition. Orthodontists and other dental specialists have developed additional imaging programs that provide more details about the mouth and jaw area than can be obtained from **CT scans** and x-ray studies.

#### *Craniofacial reconstruction of birth defects and genetic abnormalities*

Craniofacial reconstruction in children with congenital abnormalities of the head and face is preceded by a consultation between the surgeon, other specialists, and the child's parents. It is important to determine the exact cause of the child's deformities, since some abnormalities may be found in as many as 150 different genetic disorders. Following the diagnosis, a comprehensive treatment plan is made that includes long-term psychosocial as well as surgical follow-up. Craniofacial reconstruction in children is complex because the surgeon must allow for changes in the proportions of the child's face and skull as he or she matures as well as attempt to make the facial features look as normal as possible. It is difficult to provide a general description of craniofacial surgery in children because there are many variables among children diagnosed with the same disorder as well as a large number of different disorders requiring craniofacial reconstruction. Reconstructions in children, however, are always done under **general anesthesia** and usually take between three and six hours to complete.

#### *Craniofacial reconstruction following trauma or surgery*

Craniofacial reconstruction following trauma is a highly individualized process, depending on the nature and location of the patient's injuries. Emergency workers are trained to evaluate and clear the patient's airway before treating facial injuries as such; severe injuries to the midface and lower face frequently result in airway blockage caused by blood, loose teeth

or bone fragments, or the tongue falling backward toward the windpipe. The trauma team may have to intubate the patient or perform an emergency **cricothyroidotomy** in order to help the patient breathe. The second priority in treating traumatic facial injuries is controlling severe bleeding.

Imaging studies of craniofacial injuries may need to be postponed for 24–72 hours in order to treat injuries to other organ systems. Over 60% of patients with severe facial trauma have other serious injuries in the head, chest, or abdomen; this high rate reflects the tremendous forces needed to fracture the human frontal bone, zygoma, and maxilla. In particular, a doctor who is examining a patient with severe facial trauma will be particularly concerned about damage to the brain, the spinal column in the neck region, and the eyes. All Le Fort II and III fractures have the potential for permanent damage to the eyes. There are specific maneuvers that the doctor can perform to assess the location and severity of bone fractures, possible dislocation of the jaw, and injury to the eyes and nose before taking an x ray or CT scan.

When the patient is out of immediate danger, x-ray studies and computed tomography (CT) scans are taken of the craniofacial injuries. Three-dimensional scans assist the surgeon in analyzing the fractures and the condition of the other structures in the face and head. Imaging studies can be used to generate computer images for plastic or metal implants to be matched to the patient's injuries for filling in sections of missing bone.

Surgery following facial trauma may take as long as four to 14 hours, as the goal is to repair as much as possible in one operation. The surgeon may use bone grafts, taking bone from other parts of the body to repair the facial bones, or fill in smaller areas of missing bone with hydroxyapatite cement or polymer implants. Broken facial bones are held in place with titanium miniplates and surgical screws. This technique is called rigid fixation; it often does away with the need to wire the jaws in place, and it speeds the patient's recovery. Lacerations (tears) in the skin are usually simply closed with **stitches**, although the surgeon will be careful to minimize scarring. If large areas of skin are missing, the surgeon will cut a flap, which is a section of living tissue carrying its own blood supply, from another area of the patient's body and transplant it to the face. Some facial injuries may require the assistance of a neurosurgeon, oral surgeon, or ophthalmologist.

Cancers on the skin of the face are usually removed and closed with a few stitches, although skin flaps may

be required if the area of the face that is affected is large. Cancers of the head or neck may require bone grafts as well as skin flaps after the tumor has been removed. **Reconstructive surgery** after cancer treatment may involve the use of a microscope and special instruments to rejoin the facial blood vessels and nerve fibers. This technique, which is known as **microsurgery**, is done to preserve the function of the muscles in the face as well as restoring the patient's appearance as much as possible.

### Diagnosis/Preparation

Diagnosis of the need for craniofacial reconstruction depends on the cause of the abnormality, injury, or disfigurement. The obstetrician or the child's pediatrician will often make the diagnosis of craniofacial abnormalities in children at the time of delivery. Some genetic disorders that are associated with congenital facial abnormalities, including Down syndrome and Treacher Collins syndrome, can be detected before birth by chromosomal analysis. In adults, the diagnosis is usually made by trauma surgeons in the emergency room or by physicians who have treated the patient for cancer.

Imaging studies, including x-ray photographs, CT scans, and **magnetic resonance imaging (MRI)**, are used to analyze the patient's abnormalities or injuries before the operation in order to plan the surgery. The surgeon may also consult a neurosurgeon or ophthalmologist if the abnormality or injury involves the functioning of the patient's brain, spinal cord, or eyes.

### Aftercare

#### *Medical and surgical*

Children who have had reconstructive surgery for congenital abnormalities are usually taken to a pediatric **intensive care unit** for a day or two, and remain in the hospital for a total of four to five days. Adults who have had reconstructive surgery following trauma may be monitored in an intensive care unit for one to two days after the operation, particularly if they required special treatment for airway problems. The total length of the hospital stay varies according to the severity of the patient's other injuries; some burn victims may be hospitalized for several months.

Short-term aftercare includes medications for pain, changes of surgical **dressings**, breathing exercises, and **antibiotics** to reduce the possibility of infection. Patients with injuries to the jaw or mouth may be given special semi-liquid or soft diets. Children are restricted from swimming for two months after reconstructive surgery and from more active sports for six months.

Long-term follow-up may include revision surgery six to 12 months after facial trauma. In the case of children, the patient will be followed until his or her growth is complete; most will need periodic consultations with an orthodontist as well as with the plastic surgeon. A dentist or an oral surgeon should check on patients who have had craniofacial surgery following trauma during their recovery to make sure that the teeth and jawbones are in proper alignment. All Le Fort fractures (I, II, and III) involve damage to the patient's normal occlusion (bite pattern).

Some patients may choose to have **cosmetic surgery** to remove or minimize facial scars after healing is complete, usually about six months after the reconstructive operation.

### *Psychological*

The psychological aftereffects of a disfiguring congenital abnormality or post-traumatic injury are often problematic. Craniofacial reconstruction in children with congenital syndromes typically includes ongoing psychological assessment and counseling to help the parents as well as the child cope with feelings of guilt as well as deal with teasing or ridicule from others. Many parents blame themselves for their child's condition if it is associated with a genetic disorder. Children who have had a disfiguring injury often develop post-traumatic stress disorder (PTSD), depression, or anxiety. One study found that 98% of children between the ages of three and 12 who had been disfigured by accidents or dog bites had symptoms of PTSD within five days of the traumatic event. A year later, 44% of the children still had symptoms, and 21% met the full diagnostic criteria for PTSD. Psychiatric symptoms in children are often intensified as the youngsters reach adolescence and become even more preoccupied with their appearance.

Adult patients also have high rates of depression, PTSD, or anxiety disorders following craniofacial reconstruction. Support groups as well as individual psychotherapy appear to be effective in helping people learn to live with disfiguring injuries or the aftermath of cancer surgery. Specific concerns include coping with awkward social situations as well as internal feelings of guilt or anger. Some researchers have reported that men find it harder to adjust to facial disfigurement than women, possibly because males in Western societies are not encouraged to discuss concerns about their appearance.

### Risks

Some of the risks of craniofacial reconstruction are common to all surgical procedures done under

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Craniofacial reconstruction of congenital abnormalities requires a team of medical specialists, including plastic surgeons, maxillofacial surgeons, neurosurgeons, dentists, ophthalmologists, and psychiatrists. These procedures can be done in a department of plastic surgery in a teaching hospital; increasingly, however, they are being performed in separate clinics or institutes that specialize in craniofacial reconstruction in children.

Craniofacial reconstruction following trauma is started as soon as possible once the patient's general condition is stable. Although at one time surgeons delayed the treatment of disfiguring injuries for several weeks, recent studies have found that early treatment gives better results as well as minimizing the need for revision plastic surgery. These procedures can be started in a hospital emergency room or done in a specialized trauma center. Facial injuries resulting from burns or electrical trauma may be treated at special burn centers.

Craniofacial reconstruction following cancer treatment is done in specialized departments of plastic and reconstructive surgery within larger hospitals. Many of these are teaching hospitals associated with major medical schools.

Forensic craniofacial reconstruction is done in specialized facilities in university departments of anthropology or in laboratories related to the criminal justice system.

general anesthesia. These include bleeding, breathing problems, bruises underneath the skin, reactions to the anesthesia, and infection.

Risks that are specific to craniofacial reconstruction include damage to the nerves in the face and head; visible scarring; bone graft failure; and the need for further surgery.

Risk factors that can affect the results of craniofacial reconstruction include:

- poor nutrition
- HIV infection
- a weakened immune system
- damage to the skin from radiation therapy

## QUESTIONS TO ASK THE DOCTOR

- Am I likely to need further surgery after recovery from craniofacial reconstruction?
- How normal can I expect to look at the end of the process?
- What are the risks of permanent damage to my eyesight or hearing?
- Does the hospital or clinic have a support group for people who have undergone craniofacial reconstruction?

- a connective tissue disease, such as lupus or scleroderma
- smoking
- time elapsed between a traumatic injury and surgical treatment
- poor blood circulation in the affected area

### Normal results

Normal results of craniofacial reconstruction vary, depending on the type of injury or defect. Good results include improvement or restoration of the general shape of the patient's head or face; improving or maintaining the functioning of the eyes, ears, nose, mouth, and teeth; and a more nearly normal appearance to the face.

### Morbidity and mortality rates

Morbidity and mortality rates vary widely, depending on the patient's age, general health, and the cause of the injury or abnormality.

### Alternatives

There are no mainstream alternatives to craniofacial reconstruction in the treatment of birth defects, traumatic injuries, or disfigurement resulting from cancer surgery.

DNA analysis can be used together with craniofacial reconstruction to help identify badly disfigured or damaged human remains.

### Resources

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American Burn Association. 625 North Michigan Avenue, Suite 1530, Chicago, IL 60611. (312) 642 9260. [www.ameriburn.org](http://www.ameriburn.org).

American Cleft Palate Craniofacial Association. 104 South Estes Drive, Suite 204, Chapel Hill, NC 27514. (919) 933 9044. [www.cleftline.org](http://www.cleftline.org).

American Society of Plastic Surgeons (ASPS). 444 East Algonquin Road, Arlington Heights, IL 60005. (847) 228 9900. [www.plasticsurgery.org](http://www.plasticsurgery.org).

FACES: The National Craniofacial Association. P. O. Box 11082, Chattanooga, TN 37401. (800) 332 2373. [www.facescranio.org](http://www.facescranio.org).

Federal Bureau of Investigation (FBI), Laboratory Division. J. Edgar Hoover Building, 935 Pennsylvania Avenue, NW, Washington, DC 20535 0001. [www.fbi.gov/hq/lab/labhome.htm](http://www.fbi.gov/hq/lab/labhome.htm).

National Down Syndrome Society (NDSS). 666 Broadway, New York, NY 10012. (212) 460 9330 or (800) 221 4602. [www.ndss.org](http://www.ndss.org).

National Organization for Rare Disorders (NORD). 55 Kenosia Avenue, P. O. Box 1968, Danbury, CT 06813 1968. (203) 744 0100. [www.rarediseases.org](http://www.rarediseases.org).

University of Maryland Medical Center, R. Adams Cowley Shock Trauma Center. 22 South Greene Street, Baltimore, MD 21201. (410) 328 2757 or (800) 373 4111. [www.umm.edu/shocktrauma](http://www.umm.edu/shocktrauma).

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Rebecca Frey, PhD



## Craniotomy

### Definition

A craniotomy is a procedure to remove a lesion in the brain through an opening in the skull (cranium).

### Purpose

A craniotomy is a type of brain surgery. It is the most commonly performed surgery for brain **tumor removal**. It also may be done to remove a blood clot (hematoma), to control hemorrhage from a weak, leaking blood vessel (cerebral aneurysm), to repair arteriovenous malformations (abnormal connections of blood vessels), to drain a brain abscess, to relieve pressure inside the skull, to perform a biopsy, or to inspect the brain.

### Demographics

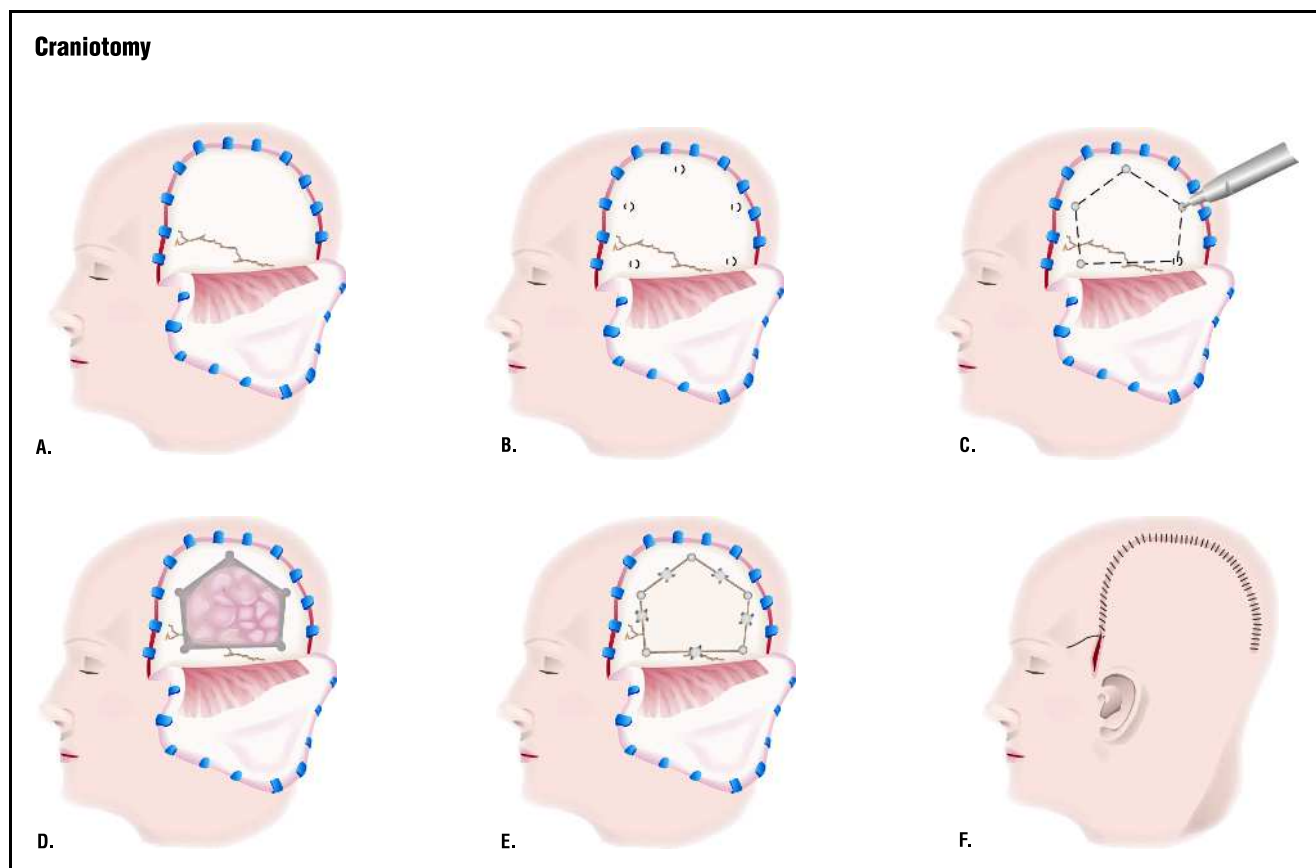
Because craniotomy is a procedure that is utilized for several conditions and diseases, statistical information for

the procedure itself is not available. However, because craniotomy is most commonly performed to remove a brain tumor, statistics concerning this condition are given. Approximately 90% of primary brain cancers occur in adults, more commonly in males between 55 and 65 years of age. Tumors in children peak between the ages of three and 12. Brain tumors are presently the most common cancer in children (four out of 100,000).

### Description

There are two methods commonly utilized by surgeons to open the skull. Either an incision is made at the nape of the neck around the bone at the back (occipital bone) or a curving incision is made in front of the ear that arches above the eye. The incision penetrates as far as the thin membrane covering the skull bone. During skin incision the surgeon must seal off many small blood vessels because the scalp has a rich blood supply.

The scalp tissue is then folded back to expose the bone. Using a high-speed drill, the surgeon drills a



In a craniotomy, the skin over a part of the skull is cut and pulled back (A). Small holes are drilled into the skull (B), and a special saw is used to cut the bone between the holes (C). The bone is removed, and a tumor or other defect is visualized and repaired (D). The bone is replaced (E), and the skin closed (F). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Abscess**—A localized collection of pus or infection that is walled off from the rest of the body.

**Arteriogram**—An x-ray study of an artery that has been injected with a contrast dye.

**Arteriovenous malformation**—Abnormal, direct connection between the arteries and veins. Arteriovenous malformations can range from very small to large.

**Cerebral aneurysm**—An abnormal, localized bulge in a blood vessel that is usually caused by a congenital weakness in the wall of the vessel.

**Cranium**—Skull; the bony framework that holds the brain.

**Computed tomography (CT)**—An imaging technique that produces three-dimensional pictures of organs and structures inside the body using a 360° x-ray beam.

**Edema**—An accumulation of watery fluid that causes swelling of the affected tissue.

**Hematoma**—An accumulation of blood, often clotted, in a body tissue or organ, usually caused by a break or tear in a blood vessel.

**Hemorrhage**—Very severe, massive bleeding that is difficult to control.

**Magnetic resonance imaging (MRI)**—An imaging technique that uses magnetic fields and radio waves to create detailed images of internal body organs and structures, including the brain.

pattern of holes through the cranium (skull) and uses a fine wire saw to connect the holes until a segment of bone (bone flap) can be removed. This gives the surgeon access to the inside of the skull and allows him to proceed with surgery inside the brain. After removal of the internal brain lesion or other procedure is completed, the bone is replaced and secured into position with soft wire. Membranes, muscle, and skin are sutured into position. If the lesion is an aneurysm, the affected artery is sealed at the leak. If there is a tumor, as much of it as possible is resected (removed). For arteriovenous malformations, the abnormality is clipped and the repair redirects the blood flow to normal vessels.

## Diagnosis/Preparation

Since the lesion is in the brain, the surgeon uses imaging studies to definitively identify it. Neuroimaging is usually accomplished by the following:

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The procedure is performed in a hospital with a neurosurgery department and an intensive care unit. The procedure is performed by a board certified neurosurgeon, who has completed two years of general surgery training and five years of neurosurgical training.

- CT (computed tomography, uses x-rays and injection of an intravenous dye to visualize the lesion)
- MRI (magnetic resonance imaging, uses magnetic fields and radio waves to visualize a lesion)
- arteriogram (an x-ray of blood vessels injected with a dye to visualize a tumor or cerebral aneurysm)

Before surgery the patient may be given medication to ease anxiety and to decrease the risk of seizures, swelling, and infection after surgery. Blood thinners (Coumadin, heparin, **aspirin**) and **nonsteroidal anti-inflammatory drugs** (ibuprofen, Motrin, Advil, aspirin, Naprosyn, Daypro) have been correlated with an increase in blood clot formation after surgery. These medications must be discontinued at least seven days before the surgery to reverse any blood thinning effects. Additionally, the surgeon will order routine or special laboratory tests as needed. The patient should not eat or drink after midnight the day of the surgery. The patient's scalp is shaved in the **operating room** just before the surgery begins.

## Aftercare

Craniotomy is a major surgical procedure performed under **general anesthesia**. Immediately after surgery, the patient's pupil reactions are tested, mental status is assessed after anesthesia, and movement of the limbs (arms/legs) is evaluated. Shortly after surgery, breathing exercises are started to clear the lungs. Typically, after surgery patients are given medications to control pain, swelling, and seizures. Codeine may be prescribed to relieve headache. Special leg stockings are used to prevent blood clot formation after surgery. Patients can usually get out of bed in about a day after surgery and usually are hospitalized for five to 14 days after surgery. The **bandages** on the skull are removed and replaced regularly. The sutures closing the scalp are removed by the surgeon, but the soft wires used to reattach the portion of the skull that was removed are permanent and require no further

## QUESTIONS TO ASK THE DOCTOR

How is this procedure done? What kinds of tests and preparation are necessary before surgery? What risks are associated with the procedure? How often is normal brain tissue damaged during this type of surgery? What is the expected outcome of the surgery? What complications may result from this type of surgery? What is the recovery time? How many of these procedures have you done in the past year?

attention. Patients should keep the scalp dry until the sutures are removed. If required (depending on area of brain involved), occupational therapists and physical therapist assess, the patient's status postoperatively and help the patient improve strength, daily living skills and capabilities, and speech. Full recovery may take up to two months, since it is common for patients to feel fatigued for up to eight weeks after surgery.

### Risks

The surgeon will discuss potential risks associated with the procedure. Neurosurgical procedures may result in bleeding, blood clots, retention of fluid causing swelling (edema), or unintended injury to normal nerve tissues. Some patients may develop infections. Damage to normal brain tissue may cause damage to an area and subsequent loss of brain function. Loss of function in specific areas can cause memory impairment. Some other examples of potential damage that may result from this procedure include deafness, double vision, numbness, paralysis, blindness, or loss of the sense of smell.

### Normal results

Normal results depend on the cause for surgery and the patient's overall health status and age. If the operation was successful and uncomplicated recovery is quick, since there is a rich blood supply to the area. Recovery could take up to eight weeks, but patients are usually fully functioning in less time.

### Morbidity and mortality rates

There is no information about the rates of diseases and **death** specifically related to craniotomy. The operation is performed as a neurosurgical intervention for several different diseases and conditions.

### Alternatives

There are no alternative treatments if a neurosurgeon deems this procedure as necessary.

### Resources

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- American Association of Neurological Surgeons. 5550 Meadowbrook Drive, Rolling Meadows, IL 60008. (888) 566 AANS (2267). Fax: (847) 378 0600. E mail: [info@aans.org](mailto:info@aans.org). <http://www.neurosurgery.org/aans/index.asp>.

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Robert Ramirez, B.S.

Creatine kinase test see **Cardiac marker tests**

## Creatine phosphokinase (CPK)

### Definition

Creatine phosphokinase or CPK is an enzyme found in cells that is used to turn creatine into phosphate. This phosphate is a quick source of cellular energy. Muscle cells are the primary source of CPK in the body. The CPK test measures the amount of CPK present in the bloodstream.

## Purpose

Because damaged muscle tissue releases CPK into the blood, the detected levels are an indication of the extent and time of the damage. There are different forms of CPK (CPK isoenzymes) that can help determine what tissue has been damaged.

## Precautions

There are many variables that contribute to the amount of enzymes present in the bloodstream, including a person's activity level and even if a person is taking a certain type of medication or drug. In a healthy adult, the normal range of total CPK falls between 22 to 198 (units per liter). CPK levels higher than this indicate that muscle damage has occurred. If the CPK test result is elevated, further tests are performed to determine where the muscle damage occurred. There are many causes for elevated levels of CPK. For this reason, the general total CPK test is only approximately 70% accurate. The CPK isoenzyme testing is more specific and therefore approximately 90% accurate.

Drugs that may increase CPK levels:

- Ampicillen
- Anticoagulants
- Alcohol
- Cocaine
- Aspirin
- Morphine
- Furosemide
- Dexamethasone
- Clofibrate
- Amphotericin B
- Isotretinoin (acne treatment)
- Some anesthetics

## Description of CPK Isoenzyme Testing

CPK is composed of three different isoenzymes

- CPK-1 (CPK-BB) is concentrated in the brain and lungs
- CPK-2 (CPK-MB) is found mostly in heart tissue
- CPK-3 (CPK-MM) is found mostly in skeletal muscle

If the level of CPK-1 is elevated that would indicate that the damage occurred to the brain or lung tissue. For the brain, this could mean, a stroke, brain cancer, brain injury, or a seizure. For the lungs, elevated levels could indicate a pulmonary embolism. If the level of CPK-2 is elevated, that would indicate that the damage has occurred in the heart tissue. For the heart, this could mean a heart attack has occurred.

## KEY TERMS

**Myocarditis**—Inflammation of the muscles of the walls of the heart due to a viral infection.

**Myositis**—Inflammation of muscle tissue.

**Pulmonary embolism**—A blood clot in the lungs.

CPK-2 levels rise 3-6 hours after a heart attack, peak at 12-24 hours and will return to normal 12-48 hours after tissue damage occurs. Elevated CPK-2 levels could also indicate other heart trauma, myocarditis, or electrical injuries. CPK-3 levels that are elevated usually indicate an injury or stress to skeletal muscle. For skeletal muscle this could indicate strenuous exercise, seizures, injury or trauma to muscle tissue, multiple intramuscular injections, myositis or muscular dystrophy. Individuals who are affected with certain types of muscular dystrophy may have levels of CPK as high as 15,000 to 35,000 (units per liter).

## Preparation

CPK levels are obtained by a routine blood draw. There is no preparation for the blood draw, except that individuals should avoid vigorous or prolonged exercise prior to the test. The test may be repeated several times over a period of time to look for significant rising or falling of the CPK levels.

## Aftercare

Aftercare following a routine blood test consists of care of the area around the puncture site. Pressure is applied for a few seconds prior to covering the wound with a bandage.

## Risks

The risks associated with routine blood draw include bruising, swelling or excessive bleeding from the puncture site and dizziness or fainting may occur during or shortly after the blood draw.

## Normal Results

As stated above, in a healthy adult, the normal range of total CPK falls between 22 to 198 (units per liter).

## Resources

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Medline Plus, A service of the U.S. National Library of Medicine and the NIH, 8600 Rockville Pike, Bethesda, MD 20894. <http://www.nlm.nih.gov/medlineplus/ency/article/003503.htm>.

Renee Laux, M.S.

Creatinine test see **Kidney function tests**

## Cricothyroidotomy

### Definition

Cricothyroidotomy is usually regarded as an emergency surgical procedure in which a surgeon or other trained person cuts a hole through a membrane in the patient's neck into the windpipe in order to allow air into the lungs. Cricothyroidotomy is a sub-type of surgical procedure known as a **tracheotomy**; in some situations, it is considered an elective alternative to other types of tracheotomy.

### Purpose

The primary purpose of a cricothyroidotomy is to provide an emergency breathing passage for a patient whose airway is closed by traumatic injury to the neck; by burn inhalation injuries; by closing of the airway due to an allergic reaction to bee or wasp stings; or by unconsciousness. It may also be performed in some seriously ill patients with structural abnormalities in the neck. Some surgeons consider a cricothyroidotomy to be preferable to a standard tracheotomy in treating patients in an **intensive care unit**.

### Demographics

The demographics of cricothyroidotomies are difficult to establish because the procedure is relatively uncommon in the general population, even in emergency situations. In the emergency room, the incidence varied between 1.7% and 2.7%. A study found that nine of a group of 1,560 patients admitted for blunt or penetrating injuries of the neck required emergency cricothyroidotomies, or about 0.5%.

Another study found that the most important single cause of injuries requiring emergency cricothyroidotomy was traffic accidents (51%), followed by gunshot and knife wounds (29%); falls (5%); and criminal assault (5%).

Most cricothyroidotomies are performed on adolescent and young adult males, because this group accounts for the majority of cases of neck trauma in the United States. It is estimated that injuries to the neck account for 5–10% of all serious traumatic injuries.

### Description

There are two basic types of cricothyroidotomy: needle cricothyroidotomy and surgical cricothyroidotomy.

#### *Needle cricothyroidotomy*

In a needle cricothyroidotomy, a syringe with a needle attached is used to make a puncture hole through the cricothyroid membrane that overlies the trachea. After the needle has reached the trachea, a catheter is passed over the needle into the windpipe and attached to a bag-valve device.

#### *Surgical cricothyroidotomy*

In a surgical cricothyroidotomy, the doctor or other emergency worker makes an incision through the cricothyroid membrane into the trachea in order to insert a piece of tubing for ventilating the patient.

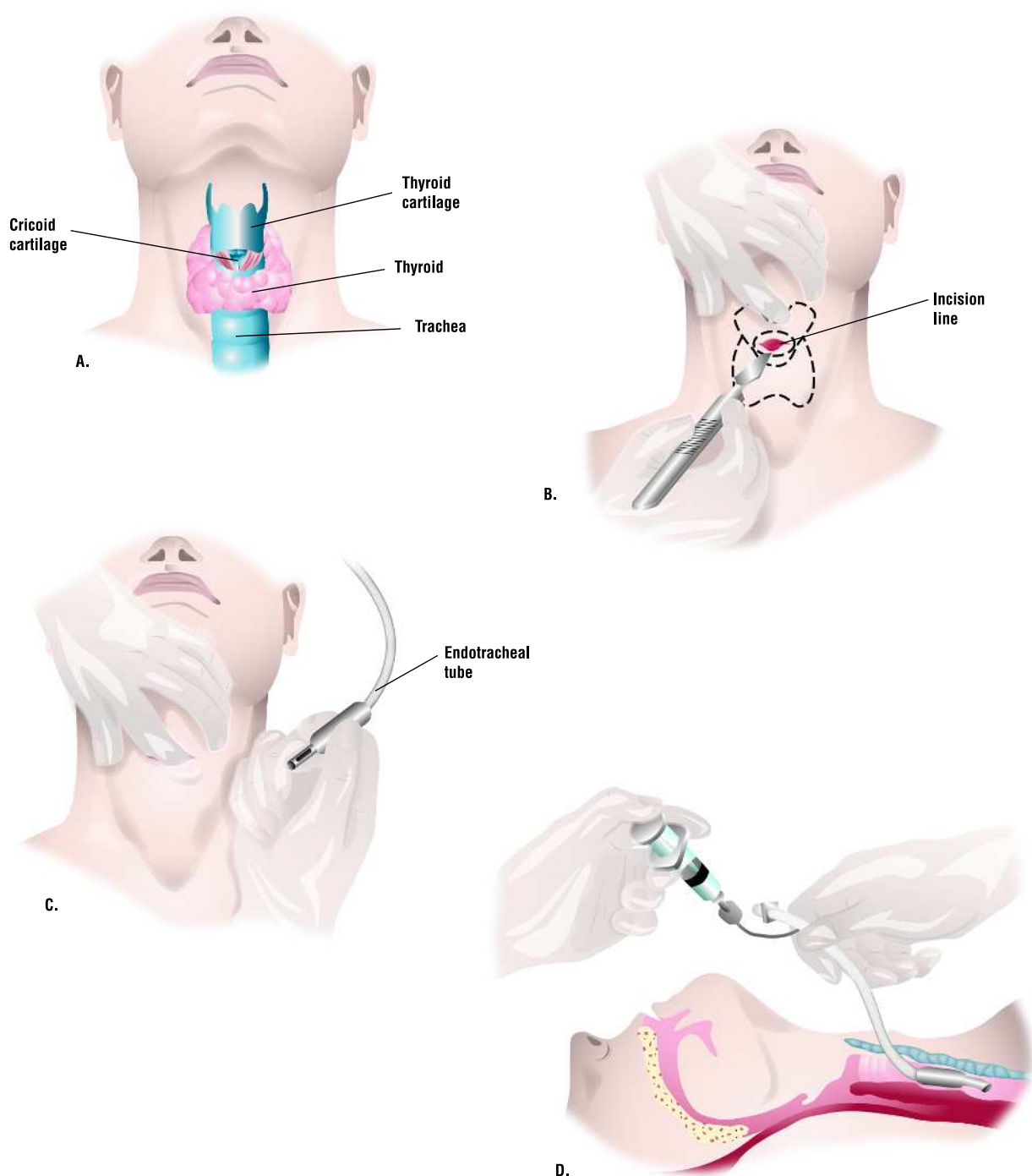
### Diagnosis/Preparation

The primary concerns in emergency medical treatment are sometimes known as the ABCs: airway patency (openness), breathing, and circulation. Keeping the airway patent is critical to an injured person's survival. The signs of a blocked airway in people are obvious, including a bluish complexion (cyanosis); noisy breathing, unusual breath sounds, or choking; emotional agitation or panic; and often loss of consciousness.

In an emergency situation, the following are considered reasons for performing a cricothyroidotomy first, rather than attempting to open or clear the patient's airway by other methods:

- Major injuries to the face or jaw, such as multiple fractures of the jawbone or severe fractures of the patient's midface. In many cases of facial injury, the airway is blocked by broken teeth or fragments of bone from the jaw and cheekbones.
- Burns in or around the mouth.
- A neurological disorder or damage that has caused the patient's teeth to clamp shut.

## Cricothyroidotomy



To perform a cricothyroidotomy, the surgeon into the cricoid cartilage of the throat (B). The incision is held open while an endotracheal tube is inserted (C). The tube is secured in the trachea to maintain an airway for the patient (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Airway**—The passageway through the mouth, nose, and throat that allows air to enter and leave the lungs; the term can also refer to a tube or other artificial device used to create an air passageway into and out of the lungs when the patient is under general anesthesia or unable to breathe properly.

**Cricoid cartilage**—A ring-shaped piece of cartilage that forms the lower and rear parts of the voice box or larynx; it is sometimes called the annular cartilage because of its shape.

**Cricothyroid membrane**—The piece of connective tissue that lies between the thyroid and cricoid cartilages.

**Cyanosis**—A bluish discoloration of the skin, caused by a loss of oxygen content in the blood.

**Endotracheal intubation**—A procedure in which a tube is inserted into the trachea in order to administer anesthesia or ventilate the patient.

**Hypercarbia**—An excess of carbon dioxide in the blood.

**Patency**—Being wide open, as in a patient's airway.

**Pneumothorax**—A condition in which air or gas has accumulated in the space in the chest around the lungs.

**Subglottic stenosis**—An abnormal narrowing of the trachea below the level of the vocal cords.

**Thyroid cartilage**—The largest cartilage in the human larynx, or voice box. It is sometimes called the Adam's apple.

**Trachea**—The windpipe.

**Tracheotomy**—The surgical creation of an opening into the windpipe through the neck; it is also called a tracheostomy.

**Transtracheal jet ventilation (TTJV)**—A technique for ventilating a patient that involves passing oxygen under pressure through a catheter that has been passed through the patient's cricothyroid membrane.

**Ventilate**—To assist a patient's breathing by use of a mechanical device or surgical procedure.

- Fractured larynx. Fractures of the larynx most commonly result from automobile or motorcycle accidents, but also occur in cases of strangulation or attempted suicide by hanging.
- Larynx swollen shut by allergic reaction to bee or wasp venom.

### Preparation

The first steps in preparation are the same for needle and surgical cricothyroidotomies. The patient is positioned lying on the back with a towel under the shoulders and the neck stretched backward (hyperextended). If the patient is conscious, he or she is given a local anesthetic. The doctor then palpates, or feels, the patient's throat for the thyroid cartilage, or Adam's apple. This piece of cartilage is an anatomical landmark for this procedure, which means that it is a structure that is relatively easy to identify and serves as a reference point for other structures. In men, the Adam's apple is easy to find by running the finger down the center of the neck. In women, however, the thyroid cartilage is less prominent. Below the thyroid cartilage is a softer area about the width of a finger; this is the cricothyroid membrane, which is a piece of tissue lying between the thyroid cartilage above it and the cricoid cartilage below it.

When the doctor has located the cricothyroid membrane, he or she will scrub the skin over it with a povidone-iodine solution to prevent infection.

### Needle cricothyroidotomy

In a needle cricothyroidotomy, the doctor uses a 12- or 14-gauge catheter and needle assembly. The needle is advanced through the cricothyroid cartilage at a 45-degree angle until the trachea is reached. When the doctor is able to withdraw air through the syringe, he or she knows that the catheter is in the correct spot. The catheter is then pushed forward over the needle, which is then removed. An endotracheal tube connector is then fitted onto the end of the catheter and connected to a bag-valve unit with an oxygen reservoir.

A needle cricothyroidotomy will supply the patient with enough oxygen for about 40–45 minutes; it is a time-limited technique because it does not allow the efficient escape of carbon dioxide from the bloodstream. It will, however, help to ventilate the patient until he or she can be taken to a hospital or trauma center.

Needle cricothyroidotomy is the only form of this procedure that can be done in children under 12 years of age. The reason for this restriction is that the upper part of the trachea is not fully developed in children, and a surgical incision through the cricothyroid

membrane increases the risk of the child's developing subglottic stenosis, which is a condition in which the trachea is abnormally narrow below the level of the vocal cords due to an overgrowth of soft tissue. It is often seen in children who were intubated as infants.

### *Surgical cricothyroidotomy*

In a surgical cricothyroidotomy, the doctor steadies the patient's thyroid cartilage with one hand and makes a horizontal (transverse) incision across the cricothyroid membrane. The incision is deepened until the airway is reached. The doctor then rotates the edge of the scalpel 90° in order to open the incision to receive an endotracheal or tracheotomy tube. A hemostat or surgical clamp may be used to hold the incision open while the doctor prepares to insert the tube through the opening into the trachea. After checking the tube to make certain that it is in the proper location, the doctor tapes it in place. If necessary, the doctor may use suction to clear the patient's airway.

In some emergency situations, the doctor or other medical professional may not have an antiseptic available to cleanse the skin over the patient's throat, and may have to use any sharp-edged implement that is handy to make the incision. Emergency cricothyroidotomies have been performed with scissors, hunting or pocketknives, razor blades, broken glass, and the jagged edges of a lid from a tin can. The airway has been held open with such objects as paper clips, nail clippers, the plastic barrel from a ballpoint pen, and a piece of plastic straw from a sports water bottle.

## Aftercare

### *Needle cricothyroidotomy*

A needle cricothyroidotomy must be replaced by a formal surgical tracheotomy or other means of ventilating the patient within 45 minutes.

### *Surgical cricothyroidotomy*

A surgical cricothyroidotomy can be left in place for about 24 hours, but should be replaced within that time period by a formal tracheotomy performed in a hospital **operating room**.

Other aspects of aftercare depend on the cause of the airway blockage and the nature of the patient's injuries. The head and neck contain major blood vessels, a large portion of the central nervous system, the organs of sight, smell, hearing, and taste, and the central airway—all within a relatively small area. Injuries to the face and neck often require treatment by specialists in neurology,

trauma surgery, otolaryngology, ophthalmology, and **plastic surgery** as well as by specialists in emergency medicine.

## Risks

### *Needle cricothyroidotomy*

The risks of a needle cricothyroidotomy include:

- external scar from needle puncture
- bleeding
- accidental perforation of the esophagus
- hypercarbia (overly high levels of carbon dioxide in the blood)

### *Surgical cricothyroidotomy*

The risks of surgical cricothyroidotomy include:

- large visible external scar from the incision
- subglottic stenosis
- bleeding
- accidental perforation of the esophagus
- fracture of the larynx
- pneumothorax, a condition in which air has entered the space around the lungs
- damage to the vocal cords resulting in hoarseness or a changed voice

## Normal results

### *Needle cricothyroidotomy*

Normal results for a needle cricothyroidotomy would be adequate ventilation of a patient with a blocked airway for a brief period of time of about 45 minutes.

### *Surgical cricothyroidotomy*

Normal results of a surgical cricothyroidotomy would be adequate ventilation in emergency circumstances of a patient with a blocked airway for a period of about 24 hours.

## Morbidity and mortality rates

In general, cricothyroidotomy has a very low mortality rate, even when performed outside a hospital. By contrast, the mortality rate for patients who lose airway patency is 33%. Overall, emergency cricothyroidotomy is considered an effective way to create an emergency surgical airway with low overall morbidity.



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Under ideal circumstances, a cricothyroidotomy would be performed in a hospital emergency room, ICU, or trauma center by a general surgeon, otolaryngologist, or anesthesiologist. Because it is an emergency procedure, however, a medical student, physician's assistant, paramedic, or nurse may also perform cricothyroidotomies. Many trauma centers require paramedics and nurses specializing in emergency medicine to practice performing cricothyroidotomies at least twice a year in a clinical laboratory in order to keep their skill level high. Since the procedure is risky but uncommon, it is important for emergency personnel to feel comfortable with the equipment and techniques required.

Military personnel are trained to perform emergency cricothyroidotomies in combat situations. There are also cases reported of cricothyroidotomies being done in emergencies by civilian bystanders with some medical training.

## Alternatives

Cricothyroidotomy is generally considered a procedure of last resort, to be performed when other ways of opening the patient's airway have failed or are unavailable. It is frequently done if **endotracheal intubation** has been attempted and failed, or if intubation cannot be performed due to the nature of the patient's injuries. Endotracheal intubation is a procedure in which a breathing tube is introduced directly into the trachea through the patient's mouth or nose with the help of a laryngoscope. It is most commonly done during **general anesthesia**, but can also be performed to help the patient breathe.

One alternative to cricothyroidotomy is a technique known as transtracheal jet ventilation (TTJV). In TTJV, a syringe is used to introduce a catheter through the patient's cricothyroid membrane. The catheter is connected to a high-pressure oxygen supply. In hospital settings, TTJV has about the same rate of complications as a surgical cricothyroidotomy. Its disadvantages are that it cannot be used outside a hospital setting and it takes longer to perform. A surgical cricothyroidotomy can be performed in 30 seconds to two minutes; TTJV takes twice to three times as long to perform.

## QUESTIONS TO ASK THE DOCTOR

- Am I likely to have lasting side effects from this emergency procedure?

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National Association of Emergency Medical Technicians (NAEMT). P. O. Box 1400, Clinton, MS 39060 1400. (800) 34 NAEMT. [www.naemt.org](http://www.naemt.org).

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Cryosurgery see **Cryotherapy**

Cryosurgery for retinal detachment see **Retinal cryopexy**

## Cryotherapy

### Definition

Cryotherapy is a technique that uses an extremely cold liquid or instrument to freeze and destroy abnormal cells that require removal. The technique has been in use since the turn of the century, but modern techniques have made it widely available to dermatologists and primary care doctors. The technique is also known as cryocautery or cryosurgery.



**A doctor using cryotherapy to remove warts from patient's foot.** (Pulse Picture Library, Inc./Phototake. Reproduced by permission.)

### Purpose

Cryotherapy is used to destroy a variety of benign skin growths, such as warts, precancerous lesions (actinic keratoses), and malignant lesions (basal cell and squamous cell cancers). It has been used at several medical centers for tumors of the prostate, liver, lung, breast, and brain as well as for cataracts, gynecological problems, and other diseases. The goal of cryotherapy is to freeze and destroy targeted skin growths while preserving the surrounding skin from injury.

### Description

In dermatology applications, there are three main techniques used in cryotherapy. In the simplest technique, usually reserved for warts and other benign skin growths, the physician dips a cotton swab or other applicator into a cup containing a “cryogen” such as liquid nitrogen and applies it directly to the skin growth to freeze it. At a temperature of  $-320^{\circ}\text{F}$  ( $-196^{\circ}\text{C}$ ), liquid nitrogen is the coldest cryogen available. The goal is to freeze the skin growth as quickly as possible, and then let it thaw slowly to cause maximum destruction of the skin cells. A second application may be necessary depending on the size of the growth. In another approach, a device is used to direct a small spray of liquid nitrogen or other cryogen directly onto the skin growth. Freezing may last from five to 20 seconds, depending on the size of the lesion. A second freeze-thaw cycle may be required. Sometimes, the physician inserts a small needle connected to a **thermometer** into the lesion to make certain the lesion is cooled to a temperature low enough to guarantee maximum destruction. In a third option, liquid nitrogen or another cryogen is circulated through a probe to cool it to low temperatures. The probe is then brought into direct contact with the skin lesion to freeze it. The freeze time can take two to three times longer than with the spray technique.

When used for cancer treatment, cryotherapy is usually performed as follows: for external tumors, liquid nitrogen is applied directly to the cancer cells with a cotton swab or spraying device; for internal tumors, liquid nitrogen is circulated through an instrument called a cryoprobe that is placed in contact with the tumor. To guide the cryoprobe and to monitor the freezing of the cells, the treating physician uses **ultrasound** to guide his work and spare nearby healthy tissue.

### Preparation

No extensive preparation is required prior to cryotherapy. The area to be treated should be clean and

## KEY TERMS

**Actinic keratosis**—A crusty, scaly precancerous skin lesion caused by damage from the sun; frequently treated with cryotherapy.

**Basal cell cancer**—The most common form of skin cancer that usually appears as one or several nodules having a central depression; it rarely spreads (metastasizes), but is locally invasive.

**Cervical cryotherapy**—Surgery performed after a biopsy has confirmed abnormal cervical cells (dysplasia).

**Cryogen**—A substance with a very low boiling point, such as liquid nitrogen, used in cryotherapy treatment.

**Melanoma**—The most dangerous form of skin cancer.

**Squamous cell cancer**—A form of skin cancer that usually originates in sun-damaged areas or pre-existing lesions; at first local and superficial, it may later spread to other areas of the body.

**Ultrasound**—Imaging technique by which computerized moving pictures of the body are generated by high-frequency sound waves.

dry, but sterile preparation is not necessary. Patients should know that they will experience some pain at the time of the freezing, but **local anesthesia** is usually not required. In dermatology applications, the physician may want to reduce the size of certain growths such as warts prior to the cryotherapy procedure, and may have patients apply salicylic acid preparations to the growth over several weeks. Sometimes, the physician will pare away some of the tissue using a device called a curette or a scalpel. In the case of **cervical cryotherapy**, the procedure is not performed during, or from two to three days before, the menstrual period.

## Aftercare

In dermatology applications, redness, swelling, and the formation of a blister at the site of cryotherapy are all expected results of the treatment. A gauze dressing is applied, and patients should wash the site three or four times daily while fluid continues to ooze from the wound, usually for five to 14 days. A dry crust will form that falls off by itself. Wounds on the head and neck may take four to six weeks to heal, but those on the body, arms, and legs can take longer. Some patients experience pain at the site following the treatment. This can usually be eased with **acetaminophen** (Tylenol),

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Cryotherapy is performed by the treating physician, who may be a gynecologist (cervical cryotherapy) or a dermatologist (wart removal) or an oncologist (tumor removal). The procedure is usually carried out on an outpatient basis, but may require a hospital setting depending on the condition requiring the cryotherapy.

though in some cases a stronger pain reliever may be required.

## Risks

In dermatology applications, cryotherapy poses little risk and can be well tolerated by elderly and other patients who are not good candidates for other surgical procedures. As with other surgical procedures, there is some risk of scarring, infection, and damage to underlying skin and tissue. These risks are generally minimal in the hands of experienced physicians.

Care should be taken, however, in subjecting people with diabetes or certain circulation problems to cryotherapy for growths located on their lower legs, ankles, and feet. In these patients, healing can be poor and the risk of infection can be higher than for other patients.

Although cryotherapy is a relatively low-risk procedure, some side effects may occur as a result of the treatment. They include:

- **Infection**—though uncommon, infection is more likely on the lower legs where healing can take several months.
- **Pigmentary changes**—both hypopigmentation (lightening of the skin) and hyperpigmentation (darkening of the skin) are possible after cryotherapy. Both generally last a few months, but can be longer lasting.
- **Nerve damage**—though rare, damage to nerves is possible, particularly in areas where they lie closer to the surface of the skin, such as the fingers, the wrist, and the area behind the ear. Reports suggest this will disappear within several months.

In cancer treatment, cryosurgery does have side effects, although they may be less severe than those associated with conventional surgery or radiation therapy. Cryosurgery of the liver may cause damage to the bile ducts or major blood vessels, which can lead

## QUESTIONS TO ASK THE DOCTOR

- What happens on the day of surgery?
- What type of anesthesia will be used?
- What will I feel during cryotherapy?
- What happens after cryotherapy?
- What are the risks associated with cryotherapy?
- How is cryotherapy done?
- Will there be a scar?

to heavy bleeding or infection. Cryosurgery for prostate cancer may affect the urinary system. It also may cause incontinence (lack of control over urine flow) and impotence (loss of sexual function), although these side effects are often temporary. Cryosurgery for cervical tumors has not been shown to affect fertility, but this possibility is under study. More studies must be conducted to determine the long-term effects of cryosurgery as a cancer treatment approach.

### Normal results

Some redness, swelling, blistering, and oozing of fluid are all common results of cryotherapy. Healing time can vary depending on the site treated and the cryotherapy technique used. When cryogen is applied directly to the growth, healing may occur in three weeks. Growths treated on the head and neck with the spray technique may take four to six weeks to heal, while growths treated on other areas of the body may take considerably longer. Cryotherapy boasts high success rates in permanently removing skin growths; even for malignant lesions such as squamous cell and basal cell cancers, studies have shown a cure rate of up to 98%. For certain types of growths, such as some forms of warts, repeat treatments over several weeks are necessary to prevent the growth's return.

### Alternatives

Alternatives to cryotherapy depend on the specific medical condition being treated. A general alternative is the use of conventional surgical procedures.

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American Academy of Dermatology, 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL, 60168-4014, (847) 330-0230, (847) 240-1859, <http://www.aad.org>.

American Society for Dermatologic Surgery, 555 Meadowbrook Drive, Suite 120, Rolling Meadows, IL, 60008, (847) 956-0900, <http://www.asds.net>.

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## Cryotherapy for cataracts

### Definition

Cryosurgery, or **cryotherapy**, is a technique that destroys abnormal tissue by freezing the cells. Cryotherapy can be used in the treatment of cataracts.

### Purpose

The procedure is used to treat cataracts. A cataract is a form of clouding that develops in the lens of



the eye. The crystalline lens consists mainly of protein matter and water. Normally, the protein is packed so as to allow light to pass through the lens. A cataract forms when protein molecules start aggregating and clump together, eventually clouding the lens and blocking light. If left untreated, cataracts may eventually cause blindness. Cryotherapy is performed to remove the clouding protein matter from the lens.

### Demographics

According to the National Institutes of Health, more than 50% of people over the age of 80 in the United States have a cataract or have had cataract surgery. Some estimates put this figure at 70% or more. Women are affected by cataracts more often than men. African Americans suffer impaired vision from both cataracts and glaucoma at twice the rate of Caucasian Americans, primarily due to lack of treatment.

### Description

Cryotherapy involves the application of a very cold probe to the outside of the eye, which, because of the thin nature of the eye wall (sclera), transmits the freezing temperature to the retina. The intense cold stimulation to the retina can seal abnormal leaky retinal blood vessels. This technique is indicated for the treatment of cataracts that obscure the passage of light into the eye, thus limiting the effectiveness of techniques such as laser therapy.

Cryotherapy uses a cryogenic substance, such as liquid nitrogen, to freeze the cataract. At a temperature of  $-320^{\circ}\text{F}$  ( $-196^{\circ}\text{C}$ ), liquid nitrogen is the coldest cryogenic substance available. The ophthalmologist uses a device to direct a small spray of liquid nitrogen directly onto the cataract. Freezing may last from 5 to 20 seconds, depending on the size of the cataract. A second freeze-thaw cycle may be required. Sometimes, the ophthalmologist will insert a small needle connected to a **thermometer** to make certain the cataract is cooled to a low enough temperature to guarantee destruction. In another option, liquid nitrogen or another cryogen is circulated through a probe to cool it to low temperatures. The probe is then brought into direct contact with the cataract to freeze it. The freeze time can take two to three times longer than with the spray technique.

### Diagnosis/Preparation

In order to see the back of the eye properly, the examining ophthalmologist uses two powerful microscopes, the slit lamp and ophthalmoscope. Eye drops are also often used to make the pupil bigger, so that

## KEY TERMS

**Extracapsular surgery**—A cataract surgical procedure in which an incision is made in the cornea to remove the hard center of the lens. The natural lens is then replaced with an intraocular lens (IOL).

**Glaucoma**—Eye diseases characterized by an increase in intraocular pressure which causes pathological changes in the optic disk and defects in the field of vision.

**Phacoemulsification**—A surgical procedure for removal of the crystalline lens in which a needle is inserted through a small incision on the side of the cornea of the eye, allowing the lens contents to fall through the dilated pupil into the anterior chamber where they are broken up by ultrasound and aspirated out of the eye through the incision.

the back of the eye can be seen more clearly. The effect of these drops wears off after a few hours. Once a cataract has been diagnosed and has progressed to the point that it is interfering with daily activities and normal lifestyle, an appointment is made to treat the cataract.

For cryotherapy, the patient may be asked to skip breakfast, depending on the time of surgery. Upon arrival for cryotherapy, he or she is given eye drops, and perhaps medications to help relax. A local or topical anesthetic is used to make the procedure painless. The patient may see light and movement, but will not be able to see the cryotherapy when it is performed. The skin around the eye is thoroughly cleansed, and sterile coverings are placed around the patient's head.

### Aftercare

After cryotherapy, a patch is placed over the operated eye and the patient is asked to rest for a while. The attending physician checks to see if there are any problems, such as bleeding. Most people who have cataract cryotherapy go home the same day. Arrangements for transportation home should be made because individuals cannot drive after cataract surgery. After the procedure, the doctor schedules exams to check the progress of the vision. Eyedrops or pills may be given to help healing and to control pressure inside the eye. The patient is also asked to wear an eye shield or eyeglasses to help protect the eye, and he or she is told to avoid rubbing or pressing on the eye, and to not lift heavy objects because bending increases pressure in the

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Cryotherapy can be done in the treating doctor's office. The doctor is usually an ophthalmologist, specialized in the treatment of cataracts. An ophthalmologist is a physician who specializes in the medical and surgical care of the eyes and visual system and in the prevention of eye disease and injury. He has completed four or more years of college premedical education, four or more years of medical school, one year of internship, and three or more years of specialized medical, surgical, and refractive training and experience in eye care.

eye. Walking, climbing stairs, and light household chores can be performed.

### Risks

Narcotic analgesia may be required after the procedure to relieve pain. Cryotherapy also causes significant swelling of the eye and eyelid, which makes postoperative assessment difficult. Problems after cryotherapy are rare, but can occur and may include infection, bleeding, inflammation (pain, redness, swelling), loss of vision, or light flashes. With careful medical attention, these problems usually can be treated successfully.

### Normal results

Surgical treatment for cataracts usually results in excellent vision; however, if other problems are present besides the cataract, as, for example, degeneration of the retina or optic nerve, results will not be as favorable.

### Alternatives

The alternative treatment for cataracts is surgical cataract removal, which is one of the most common surgical procedures performed in the United States. Approximately 90% of patients who undergo this surgery experience improved vision. Two procedures are commonly used to surgically remove a cataract: phacoemulsification and extracapsular surgery. During phacoemulsification a small cut is made in the cornea, and a probe that emits ultrasonic waves is inserted into the eye. The ultrasonic waves break up the lens, which is then suctioned out of the eye. During extracapsular the doctor makes a larger cut in the eye and removes the majority of the lens in one piece.

## QUESTIONS TO ASK THE DOCTOR

- Will my vision improve?
- What are the risks of cryotherapy?
- What is the likely hood of pain during or after surgery?
- How long will it take to recover from the surgery?
- What are the likely side-effects of cryotherapy?
- How much cryotherapy do you perform each year for cataracts?

There are no medications, dietary supplements, exercises, or optical devices that have been shown to prevent or cure cataracts.

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- New England Ophthalmological Society, P.O. Box 9165, Boston, MA, 02114, (617) 227 6484, <http://www.neos.eyes.org>.

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Cryotherapy for the cervix see **Cervical cryotherapy**

CSF analysis see **Cerebrospinal fluid (CSF) analysis**

CT-myelogram see **Myelography**

## CT scans

### Definition

Computed tomography (CT) scans are completed with the use of a 360-degree X-ray beam and computer production of images. These scans allow for cross-sectional views of body organs and tissues. Computed tomography is also known as computerized axial tomography or CAT scan.

### Purpose

CT scans are used to image a wide variety of body structures and internal organs. Since the 1990s, CT equipment has become more affordable and available. In some diagnoses, CT scans have become the first imaging exam of choice. Because the computerized image is so sharp, focused, and three-dimensional, many tissues can be better differentiated than on standard X-rays. Common CT indications include:

- Sinus studies—the CT scan can show details of sinusitis and bone fractures. Physicians may order a CT scan of the sinuses to provide an accurate map for surgery.
- Brain studies—brain scans can detect tumors, strokes, and hematomas (collections of blood that have escaped from the vessels). The introduction of CT scanning, especially spiral CT, has helped reduce the need for more invasive procedures such as cerebral angiography.
- Body scans—CT scans of the body will often be used to observe abdominal organs, such as the liver, kidneys, adrenal glands, spleen, pancreas, biliary tree and lymph nodes, and extremities.
- Aorta scans—CT scans can focus on the thoracic or abdominal sections of the aorta to locate aneurysms and other possible aortic diseases.
- Chest scans—CT scans of the chest are useful in distinguishing tumors and in detailing accumulation of fluid in chest infections.

### Description

Computed tomography is a combination of focused x-ray beams, a detector array, and computerized production of an image. Introduced in the early 1970s, this radiologic procedure has advanced rapidly and is now widely used, sometimes in the place of standard X-rays.

## KEY TERMS

**Aneurysm**—The bulging of the blood vessel wall. Aortic aneurysms are the most dangerous. Aneurysms can break and cause bleeding.

**Contrast (agent, medium)**—A substance injected into the body that delineates certain structures that would otherwise be hard or impossible to see on the radiograph (film).

**Gantry**—A name for the portion of a CT scanner which houses the X-ray tube and detector array used to capture image information and send it to the computer.

**Hematoma**—A collection of blood that has escaped from the vessels. It may clot and harden, causing pain to the patient.

**Hydrocephalus**—Abnormal dilatation of fluid-containing ventricles in the brain.

**Metastasis**—Secondary cancer, or cancer that has spread from one body organ or tissue to another.

**Radiologist**—A medical doctor specially trained in radiology (X-ray) interpretation and its use in the diagnosis of disease and injury.

**Spiral CT**—Also referred to as helical CT, this method allows for continuous 360-degree X-ray image capture.

**Thoracic**—Refers to the chest area. The thorax runs between the abdomen and neck and is encased in the ribs.

### CT equipment

A CT scan may be performed in a hospital or outpatient imaging center. Although the equipment looks large and intimidating, it is very sophisticated and fairly comfortable. The patient is asked to lie on a narrow table that slides into the center of the scanner, called the gantry. The scanner looks like a square doughnut with a round opening in the middle, which allows the X-ray beam to rotate around the patient. The scanner's gantry section may also be tilted slightly to allow for certain cross-sectional angles.

### CT procedure

The patient will feel the table move very slightly as the precise adjustments for each sectional image are made. A technologist watches the procedure from a window and views the images on a monitor.

It is essential that the patient lie very still during the procedure to prevent motion blurring. In some studies, such as chest CT scans, the patient will be asked to hold his or her breath during image capture.

Following the procedure, films of the images are usually printed for the radiologist and referring physician to review. A radiologist can also interpret CT exams on a special viewing console. The procedure time will vary in length depending on the area being imaged. Average study times are from 30 to 60 minutes. Some patients may be concerned about claustrophobia, but the width of the gantry portion of the scanner is wide enough to preclude problems with claustrophobia, in most instances.

### *The CT image*

Traditional X-rays image organs in two dimensions, with the possibility that organs in the front of the body are superimposed over those in the back. CT scans allow for a more three-dimensional effect. Some have compared CT images to slices in a loaf of bread. Precise sections of the body can be located and imaged as cross-sectional views. The technologist's console displays a computerized image of each section captured by the X-ray beam and detector array. Thus, various densities of tissue can be easily distinguished.

### *Contrast agents*

Contrast agents are often used in CT exams and in other radiology procedures to demonstrate certain anatomic details that otherwise may not be seen easily. Some contrast agents are natural, such as air or water. Other times, a water-based contrast agent is administered for specific diagnostic purposes. Barium sulfate is commonly used in gastrointestinal procedures. The patient may drink this contrast medium, or receive it in an enema. Oral and rectal contrasts are usually given when examining the abdomen or gastrointestinal tract, and not used when scanning the brain or chest. Iodine-based contrast media are the most widely used intravenous contrast agents and are usually administered through an antecubital (in front of the elbow) vein.

If contrast agents are used in the CT exam, these will be administered several minutes before the study begins. Abdominal CT patients may be asked to drink a contrast medium. Some patients may experience a salty taste, flushing of the face, warmth, slight nausea, or hives from an intravenous contrast injection. Technologists and radiologists have equipment and training to help patients through these minor reactions and

to handle more severe reactions. Severe reactions to contrast agents are rare, but do occur.

### *Spiral CT*

Spiral CT, also called helical CT, is a newer version of CT scanning that is continuous in motion and allows for three-dimensional re-creation of images. For example, traditional CT allows the technologist to take slices at very small and precise intervals one after the other. Spiral CT allows for a continuous flow of images, without stopping the scanner to move to the next image slice. A major advantage of spiral CT is higher resolution and the ability to reconstruct images anywhere along the length of the study area. The procedure also speeds up the imaging process, meaning less time for the patient to lie still. The ability to image the contrast medium more rapidly after it is injected and when it is at its highest level, is another advantage of the spiral CT scans high speed.

Some facilities have both spiral and conventional CT available. Although spiral is more advantageous for many applications, conventional CT is still a superior and precise method for imaging many tissues and structures. The physician will evaluate which type of CT works best for the specific exam purpose.

### **Preparation**

If a contrast medium must be administered, the patient may be asked to fast from about four to six hours prior to the procedure. This is so if a patient experiences nausea, vomiting will not occur. Patients will usually be given a hospital gown to wear during the procedure. All metal and jewelry must be removed to avoid artifacts on the film. Pregnant women or those who could possibly be pregnant should not have a CT scan unless the diagnostic benefits outweigh the risks. Contrast agents are often used in CT exams and the use of these agents should be discussed with the medical professional prior to the procedure. Patients may be asked to sign a consent form concerning the administration of contrast media. One common ingredient in contrast agents, iodine, can cause allergic reactions. Patients who are known to be allergic to iodine (or shellfish) should inform the physician prior to the CT scan.

### **Aftercare**

No aftercare is generally required following a CT scan. Immediately following the exam, the technologist will continue to watch the patient for possible adverse contrast reactions. Patients are instructed to advise the technologist of any symptoms, particularly



respiratory difficulty. The site of contrast injection will be bandaged and may feel tender following the exam. Hives may develop later and usually do not require treatment.

### Risks

Radiation exposure from a CT scan is similar to, though higher than, that of a conventional X-ray. Although this is a risk to pregnant women, the exposure to other adults is minimal and should produce no effects. Severe contrast reactions are rare, but they are a risk of many CT procedures. There is also a small risk of renal failure in high-risk patients.

### Normal results

Normal findings on a CT exam show bone, the most dense tissue, as white areas. Tissues and fluid will appear as various shades of gray, and fat will be dark gray or black. Air will also look black and darker than fat tissue. Intravenous, oral, and rectal contrast appear as white areas. The radiologist can determine if tissues and organs appear normal by the different gradations of the gray scale. In CT, the images that can cut through a section of tissue or organ provide three-dimensional viewing for the radiologist and referring physician.

Abnormal results may show different characteristics of tissues within organs. Accumulations of blood or other fluids where they do not belong may be detected. Radiologists can differentiate among types of tumors throughout the body by viewing details of their makeup.

### Sinus studies

The increasing availability and lowered cost of CT scanning has led to its increased use in sinus studies, either as a replacement for a sinus X-ray or as a follow-up to an abnormal sinus radiograph. The sensitivity of CT allows for location of areas of sinus infection, particularly chronic infection, and is useful for planning prior to functional **endoscopic sinus surgery**. CT scans can show the extent and location of tiny fractures of the sinus and nasal bones. Foreign bodies in the sinus and nasal area are also easily detected by CT. CT imaging of the sinuses is important in evaluating trauma or disease of the sphenoid bone (the wedge-shaped bone at the base of the skull). Sinus tumors will show as shades of gray indicating the difference in their density from that of normal tissues in the area.

### Brain studies

The precise differences in density allowed by CT scanning can clearly show tumors, strokes, or other lesions in the brain area as altered densities. These lighter or darker areas on the image may indicate a tumor or hemorrhage within the brain. Different types of tumors can be identified by the presence of edema, by the tissue's density, or by abnormal contrast enhancement. Congenital abnormalities in children, such as hydrocephalus, may also be confirmed with CT. Hydrocephalus is suggested by enlargement of the fluid structures, called ventricles, of the brain.

### Body scans

The body scan can identify abnormal body structures and organs. Throughout the body, a CT scan may indicate tumors or cysts; enlarged lymph nodes; abnormal collections of fluid, blood, or fat; and metastasis of cancer. Fractures or damage to soft tissues can be more easily seen on the sensitive images produced by CT scanning. Liver conditions, such as cirrhosis, abscess, and fatty liver, may be observed with a CT body scan.

### The aorta

CT provides the ability to visualize and measure the thickness of the aorta, which is very helpful in diagnosing aortic aneurysms. The use of contrast will help define details within the aorta. In addition, increased areas of density can identify calcification, which helps differentiate between acute and chronic problems. An abnormal CT scan may indicate signs of aortic clots. Aortic rupture is suggested by signs, such as a hematoma around the aorta or the escape of blood or contrast from its cavity.

### Chest scans

In addition to those findings which may indicate aortic aneurysms, chest CT studies can show other problems in the heart and lungs. The computer will not only show differences between air, water, tissues, and bone, but will also assign numerical values to the various densities. Mass lesions in the lungs may be indicative of tuberculosis or tumors. CT will help distinguish between the two. Enlarged lymph nodes in the chest area may indicate lymphoma. Spiral CT is particularly effective at identifying pulmonary emboli (clots in the lung's blood vessels).

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## Curettage and electrosurgery

### Definition

Curettage is the surgical removal of growths or tissue from the wall of a body cavity or other surface, using a spoon-like instrument with a sharp edge called a curette. Electrosurgery is a procedure that cuts, destroys, or cauterizes tissue using a high-frequency electric current applied locally with a pencil-shaped metal instrument or needle. When the two procedures are combined, the surgery is referred to as curettage and electrosurgery.

### Purpose

The general purpose of curettage is to scrape an area free of undesirable tissue. The purposes of electrosurgery are to destroy benign and malignant lesions, control bleeding, and cut or excise tissue.

Specifically, a curettage and electrosurgery procedure is used to treat the following conditions:

- benign skin lesions, such as angiomas, nevi, and warts
- actinic keratoses (AKs), which are premalignant skin lesions
- skin cancers, chiefly basal cell carcinoma (BCC) and cutaneous squamous cell carcinoma (SCC)
- genital warts that result from human papillomavirus (HPV) infection

### Demographics

Curettage—with or without electrosurgery—is the second most commonly used treatment in the United

## KEY TERMS

**Anesthesia**—A combination of drugs administered by a variety of techniques by trained professionals that provide sedation, amnesia, analgesia, and immobility adequate for the accomplishment of the surgical procedure with minimal discomfort, and without injury, to the patient.

**Anesthetics**—Drugs or methodologies used to make a body area free of sensation or pain.

**Basal cell carcinoma**—Basal cell carcinoma is the most common malignant tumor, affecting more than 800,000 people annually in the United States.

**Curettage**—Procedure performed with a curette, a spoon-shaped instrument used to scrape tissue.

**Cutaneous squamous cell carcinoma**—Malignant skin tumor of the epidermis or its appendages.

States. (Cryosurgery is the most commonly used treatment in the United States.)

Approximately 15% of actinic keratoses develop into squamous cell carcinoma. Based on current demographics in the United States, the incidence of actinic keratoses is expected to increase. Older individuals are more likely than younger ones to have actinic keratoses, because cumulative sun exposure increases with age. A survey of older Americans found keratoses in more than half of all men and more than a third of women between the ages of 65 and 74 who had a high degree of lifetime sun exposure. Some medical experts believe that the majority of people who live to the age of 80 have AKs.

Basal cell carcinoma is the most common form of skin cancer and the most common of all types of cancer. It affects about 800,000 individuals in the United States each year. BCC is primarily caused by chronic exposure to sunlight and until recently those most often affected were older, especially older men who worked outdoors. In the last several decades, the incidence of BCC among younger people has increased. So has the number of cases in women. However, many more men are still affected by BCC than women.

Squamous cell carcinoma is the second most common form of skin cancer, affecting more than 200,000 Americans each year. It too is most often caused by chronic exposure to sunlight.

Genital human papillomavirus infection is the most common sexually transmitted disease in the United States with about 55 million new cases reported

each year. Genital warts are the most easily recognized sign of HPV infection, but many people with HPV infection never develop genital warts. Both drugs and surgery are used to treat genital warts, but the warts often come back after treatment because the treatment only removes the warts and does not cure the underlying infection.

### Description

In the case of AK, the procedure is carried out under **local anesthesia** to reduce discomfort during curettage. First, the surgeon uses a curette to scrape off the undesirable AK cells down to the level of uninvolved tissue. This is followed by electrosurgery to widen the area of AK cell destruction and removal, and to cauterize the wound to limit bleeding.

In the treatment of skin cancers, curettage is used to scrape away the tumor cells and then an extra margin of surrounding tissue is destroyed by electrosurgery. These steps may be repeated several times in the same treatment session. Curettage and electrosurgery are considered suitable for small primary lesions on sun-exposed skin. It is less effective in the case of recurrent lesions that have attendant scar tissue. Tumors that have spread into subcutaneous tissues or subcutaneous fat are less likely to be cured when treated with this procedure.

The major techniques that may be involved in the electrosurgery step include electrodesiccation (removal of water), fulguration (production of a spark to destroy tissue), electrocoagulation (forming blood clots to stop bleeding), and electrosection (cutting). Electrosurgery can be used to incise, to shave, and to remove lesions. The correct output power is determined by starting at low power and increasing the power level until the desired result is achieved (destruction, coagulation, or cutting).

### Diagnosis/Preparation

Skin biopsies and histologic examination confirm diagnoses for AKs and skin cancers such as basal cell carcinoma. A recommendation for curettage and electrosurgery is made following patient evaluation.

Injectable lidocaine is administered before most curettage and electrosurgical procedures. Lidocaine is often used together with epinephrine to further reduce blood loss. Anesthesia may not be necessary when small lesions are being treated. Another alternative is to use a mixture of local anesthetics, containing 2.5% lidocaine and 2.5% prilocaine, in a cream base. The cream is applied to the skin at least one hour before the procedure to achieve topical anesthesia.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Curettage and electrosurgery is done in a hospital or clinic, although most physicians have small electrosurgical units in their offices to treat benign lesions. The procedure is usually performed by a dermatologist or dermatologic surgeon. The American Academy of Family Physicians and several private organizations offer basic training sessions in electrosurgery.

### Aftercare

After the procedure, the patient is advised to keep the wound clean and dry. The healing process takes at least several weeks or longer, depending on the size of the wound and other factors. Electrosurgery produces two types of skin wounds—partial- and full-thickness wounds. Partial-thickness wounds result from the electrodesiccation of skin lesions and the curettage and desiccation of basal cell carcinomas. These wounds may be cleansed daily and then covered with an antibiotic ointment that provides a moist environment for new tissue growth. The wound may then be covered with common adhesive **bandages**. Full-thickness wounds require closure with sutures.

### Risks

As with every type of surgical procedure, there is a risk of infection. **Antibiotics** are not routinely given, but some physicians believe they may minimize the risk. Other potential risks include:

- Subcutaneous bleeding. If it occurs, subcutaneous bleeding may create a hematoma and require the wound to be reopened and drained.
- Temporary or permanent nerve damage. This may result from excision in an area with extensive nerves.
- Wounds that reopen. If this occurs, the risk of infection and scarring increases.
- Scarring.

### Normal results

Curettage and electrosurgery results in the removal of the targeted skin lesion, AK, skin cancer, or genital wart and in the formation of a minor wound that heals rapidly after the procedure.

## QUESTIONS TO ASK THE DOCTOR

- How is the procedure performed?
- Why is curettage and electrosurgery required?
- What are the risks of the procedure?
- Is curettage painful?
- What are the alternative treatments?
- How long will it take to recover from the surgery?
- What are the after-effects of the surgery?
- How many curettage and electrosurgery procedures do you perform each year?

### Alternatives

Alternative treatment for AKs include:

- cryosurgery, the most common method of treating AKs in the United States
- dermabrasion, a procedure performed with an instrument that removes skin with a rapidly rotating brush
- laser removal, a treatment that uses the infrared beam of a carbon dioxide laser to destroy AK cells
- surgical excision, an uncommon treatment for AKs, used only if the lesions are very thick or difficult to remove by other means

Alternative treatment for skin cancers include:

- cryosurgery, a treatment that uses subfreezing temperature to destroy the tumor
- surgical excision, a procedure useful for both primary and recurrent tumors
- Mohs micrographic surgery, a treatment used to deal with some recurrent lesions
- laser surgery, a procedure that uses a laser to excise or destroy the tumor
- radiation therapy, a treatment that is useful for definitive treatment of primary tumors and some recurrent cancers
- interferon therapy, a drug therapy that prevents the growth of cancerous cells
- photodynamic therapy, a treatment in which the patient is given a photoactive compound followed by photoirradiation

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- American Academy of Dermatology Association. 1350 I Street NW, Suite 880, Washington, DC 20005. (202) 842-3555. <http://www.aadassociation.org/>.
- American College of Obstetricians and Gynecologists. 409 12th St., S.W., PO Box 96920 Washington, D.C. 20090-6920. (312) 786-1468. <http://www.acog.com/>.
- American Society for Dermatologic Surgery (ASDS). 5550 Meadowbrook Dr., Suite 120, Rolling Meadows, IL 60008. (847) 956-0900. <http://www.asds.net.org>.
- National Association for Women's Health. 300 W. Adams Street, Suite 328, Chicago, IL 60606-5101. (312) 786-1468. <http://www.nawh.org/>.

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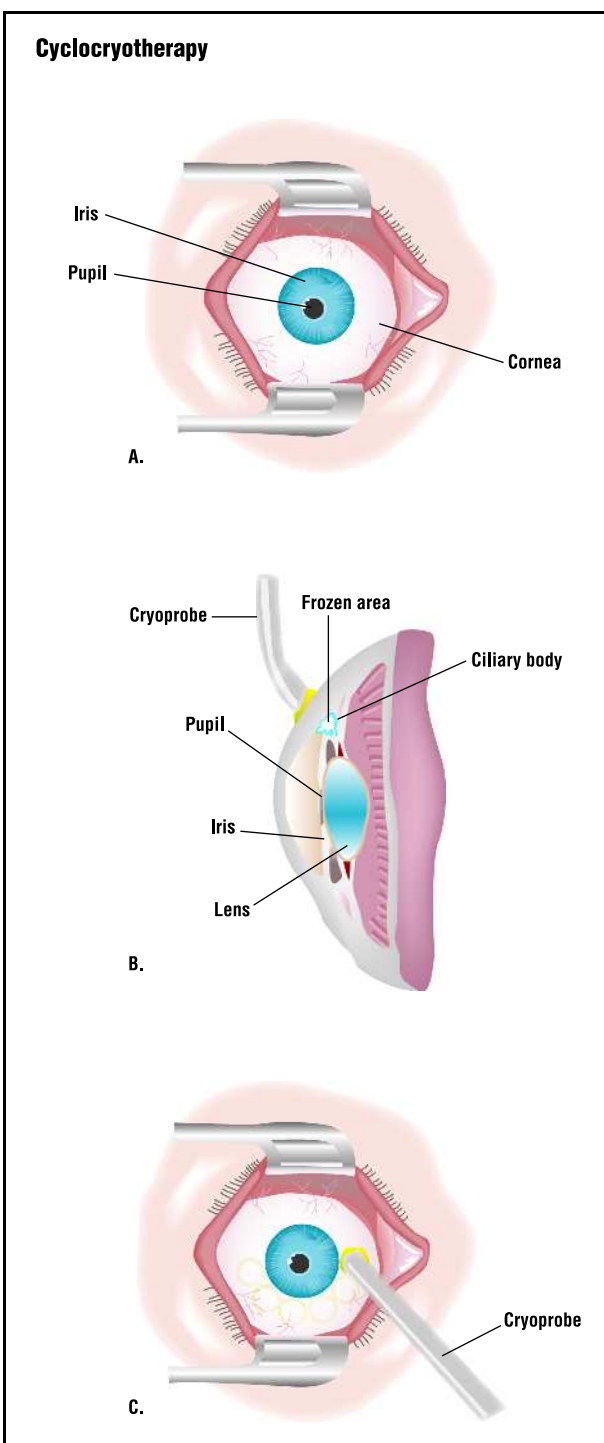
Monique Laberge, Ph.D.

## Cyclocryotherapy

### Definition

Cyclocryotherapy (CCT) is a procedure that employs temperatures as low as -112°F (-80°C) to destroy the ciliary body, an organ in the anterior chamber of the eye behind the iris, which produces aqueous fluid. A certain





For cyclocryotherapy, the patient's eyelids are first retracted (A). A cryoprobe is applied to the outside of the eyeball in the area surrounding the iris (B). The probe freezes ciliary bodies in 50-60 seconds. The probe is applied to adjoining sites in a semicircle around the iris during one treatment (C). (Illustration by GGS Information Services. Cengage Learning, Gale.)

amount of fluid is required to maintain the integrity of the eye, but an increase in intraocular fluid leads to an elevation in intraocular pressure (IOP); elevated IOP is a major cause of glaucoma. Ablation, or destruction, of part of the ciliary body lowers the IOP by decreasing the fluid or aqueous humor within the eye and thus helping to control glaucoma. The main purpose of CCT is to treat uncontrolled or refractory glaucoma. It is also used to reduce ocular pain in some patients with end-stage glaucoma.

Glaucoma is a general term used to describe a group of potentially blinding diseases, the main sign of which is a relatively high intraocular pressure. This increase in IOP causes damage to the optic nerve and the surrounding retinal tissue. In end-stage glaucoma, a patient's visual field is severely restricted. The increased intraocular pressure usually is caused by increased aqueous fluid in the eye. Treatment of glaucoma involves medical or surgical strategies to either increase the outflow of fluid from the eye, or to decrease the production of fluid in the eye, in an attempt to lower the IOP. The objective of glaucoma treatment is to attain an intraocular fluid level low enough such that damage to the optic nerve does not occur, yet is high enough such that the integrity of the eye is not sacrificed.

CCT is a last-resort treatment for patients in whom conventional medical and surgical techniques to control glaucoma have failed. Medical treatment involves the use of eyedrops that may be administered from one to four times a day. Surgical techniques are used to treat glaucoma when the number of eyedrops becomes cumbersome to the patient, or if patient compliance with medical therapy is difficult, or if medical therapy is not effective in lowering the IOP. One non-cyclodestructive surgical technique is filtration surgery, a procedure in which an outlet for the aqueous fluid is made through the sclera, the white fibrous covering of the anterior part of the eye. Another such procedure is argon laser trabeculoplasty, in which laser burns are made on the trabecular meshwork, the major drainage system to increase the number of drainage ports from the eye. Both these procedures promote outward flow of the intraocular fluid, decreasing the IOP.

In congenital glaucoma, other procedures that open up the fluid flow within the eye such as **goniotomy** or trabeculotomy are performed. Many patients with congenital glaucoma, due to a defect in the interior structure of the eye, have a limited ability to drain the aqueous fluid sufficiently. For pediatric patients, trabeculoplasty is not successful because the maturing eye will attempt to close the outlet. CCT may be performed on patients for which cyclophotocoagulation, another method of cyclodestruction, is not an

## KEY TERMS

**Ciliary body**—The part of the eye, located behind the iris, that makes the intraocular aqueous fluid.

**Cyclocryotherapy**—The use of subfreezing temperatures to treat glaucoma.

**Glaucoma**—A group of ocular diseases with which an increase in intraocular pressure causes a restriction in visual field and can lead to blindness.

**Intraocular pressure (IOP)**—The pressure inside the eye as measured by tonometry.

**Ophthalmologist**—A medical doctor with advanced training in the diagnosis and treatment of eye disease.

**Neovascular glaucoma**—A form of glaucoma that results from uncontrolled diabetes or hypertension.

**Sclera**—The white fibrous covering of the anterior part of the eye; it surrounds the cornea.

option or not available. Many patients on whom this technique is employed have neovascular glaucoma, a type of glaucoma that is a result of uncontrolled diabetes or hypertension.

### Purpose

The main purpose of CCT is to treat uncontrolled or refractory glaucoma. It is also used to reduce pain in some patients with end-stage glaucoma. This procedure lowers the intraocular pressure by destroying the source of intraocular fluid, the ciliary body, and subsequently lowering the intraocular pressure, as well as decreasing the pain of patients with some glaucomas, the most notable of which is neovascular glaucoma.

### Demographics

Patients who undergo CCT are patients for whom certain techniques such as filtration surgery are contraindicated or for which other medical and surgical procedures have not been successful. Patients with neovascular glaucoma and congenital glaucoma make up a large percentage of the patients who undergo CCT. Because of the risks involved, cyclocryotherapy should not be performed on patients who have the potential for good vision, or on individuals who have had cataract surgery with intraocular lens implantation. CCT is a last-resort technique employed on patients for whom all other strategies have failed.

### Description

Cyclocryotherapy is usually performed while the patient is awake and supine (laying down on the back). Prior to doing CCT, the doctor will inject an anesthetic into the posterior part of the eye; however, CCT may be performed under **general anesthesia** for anxious adults and for children. In performing the procedure, the surgeon locates the ciliary body with a lighted instrument and then applies a cryoprobe with a temperature of  $-112^{\circ}\text{F}$  ( $-80^{\circ}\text{C}$ ) to the sclera of the eye. This probe is applied to the eye several times in a clockwise manner, using moderate pressure, carefully avoiding the area of the eye where the extraocular muscles, which control movement of the eye, attach to the eye. Each application by the probe lasts 50–60 seconds and usually only half of the eye is treated during the initial attempt; for less severe glaucoma and in older patients who respond better to this treatment, only a quarter of the eye will be treated. The surgeon leaves at least one quadrant of the eye untreated.

Immediately after surgery, a steroid is injected into the eye to reduce inflammation, and an eyedrop or ointment such as atropine is applied to the eye to maintain dilation of the eye. Some surgeons may inject into the eye an anesthetic that numbs the entire eye, including the muscles. This injection has many risks associated with it, such as a droopy eyelid and an increased risk of corneal ulcers.

### Diagnosis/Preparation

Cyclocryotherapy is a procedure of last resort in glaucoma patients. When all other therapies available to the patient have failed, CCT is considered, especially if the patient's vision is poor, i.e., less than 20/200, since there is a high risk of vision loss associated with this procedure. Patients and/or legal guardians of the patient are informed of the inherent risks and benefits, and CCT is performed only after **informed consent**. In preparation for CCT, the patient continues with all glaucoma medications up to the day of the procedure.

### Aftercare

It is important that the patient continue with most topical glaucoma medications after surgery because a significant spike in IOP is expected after cyclocryotherapy. Glaucoma medications that should not be continued include miotics, which constrict the pupil and thus act in opposition to atropine, and drops derived from prostaglandins, which have very limited effect in some forms of glaucoma, especially neovascular glaucoma. Steroids are administered to the eye to reduce the risk of

inflammation. Atropine, which dilates or enlarges the pupil and decreases post-operative discomfort, may be used a few times a day. Atropine and steroids are continued for a month after surgery.

As the retrobulbar anesthesia wears off, usually within 12 hours, **acetaminophen** (Tylenol) may be required for pain. In patients for whom the potential for good vision is unlikely and in whom the CCT is done to eliminate pain, the doctor may inject alcohol into the eye for continued pain relief.

Patients are seen for follow-up visits at a minimum of one day, one week, and one month after surgery. Sometimes the procedure needs to be repeated and, if this is the case, it should be done no sooner than one month after the first attempt. The area that was treated initially is treated again and may be expanded to include a third quadrant.

### Risks

The risks of this procedure are greater than for other types of glaucoma treatment. The most common side effect is pain after the procedure. A common risk of CCT is hypotony, which is a low level of fluid in the eye that can lead to phthisis bulbi, a condition in which the fluid level in the eye reaches a dangerously low level, such that the integrity of the eye is compromised. Other risks to consider are retinal detachment, inflammation of the iris, cataract formation, macular edema, and swelling of the cornea. The risk of inflammation within the eye is greater for diabetics. Loss of visual acuity, including total vision loss, is an associated risk of any of the previously mentioned risks and occurs in up to 67% of patients.

Patients with darker irises will have more side effects from this procedure, and pediatric patients with aniridia, or no iris, also have an increased rate of complications. Individuals who are aphakic, meaning they have had cataract extraction without a subsequent intraocular lens implantation, have fewer complications than patients with an intact lens.

### Normal results

Normal results of cyclocryotherapy would be a reduction in the IOP and decreased intraocular pain. The overall success rate of CCT to reduce IOP in glaucoma patients is reported to be from 34% to 92%. Approximately 70% of patients with neovascular glaucoma have an IOP reduction of at least 50%. A determination of whether or not the surgery has been effective may not be clear until a month after CCT is performed; retreatment is required in up to one-third of adult patients. Repeated procedures increase the success of

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

This procedure is performed by an ophthalmologist in an office setting. Many ophthalmologists who perform glaucoma surgery have had an additional year of subspecialty training specific to the treatment of glaucoma.

the surgery. CCT is successful in 90% of patients after a second surgery and in 95% after the third treatment. Among pediatric patients who undergo CCT, the success rate is only 30–44%, as the ciliary body of the child is more resistant to damage by **cryotherapy**, and thus repeat applications are more common.

### Morbidity and mortality rates

Within four years of treatment, hypotony will occur in up to 12% of all patients who undergo CCT, but is seen in up to 40% of patients with neovascular glaucoma. Up to two-thirds of patients will lose some visual acuity after CCT; many of them will have vision worse than 20/400. About 20% of patients who have had cyclocryotherapy will develop cataracts.

### Alternatives

An alternative to cyclocryotherapy is cyclophotocoagulation. This is another cyclodestructive procedure that employs the thermal energy of a laser instead of the freezing temperature of cryotherapy to ablate, or destroy, a part of the ciliary body. Cyclophotocoagulation is performed with the patient seated at the slit lamp biomicroscope. The eye is anesthetized prior to performing the procedure. In one type of cyclophotocoagulation, a fiberoptic laser endoscope is passed into the eye to help the surgeon visualize the interior of the eye. The energy of a laser passes through the endoscope and destroys the ciliary body directly. In another type of cyclodestruction, the energy of a diode laser is applied to the ciliary body through the sclera without the use of an endoscope.

Cyclophotocoagulation is as effective as CCT without as many of the complications inherent in CCT. The risks of transient elevation of intraocular inflammation and intraocular inflammation itself are decreased with this procedure over CCT for adult patients, but the risks associated with this procedure for pediatric patients are comparable to CCT. The

## QUESTIONS TO ASK THE DOCTOR

- How many of these procedures have you performed?
- Do you have advanced training in glaucoma surgery?
- Is CCT the best surgical procedure to treat my glaucoma or that of my child?
- What will vision be like after surgery?

cyclophotocoagulation procedure is not as painful as CCT.

Surgical removal of the part of the ciliary body is another alternative that is not often used. It is effective in lowering IOP, but the rate of complications such as hemorrhages in the vitreous, hypotony, and retinal detachment is high.

Therapeutic **ultrasound** can also be used to reduce the IOP in glaucoma patients, though the mechanism in which the IOP is lowered in this procedure is not clear.

In end-stage neovascular glaucoma patients who have no useful vision, medical treatment of pain control may sometimes be attained with the use of atropine and topical steroids alone. Retrobulbar injection of alcohol is sometimes necessary and, as a last resort in painful eyes without useful vision, enucleation, or removal, of the eye is required.

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Martha Reilly, OD

Cyclosporine see **Immunosuppressant drugs**  
Cyst removal see **Ganglion cyst removal**

## Cystectomy

### Definition

Cystectomy is a surgical procedure that removes all or part of the urinary bladder, the muscular organ that collects urine from the kidneys for excretion at a later time. Partial or segmental cystectomy removes part of the bladder; simple cystectomy removes the entire bladder; and radical cystectomy removes the bladder as well as other pelvic organs or structures.

### Purpose

Cystectomy is most commonly performed to treat cancer of the bladder. Once a patient has been diagnosed with bladder cancer, a staging system is used to indicate how far the cancer has spread and determine appropriate treatments. Superficial tumors isolated to the inner lining of the bladder (stage 0 or I) may be treated with non-surgical therapies such as chemotherapy or radiation, or with partial or simple cystectomy. Radical cystectomy is the standard treatment for cancer that has invaded the bladder muscle (Stage II, III, or IV). Muscle-invasive cancer accounts for 90% of all bladder cancers.

Other conditions that may require cystectomy include interstitial cystitis (chronic inflammation of the bladder), endometriosis that has spread to the bladder, severe urinary dysfunction, damage to the



## KEY TERMS

**Endometriosis**—A condition in which cells from the inner lining of the uterus grow elsewhere in the body.

**Lymph nodes**—Small organs located throughout the body that can filter out cancer cells and bacteria.

**Ureters**—Tubes that connect the kidneys to the bladder; urine produced by the kidneys passes through the ureters to the bladder.

bladder from radiation or other treatments, or excessive bleeding from the bladder.

## Demographics

Approximately 56,500 cases of urinary bladder cancer are diagnosed in the United States annually, with approximately 12,600 men and women **dying** of the disease each year. Men are more often diagnosed with bladder cancer (2.6 men for each woman diagnosed), and they also have a higher mortality rate (two men for each woman that dies). The average age that the disease is diagnosed is 65 years.

More cases of bladder cancer are found among white men and women. The Centers for Disease Control and Prevention (CDC) reported that from 1992–1999, whites were diagnosed with bladder cancer at a rate of 21.9 per 100,000 persons, while African Americans had a rate of only 12.4 per 100,000. The mortality rate, however, is similar among white and African-American patients (4.5 and 4.1 per 100,000 persons), respectively.

## Description

### *Partial cystectomy*

During partial or segmental cystectomy, only the area of the bladder where the cancer is found is removed. This allows for most of the bladder to be preserved. Because the cancer must not have spread to the bladder muscle and must be isolated to one area, partial cystectomy is only used infrequently for the patients who meet these select criteria.

The patient is first placed under **general anesthesia**. After an incision is made into the lower abdomen, the bladder is identified and isolated. The surgeon may choose to perform the operation with the bladder remaining inside the abdominal cavity (transperitoneal approach) or with the bladder lifted outside of the abdominal cavity (extraperitoneal approach). The

cancerous area is excised (cut out) with a 0.8 in (2 cm) margin to ensure that all abnormal cells are removed. The bladder is then closed with **stitches**. The pelvic lymph nodes may also be removed during the procedure. After the cancerous tissue is removed, it is examined by a pathologist to determine if the margins of the tissue are clear of abnormal cells.

### *Simple or radical cystectomy*

While partial cystectomy is considered a bladder-conserving surgery, simple and radical cystectomy involves the removal of the entire bladder. In the case of radical cystectomy, other pelvic organs and structures are also removed because of the tendency of bladder cancer to spread to nearby tissues. After the patient is placed under general anesthesia, an incision is made into the lower abdomen. Blood vessels leading to and from the bladder are ligated (tied off), and the bladder is divided from the urethra, ureters, and other tissues holding it in place. The bladder may then be removed.

The surgical procedure for radical cystectomy differs between male and female patients. In men, the prostate, seminal vesicles, and pelvic lymph nodes are removed with the bladder. In women, the uterus, fallopian tubes, ovaries, anterior (front) part of the vagina, and pelvic lymph nodes are removed with the bladder. If the surgery is being performed as a treatment for cancer, the removed tissues may be examined for the presence of abnormal cells.

### *Urinary diversion*

Once the bladder is removed, a new method for excreting urine must be created. One commonly used approach is the ileal conduit. A piece of the small intestine is removed, cleaned, and tied at one end to form a tube. The other end is used to form a stoma, an opening through the abdominal wall to the outside. The ureters are then connected to the tube. Urine produced by the kidneys flows down the ureters, into the tube, and through the stoma. The patient wears a bag to collect the urine.

For continent cutaneous diversion, a pouch is constructed out of portions of the small and large intestine; the ureters are connected to the pouch and a stoma is created through the abdominal wall. Urine is removed by inserting a thin tube (catheter) into the stoma when the pouch is full. Alternatively, a similar pouch called a neobladder may be created, attached to both the ureters and the urethra, in an attempt to preserve as close to normal bladder function as possible.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Cystectomy is performed in a hospital operating room by a urologist, a medical doctor who has completed specialized training in the diagnosis and treatment of diseases of the urinary tract and genital organs.

### Diagnosis/Preparation

The medical team will discuss the procedure and tell the patient where the stoma will appear and what it will look like. The patient will receive instruction on caring for a stoma and bag. A period of fasting and an enema may be required.

### Aftercare

After the operation, the patient is given fluid-based nutrition until the intestines begin to function normally again. **Antibiotics** are given to prevent infection. The nature of cystectomy means that there will be major lifestyle changes for the person undergoing the operation. Men may become impotent if nerves controlling penile erection are cut during removal of the bladder. Infertility is a consequence for women undergoing radical cystectomy because the ovaries and uterus are removed. Most women who undergo cystectomy, however, are postmenopausal and past their childbearing years.

Patients are fitted with an external bag that connects to the stoma and collects the urine. The bag is generally worn around the waist under the clothing. It takes a period of adjustment to get used to wearing the bag. Because there is no bladder, urine is excreted as it is produced. The stoma must be treated properly to ensure that it does not become infected or blocked. Patients must be trained to care for their stoma. Often, there is a period of psychological adjustment to the major change in lifestyle created by the stoma and bag. Patients should be prepared for this by their physician.

### Risks

As with any major surgery, there is a risk of infection; in this case, infection of the intestine is especially dangerous as it can lead to peritonitis (inflammation of the membrane lining the abdomen). In the case of partial cystectomy, there is a risk of urine leakage from the bladder incision site. Other risks include injury to nearby organs, complications associated with general

## QUESTIONS TO ASK THE DOCTOR

- Why is cystectomy recommended in my case?
- In the case of radical cystectomy, what other organs/structures will be removed?
- What method of urinary diversion will be performed?
- What non-surgical options are available to me?
- How long after surgery may I resume normal activity?

anesthesia (such as respiratory distress), excessive blood loss, sexual dysfunction, or urinary incontinence (inadvertent leakage of urine).

### Normal results

During a successful partial cystectomy, the cancerous or damaged area of the bladder is removed and the patient retains urinary control. A successful simple or radical cystectomy results in the removal of the bladder and the creation of a urinary diversion, with little or no effect on sexual function. Intestinal function returns to normal and the patient learns proper care of the stoma and bag. He or she adjusts to lifestyle changes and returns to a normal routine of work and recreation.

### Morbidity and mortality rates

The overall rate of complications associated with radical cystectomy may be as high as 25–35%; major complications occur at a rate of 5%. The rate of radical cystectomy-related deaths is 1–3%. Partial cystectomy has a complication rate of 11–29%. Some studies have placed the rate of cancer reoccurrence after partial cystectomy at 40–80%.

### Alternatives

Transurethral resection (TUR) is one method that may be used to treat superficial bladder tumors. A cystoscope (a thin, tubular instrument used to visualize the interior of the bladder) is inserted into the bladder through the urethra and used to remove any cancerous tissue. Non-surgical options include chemotherapy and radiation.

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## Cystocele repair

**Definition**

A cystocele is the protrusion or prolapse of the bladder into the vagina. A number of surgical interventions are available to treat cystoceles.

**Purpose**

A prolapse occurs when an organ falls out of its normal anatomical position. The pelvic organs normally have tissue (muscle, ligaments, etc.) holding them in place. Certain factors, however, may cause those tissues to weaken, leading to prolapse of the organs. A cystocele may be the result of a central or lateral (side) defect. A central defect occurs when the bladder protrudes into the center of the anterior (front) wall of the vagina due to a defect in the

pubocervical fascia (fibrous tissue that separates the bladder and vagina). The pubocervical fascia is also attached on each side to tough connective tissue called the arcus tendineus; if a defect occurs close to this attachment, it is called a lateral or paravaginal defect. A central and lateral defect may be present simultaneously. The location of the defect determines what surgical procedure is performed.

Factors that are linked to cystocele development include age, repeated childbirth, hormone deficiency, menopause, constipation, ongoing physical activity, heavy lifting, and prior **hysterectomy**. Symptoms of bladder prolapse include stress incontinence (inadvertent leakage of urine with physical activity), urinary frequency, difficult urination, a vaginal bulge, vaginal pressure or pain, painful sexual intercourse, and lower back pain. Urinary incontinence is the most common symptom of a cystocele.

Surgery is generally not performed unless the symptoms of the prolapse have begun to interfere with daily life. A staging system is used to grade the severity of a cystocele. A stage I, II, or III prolapse descends to progressively lower areas of the vagina. A stage IV prolapse descends to or protrudes through the vaginal opening. Surgery is generally reserved for stage III and IV cystoceles.

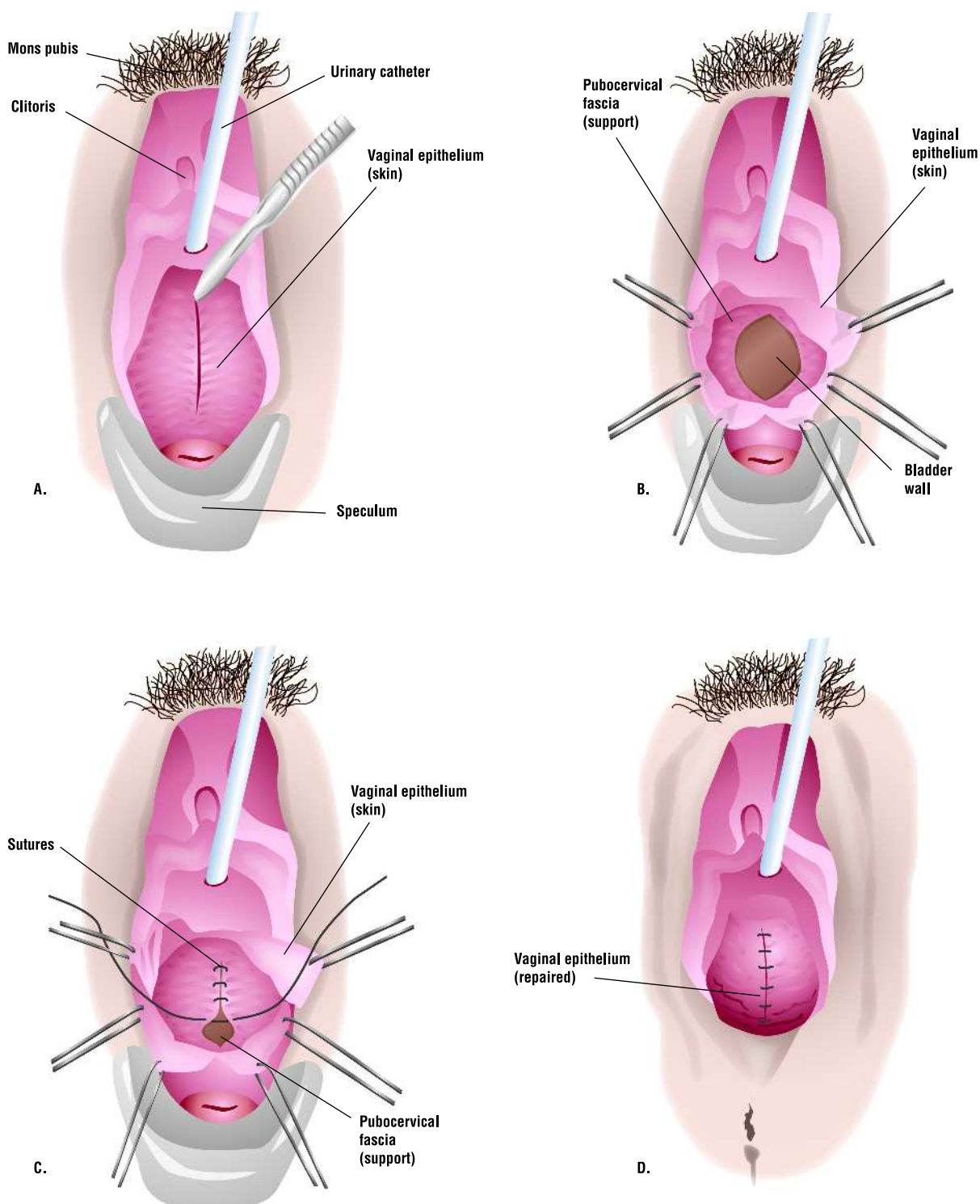
**Demographics**

Approximately 22.7 out of every 10,000 women will undergo pelvic prolapse surgery. The rate is highest among women between 60 and 69 years of age (42 per 10,000); the mean age of patients is 54.6. White women undergo pelvic prolapse surgery at a rate of 19.6 per 10,000 and a mean age of 54.3, while 6.4 per 10,000 African American women have surgery at a mean age of 49.3.

A 2002 study indicated cystocele repair accounts for 8% of all prolapse repair surgeries; in 1997, approximately 18,500 cystocele repairs were performed. Cystocele repair was combined with **rectal prolapse repair** in 10% of prolapse surgeries, with hysterectomy (surgical removal of the uterus) in 6%, and with both procedures in 16%.

**Description**

The goals of cystocele repair are to relieve a patient's symptoms, to improve or maintain urinary and sexual function, to return pelvic structures to their original position, and to prevent the formation of new defects. The anatomical structures involved in a cystocele may be approached vaginally, abdominally, or laparoscopically.

**Cystocele repair**

In this cystocele repair by anterior colporrhaphy, a speculum is used to hold open the vagina, and the cystocele is visualized (A). The wall of the vagina is cut open to reveal an opening in the supporting structures, or fascia (B). The defect is closed (C), and the vaginal skin is repaired (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)



## KEY TERMS

**Burch procedure**—A surgical procedure, also called retropubic colposuspension, in which the neck of the bladder is suspended from nearby ligaments with sutures. It is performed to treat urinary incontinence.

**Colporrhaphy**—A surgical procedure in which the vagina is sutured.

**Ligaments**—Tough fibrous connective tissue.

**Magnetic resonance imaging**—A specialized imaging technique used to visualize internal structures; it is considered superior to the standard x ray.

**Pubocervical fascia**—Fibrous tissue that separates the vagina and the bladder.

**Ultrasound**—A procedure that uses high-frequency sound waves to visualize structures in the human body.

**Speculum**—A retractor used to separate the walls of the vagina and aid in visual examination.

### *Vaginal repair*

Anterior **colporrhaphy** is the most common procedure to repair a central defect. The patient is first given general or regional anesthesia. A speculum is inserted into the vagina to hold it open during the procedure. An incision is made into the vaginal skin and the defect in the underlying fascia is identified. The vaginal skin is separated from the fascia and the defect is folded over and sutured (stitched). Any excess vaginal skin is removed and the incision is closed with **stitches**.

Lateral defects may be repaired vaginally or abdominally. During a vaginal paravaginal repair, the approach and initial incision are similar to anterior colporrhaphy. The defect to the fascia is located and reattached to the arcus tendineus using sutures. The incision may then be stitched closed.

### *Abdominal and laparoscopic repair*

A cystocele caused by a lateral defect may be treated through an abdominal incision made transversely (from side to side) just above the pubic hairline. The space between the pubic bone and bladder is identified and opened and the pubocervical fascia reattached to the arcus tendineus using methods similar to the vaginal paravaginal repair. In some cases, a retropubic colposuspension is performed during the same surgery. Also called a Burch procedure, colposuspension treats urinary incontinence by suspending

the bladder neck to nearby ligaments with sutures. Other surgical treatments for incontinence may be combined with paravaginal repair.

A lateral defect may also be repaired by **laparoscopy**, a surgical procedure in which a laparoscope (a thin, lighted tube) and various instruments are inserted into the abdomen through small incisions. A patient's recovery time following laparoscopic surgery is shorter and less painful than following a traditional laparotomy (a larger surgical incision into the abdominal cavity).

## Diagnosis/Preparation

**Physical examination** is most often used to diagnose a cystocele. A speculum is inserted into the vagina and the patient is asked to strain or sit in an upright position; this increase in intra-abdominal pressure maximizes the degree of prolapse and aids in diagnosis. The physician then inspects the walls of the vagina for prolapse or bulging.

In some cases, a physical examination cannot sufficiently diagnose pelvic prolapse. For example, cystography may be used to determine the extent of a cystocele; the bladder is filled by urinary catheter with contrast medium and then x rayed. **Ultrasound** or **magnetic resonance imaging** may also be used to visualize the pelvic structures.

Women who have gone through menopause may be given six weeks of estrogen therapy prior to surgery; this is thought to improve circulation to the vaginal walls and thus improve recovery time. **Antibiotics** may be administered to decrease the risk of postsurgical infection. An intravenous (IV) line is placed and a Foley catheter is inserted into the bladder directly preceding surgery.

## Aftercare

A Foley catheter may remain for one to two days after surgery. The patient is given a liquid diet until normal bowel function returns. The patient also is instructed to avoid activities for several weeks that cause strain on the surgical site; these include lifting, coughing, long periods of standing, sneezing, straining with bowel movements, and sexual intercourse.

## Risks

Risks of cystocele repair include potential complications associated with anesthesia, infection, bleeding, injury to other pelvic structures, dyspareunia (painful intercourse), recurrent prolapse, and failure to correct the defect.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Cystocele repair is usually performed in a hospital operating room by a gynecologist, urologist, or urogynecologist. A gynecologist is a medical doctor who specializes in the areas of women's general and reproductive health, pregnancy, and labor and childbirth. A urologist is a medical doctor who specializes in the diagnosis and treatment of diseases of the urinary tract and genital organs. A urogynecologist studies aspects of both fields.

### Normal results

A woman usually is able to resume normal activities, including sexual intercourse, in about four weeks after the procedure. After successful cystocele repair, symptoms recede, although a separate procedure may be needed to treat stress incontinence.

### Morbidity and mortality rates

The risk of cystocele recurrence following surgical repair depends on the procedure used to treat it. Anterior colporrhaphy is associated with a 0–20% rate of recurrence; this rate is higher when colporrhaphy is combined with other surgical procedures. Abdominal paravaginal repair results in a 5% chance of recurrence, while vaginal paravaginal repair has the highest recurrence rate (7–22%).

### Alternatives

Surgery is generally reserved for more severe cystoceles. Milder cases may be treated by a number of medical interventions. The physician may recommend that the patient do Kegel exercises, a series of contractions and relaxations of the muscles in the perineal area. These exercises are thought to strengthen the pelvic floor and may help prevent urinary incontinence.

A pessary, a device that is inserted into the vagina to help support the pelvic organs, may be recommended. Pessaries come in different shapes and sizes and must be fitted to the patient by a physician. Hormone replacement therapy may also be prescribed if the woman has gone through menopause; hormones may improve the quality of the supporting tissues in the pelvis.

## QUESTIONS TO ASK THE DOCTOR

- What defect is causing the cystocele?
- What surgical procedure is recommended for treatment?
- Will other procedures be performed to treat urinary incontinence (e.g. Burch procedure)?
- What nonsurgical alternatives are available?
- How soon after surgery may normal activities be resumed?

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## Cystoscopy

### Definition

Cystoscopy (cystourethroscopy) is a diagnostic procedure that uses a cystoscope, which is an endoscope especially designed for urological use to examine the bladder, lower urinary tract, and prostate gland. It can also be used to collect urine samples, perform biopsies, and remove small stones.

### Purpose

Cystoscopy is performed by urologists to examine the entire bladder lining and take biopsies of any questionable areas. Cystoscopy may be prescribed for patients who display the following conditions:

- blood in the urine (hematuria)
- inability to control urination (incontinence)
- urinary tract infection (UTI)
- signs of congenital abnormalities in the urinary tract
- suspected tumors in the bladder
- bladder or kidney stones
- signs or symptoms of an enlarged prostate
- pain or difficulty urinating (dysuria)
- disorders of or injuries to the urinary tract
- symptoms of interstitial cystitis

Blood and urine studies, in addition to x rays of the kidneys, ureters, and bladder, may be performed before a cystoscopy to obtain as much diagnostic information as possible. During the cystoscopy, a retrograde pyelogram may also be performed to examine the kidneys and ureters.

### Description

There are two types of cystoscopes used to carry out the procedure, a rigid type and a flexible type. Both types are used for the same purposes and differ only in their method of insertion. The rigid type requires that the patient adopt the lithotomy position, meaning that the patient lies on his or her back with knees up and apart. The flexible cystoscope does not require the lithotomy position.

A cystoscopy typically lasts from 10–40 minutes. The patient is asked to urinate before surgery and advised that relaxing pelvic muscles will help make this part of the procedure easier. A well-lubricated flexible or rigid cystoscope (urethroscope) is passed through the urethra into the bladder where a urine sample is taken. There may be some discomfort as the instrument is inserted. Fluid is then injected to

inflate the bladder and allow the urologist to examine the entire bladder wall. The cystoscope uses a lighted tip for guidance and enables biopsies to be taken or small stones to be removed through a hollow channel in the cystoscope.

During a cystoscopy, the urologist may remove bladder stones or kidney stones, gather tissue samples, and perform x-ray studies. To remove stones, an instrument that looks like a tiny basket or grasper is inserted through the cystoscope so that small stones can be extracted through the scope's channel. For a biopsy, special forceps are inserted through the cystoscope to pinch off a tissue sample. Alternatively, a small brush-like instrument may be inserted to scrape off some tissue. To perform x-ray studies such as a retrograde pyelogram, a dye is injected into the ureter by way of a catheter passed through the cystoscope. After completion of all required tests, the cystoscope is removed.

### Preparation

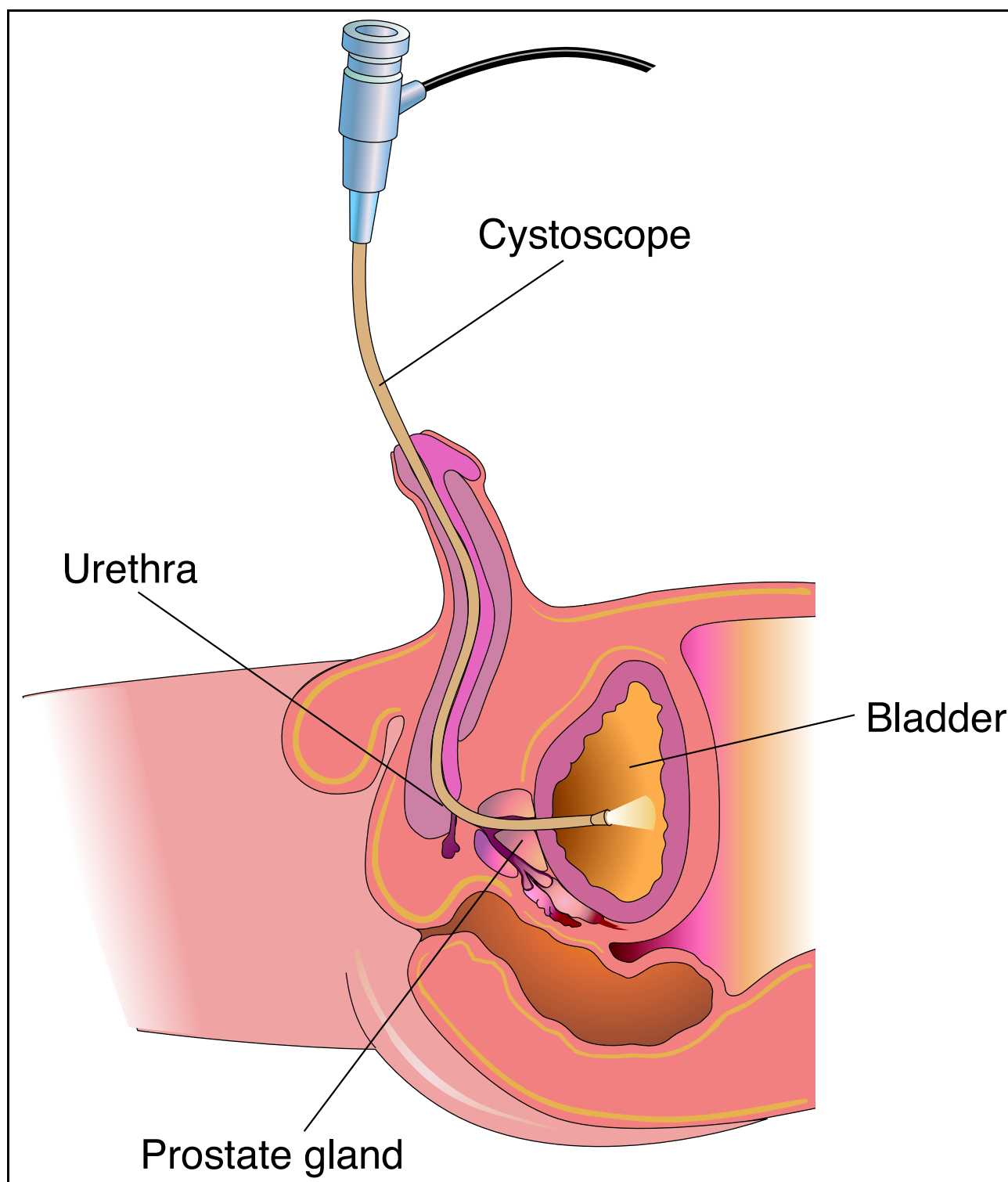
Before cystoscopy, patients may be asked to give a urine sample to check for infection and to avoid urinating for an hour before the procedure. A sedative may be given about one hour prior to the operation to help the patient relax. The region of the urethra is cleansed and a local anesthetic is applied. Spinal or **general anesthesia** may also be used for the procedure. Distension of the bladder with fluid is particularly painful, and if it needs to be done, as in the case of evaluating interstitial cystitis, general anesthesia is required. A signed consent form is necessary for this procedure.

### Aftercare

After removal of the cystoscope, the urethra is usually sore, and patients should expect to feel a burning sensation while urinating for one or two days following the procedure. To alleviate discomfort or pain, patients may be prescribed pain medication, and **antibiotics** may also be required to prevent infection. Minor pain may also be treated with over-the-counter, nonprescription drugs such as **acetaminophen**. To relieve discomfort, patients may be advised to drink two 8-oz glasses of water each hour for two hours and to take a warm bath to relieve the burning feeling. If not able to bathe, they may be advised to hold a warm, damp washcloth over the urethral opening.

Patients who have undergone a cystoscopy are instructed to:

- take warm baths to relieve pain.
- rest and refrain from driving for several days, especially if general anesthesia was used.



Cystoscopy is a diagnostic procedure which is used to view the bladder, collect urine samples, and examine the prostate gland. This procedure also enables biopsies to be taken. The primary instrument used in cystoscopy is the cystoscope, a tube which is inserted through the penis into the urethra, and ultimately into the bladder. (Illustration by Electronic Illustrators Group. Cengage Learning, Gale.)



## KEY TERMS

**Anesthetic**—A drug that causes loss of sensation. It is used to lessen the pain of surgery and other medical procedures.

**Bladder**—The bladder is located in the lower part of the abdomen; it is a structure like a small balloon that collects urine for temporary storage and is emptied from time to time by urinating.

**Catheter**—A tubular, flexible surgical instrument for withdrawing fluids from (or introducing fluids into) a body cavity, especially one for introduction into the bladder through the urethra for the withdrawal of urine.

**Cystoscope**—Endoscope especially designed for urological use to examine the bladder, lower urinary tract, and prostate gland.

**Diverticula**—A pouch or sac occurring normally or from a herniation or defect in a membrane.

**Endoscope**—A highly flexible, thin viewing instrument used to see inside body cavities.

**Endoscopy**—A minimally invasive procedure that involves examination of body organs or cavities using an endoscope.

**Interstitial cystitis**—A chronic inflammatory condition of the bladder involving symptoms of bladder pain, frequent urination, and burning during urination.

**Retrograde pyelogram**—A pyelography or x-ray technique in which a dye is injected into the kidneys through the ureters.

**Ureter**—The tube that carries urine from each kidney to the bladder.

**Urethra**—The tube that carries urine from the bladder to outside the body. In females, the urethral opening is between the vagina and clitoris; in males, the urethra travels through the penis, opening at the tip.

**Urogynecologist**—A physician that specializes in female medical conditions concerning the urinary and reproductive systems.

**Uroradiologist**—A radiologist that specializes in diagnostic imaging of the urinary tract and kidneys.

- expect any blood in the urine to clear up in one to two days.
- avoid strenuous exercise during recovery.
- postpone sexual relations until the urologist determines that healing is complete.

## Risks

As with any surgical procedure, there are some risks involved with a cystoscopy. Complications may include profuse bleeding, a damaged urethra, a perforated bladder, a urinary tract infection, or an injured penis.

Patients should contact their physician if they experience any of the following symptoms after the procedure, including pain, redness, swelling, drainage, or bleeding from the surgical site; signs of generalized infection, which may include headache, muscle aches, dizziness, or an overall ill feeling and fever; nausea or vomiting; or difficult or painful urination.

Cystoscopy is a commonly performed procedure, but it is an invasive technique that involves small yet significant risk. If anesthesia is required, there is additional risk, particularly for people who are obese, smoke, or are in poor health. Those undergoing anesthesia must inform the doctor of any medications they are taking.

## Normal results

A successful cystoscopy includes a thorough examination of the bladder and collection of urine samples for cultures. If no abnormalities are seen, the results are indicated as normal. In this case, the bladder wall appears smooth and the bladder is seen to be of normal size, shape, and position, without obstructions, growths, or stones.

The treating physician can tell the patient what was seen inside the bladder right after the procedure. If a biopsy sample was taken, this will take several days to be examined and tested.

Cystoscopy allows the urologist to detect inflammation of the bladder lining, prostatic enlargement, or tumors. If these are seen, further evaluation or biopsies may be needed. Cystoscopy with bladder distention can also evaluate interstitial cystitis. Bladder stones, urethral strictures, diverticula, or congenital abnormalities can also be detected.

## Alternatives

There are procedures that can provide some information about the lining of the bladder, for example, x rays; however, none of these provide as much information to the doctor as a cystoscopy.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Cystoscopy is typically performed on an outpatient basis, but up to three days of recovery in the hospital is sometimes required. The procedure can be performed in a hospital, doctor's office, cystoscopy suite, or urology office, depending on the condition of the patient and the anesthesia required. If general anesthesia is required, an anesthesiologist is present to administer the anesthesia and monitor the patient. The cystoscopy procedure is performed by a urologist, urologic surgeon, or urogynecologist, with assistance from nurses experienced in urologic procedures. If x rays are taken during the procedure, a urologist or radiologic technologist is required to operate the x-ray equipment. Biopsy tissue samples are sent to the clinical laboratory for examination by a pathologist.

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## QUESTIONS TO ASK THE DOCTOR

- What will happen during the procedure?
- How do I prepare for cystoscopy?
- Will cystoscopy hurt?
- How long will the test last?
- How many cystoscopies do you perform each year?
- Are there any risks associated with the procedure?

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# D

D & C see **Dilatation and curettage**

## Death and dying

### Definition

Death is the end of life, a permanent cessation of all vital functions. Dying refers to the body's preparation for death, which may be very short in the case of accidental death, or can last weeks or months in some patients such as those suffering from cancer.

### Description

#### *Risks of surgery*

Specific risks vary from surgery to surgery and should be discussed with a physician. All surgeries and every administration of anesthesia have some risks; they are dependent upon many factors including the type of surgery and the medical condition of the patient. The patient should ask the anesthesiologist about any risks that may be associated with the anesthesia. Specific standards are set by the American Society of Anesthesiologists to enhance the safety and quality of anesthesia before surgery, basic methods of monitoring patients during surgery, and the best patient care during recovery.

Overwhelming data compiled in 2001 has confirmed that albumin is an effective marker of general nutrition; low albumin levels can increase the likelihood of post-surgery complications such as pneumonia, infection, and the inability to wean from a ventilator, by as much as 50%. In a national study of 54,000 surgery patients (average age of 61 years old), it was found that only one in five surgical patients were tested for low albumin before their operations.

In a study of 2,989 hospitalized patients admitted for more than one day, risk factors such as cholesterol levels (primarily low levels of high-density lipoprotein,

HDL) and low serum albumin were associated with in-hospital death, infection, and length of stay. During the study follow-up, 62 (2%) of the patients died, 382 (13%) developed a nosocomial infection, and 257 (9%) developed a surgical site infection.

The National Veterans Affairs Surgical Risk Study was conducted in 44 Veterans Affairs Medical Centers and included 87,078 major noncardiac operations performed under general, spinal, or epidural anesthesia. Patient risk factors predictive of postoperative death included serum albumin level, American Society of Anesthesia class, emergency operation, and 31 additional preoperative variables.

Other factors related to death during surgery are: increasing age, **emergency surgery**, and general postoperative complications including cardiac, renal, and pulmonary complications. Age-related changes in the immune system play a significant role in the increased risk of infection, decreased ability to fight diseases, and slower wound healing after surgery. An aging body is more susceptible to subsequent infections because of previous illness or surgery and the subsequent weakening of the immune system. The anti-inflammatory medications (e.g., to control conditions such as arthritis) that many older people take are also known to slow wound healing.

One study found that risk of death during **coronary artery bypass graft surgery** is associated with hospital volume, i.e., the number of surgeries performed. High volume hospitals had a lower mortality rate during surgery. Mortality decreased with increasing volume of surgeries performed (3.6% in low [less than 500 cases], 3% in moderate [500-1,000 cases], and 2% in high [over 1,000 cases] volume hospitals). Thus, the volume of surgeries performed may be an important consideration when selecting a hospital.

#### *Complications of surgery*

The most common complications to surgery that can prove fatal are infection, bleeding, and complications of anesthesia.



## KEY TERMS

**Anesthesia**—Loss of sensation and usually of consciousness without loss of vital functions artificially produced by the administration of one or more agents that block the passage of pain impulses along nerve pathways to the brain.

**Anesthesiologist**—A physician specializing in administering anesthesia.

**Electrocautery**—The use of a low-voltage electrified probe used to remove tissue through cauterization (burning).

**Endoscopic**—Of, relating to, or performed by means of an endoscope or endoscopy.

**Euthanasia**—To bring about the death of another person who has an incurable disease or condition.

**High-density lipoprotein**—A cholesterol-poor, protein-rich lipoprotein of blood plasma correlated with reduced risk of atherosclerosis.

**Nosocomial**—Originating or taking place in a hospital.

**Percutaneous**—Effected or performed through the skin.

**Serum albumin**—A crystallizable albumin or mixture of albumins that normally constitutes more than half of the protein in blood serum and serves to maintain the osmotic pressure of the blood.

The Joint Commission's Board of Commissioners reviewed 64 cases related to operative and post-operative complications since the late 1990s. Of the events reviewed, 84% of the complications resulted in patient deaths, while 16% resulted in a serious injury. All of the cases occurred in acute care hospitals; cases directly related to medication errors or to the administration of anesthesia were excluded. Of these complications, 58% occurred during the postoperative procedure period, 23% during intraoperative procedures, 13% during post-anesthesia recovery, and 6% during anesthesia induction.

The following types of procedures were most frequently associated with these reported complications:

- endoscopy and/or interventional imaging
- catheter or tube insertion
- open abdominal surgery
- head and neck surgery
- thoracic surgery
- orthopedic surgery

Of the 64 cases reviewed, 90% occurred in relation to non-emergent (elective or scheduled) procedures. The most frequent complications by type of procedure included the following:

- Naso-gastric/feeding tube insertion into the trachea or a bronchus.
- Massive fluid overload from absorption of irrigation fluids during genito-urinary/gynecological procedures.
- Endoscopic procedures (including non-gastrointestinal procedures) with perforation of adjacent organs. Of all abdominal and thoracic endoscopic surgery, liver lacerations were among the most common complications.
- Central venous catheter insertion into an artery.
- Burns from electrocautery used with a flammable prep solution.
- Open orthopedic procedures associated with acute respiratory failure, including cardiac arrest in the operating room.
- Imaging-directed percutaneous biopsy or tube placement resulting in liver laceration, peritonitis, or respiratory arrest while temporarily off prescribed oxygen.

Complications associated with misplacement of tubes or catheters usually involved a failure to confirm the position of the tube or catheter, a failure to communicate the results of the confirmation procedure, or misinterpretation of the radiographic image by a non-radiologist.

## Preparing for death or incapacitation legally

An advance directive is a way to allow caregivers to know a patient's wishes, should the patient become unable to make a medical decision. The hospital must be told about a patient's advance directive at the time of admission. Description of the type of care for different levels of illness should be in an advance directive. For instance, a patient may wish to have or not to have a certain type of care in the case of terminal or critical illness or unconsciousness. An advance directive will protect the patient's wishes in these matters.

A **living will** is one type of advance directive and may take effect when a patient has been deemed terminally ill. Terminal illness in general assumes a life span of six months or less. A living will allows a patient to outline treatment options without interference from an outside party.

A durable **power of attorney** for health care (DPA) is similar to a living will; however, it takes effect any time unconsciousness or inability to make informed medical decisions is present. A family

member or friend is stipulated in the DPA to make medical decisions on behalf of the patient.

While both living wills and DPAs are legal in most states, there are some states that do not officially recognize these documents. However, they may still be used to guide families and doctors in treatment wishes.

Do-not-resuscitate (DNR) orders can be incorporated into an advance directive or by informing hospital staff. Unless instructions for a DNR are in effect, hospital staff will make every effort to help patients whose hearts have stopped or who have stopped breathing. DNR orders are recognized in all states and will be incorporated into a patient's medical chart if requested. Patients who benefit from a **DNR order** are those who have terminal or other debilitating illnesses. It is recommended that a patient who has not already been considered unable to make sound medical decisions discuss this option with his or her physician.

None of the above documents are complicated. They may be simple statements of desires for medical care options. If they are not completed by an attorney, they should be notarized and a copy should be given to the doctor, as well as to a trusted family member.

### Mourning and grieving among cultures

The death of a loved one is a severe trauma, and the grief that follows is a natural and important part of life. No two people grieve exactly the same way, and cultural differences play a significant part in the grieving process. For many, however, the most immediate response is shock, numbness, and disbelief. Physical reactions may include shortness of breath, heart palpitations, sweating, and dizziness. At other times, there may be reactions such as loss of energy, sleeplessness or increase in sleep, changes in appetite, or stomach aches. Susceptibility to common illnesses, nightmares, and dreams about the deceased are not unusual during the grieving period.

Emotional reactions are as individual as physical reactions. A preoccupation with the image of the deceased, feelings of fear, hostility, apathy, emptiness, and even fear of one's own death, may occur. Depression, diminished sex drive, sadness, and anger at the deceased may occur. Bereavement may cause short- or long-term changes in the family unit and other relationships of the bereaved.

It is important for the bereaved to work through their feelings and not avoid their emotions. If emotions and feelings are not discussed with family members,

friends, or primary support groups, then a therapist should be consulted to assist with the process.

Various cultures and religions view death in different manners and conduct mourning rituals according to their own traditions. In most cultures, visitors often come to express their condolences to the family and to bid farewell to the deceased. At times, funeral services are private. Various ethnic groups host a gathering after the funeral for those who attended. It is common for these events to become a celebration of the life of the deceased, which also helps the bereaved to begin the mourning process positively. Memories are often exchanged and toasts made in memory of the deceased. Knowing how much a loved one is cherished and remembered by friends and family is a comfort to those who experience the loss. Other methods of condolences include sending flowers to the home or the funeral parlor; sending a mass card, sending a donation to a charity that the family has chosen; or bringing a meal to the family during the weeks after the death.

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American College of Physicians American Society of Internal Medicine, 190 N. Independence Mall West, Philadelphia, PA 19106 1572. Washington Office: 2011 Pennsylvania Avenue NW, Suite 800, Washington, DC 20006 1837. (202) 261 4500 or (800) 338 2746. <http://www.acponline.org>.

Hospice Foundation of America, 2001 "S" Street, NW, Suite 300, Washington, DC 20009. (800) 854 3402 or (202) 638 5419. Fax: (202) 638 5312. Email: [jon@hospicefoundation.org](mailto:jon@hospicefoundation.org). [www.hospicefoundation.org](http://www.hospicefoundation.org).

Inter Institutional Collaborating Network on End of Life Care (IICN). (415) 863 3045. <http://www.growthhouse.org>.

National Institutes of Health, 9000 Rockville Pike, Bethesda, MD 20892. (301) 496 4000. Email: [NIHInfo@OD.NIH.GOV](mailto:NIHInfo@OD.NIH.GOV). <http://www.nih.gov/>.

Promoting Excellence in End of Life Care, RWJ Foundation National Program Office, c/o The Practical Ethics Center, The University of Montana, 1000 East Beck with Avenue, Missoula, MT 59812. (406) 243 6601. Fax: (406) 243 6633. Email: [excell@selway.umt.edu](mailto:excell@selway.umt.edu). <http://www.promotingexcellence.org>.

Washington Home Center for Palliative Care Studies(CPCS), 4200 Wisconsin Avenue, NW, 4th Floor, Washington, DC 20016. (202) 895 2625. Fax: (202) 966 5410. Email: [info@medicaring.org](mailto:info@medicaring.org). <http://www.medicaring.org>.

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## Purpose

An open wound or ulcer can not be properly evaluated until the dead tissue or foreign matter is removed. Wounds that contain necrotic and ischemic (low oxygen content) tissue take longer to close and heal. This is because necrotic tissue provides an ideal growth medium for bacteria, especially for *Bacteroides* spp. and *Clostridium perfringens* that causes the gas gangrene so feared in military medical practice. Though a wound may not necessarily be infected, the bacteria can cause inflammation and strain the body's ability to fight infection. Debridement is also used to treat pockets of pus called abscesses. Abscesses can develop into a general infection that may invade the bloodstream (sepsis) and lead to **amputation** and even **death**. Burned tissue or tissue exposed to corrosive substances tends to form a hard black crust, called an eschar, while deeper tissue remains moist and white, yellow and soft, or flimsy and inflamed. Eschars may also require debridement to promote healing.

## Description

The four major debridement techniques are surgical, mechanical, chemical, and autolytic.

### *Surgical debridement*

Surgical debridement (also known as sharp debridement) uses a scalpel, scissors, or other instrument to cut necrotic tissue from a wound. It is the quickest and most efficient method of debridement. It is the preferred method if there is rapidly developing inflammation of the body's connective tissues (cellulitis) or a more generalized infection (sepsis) that has entered the bloodstream. The physician starts by flushing the area with a saline (salt water) solution, and then applies a topical anesthetic or antalgic gel to the edges of the wound to minimize pain. Using forceps to grip the dead tissue, the physician cuts it away bit by bit with a scalpel or scissors. Sometimes it is necessary to leave some dead tissue behind rather than disturb living tissue. The physician may repeat the process again at another session.

### *Mechanical debridement*

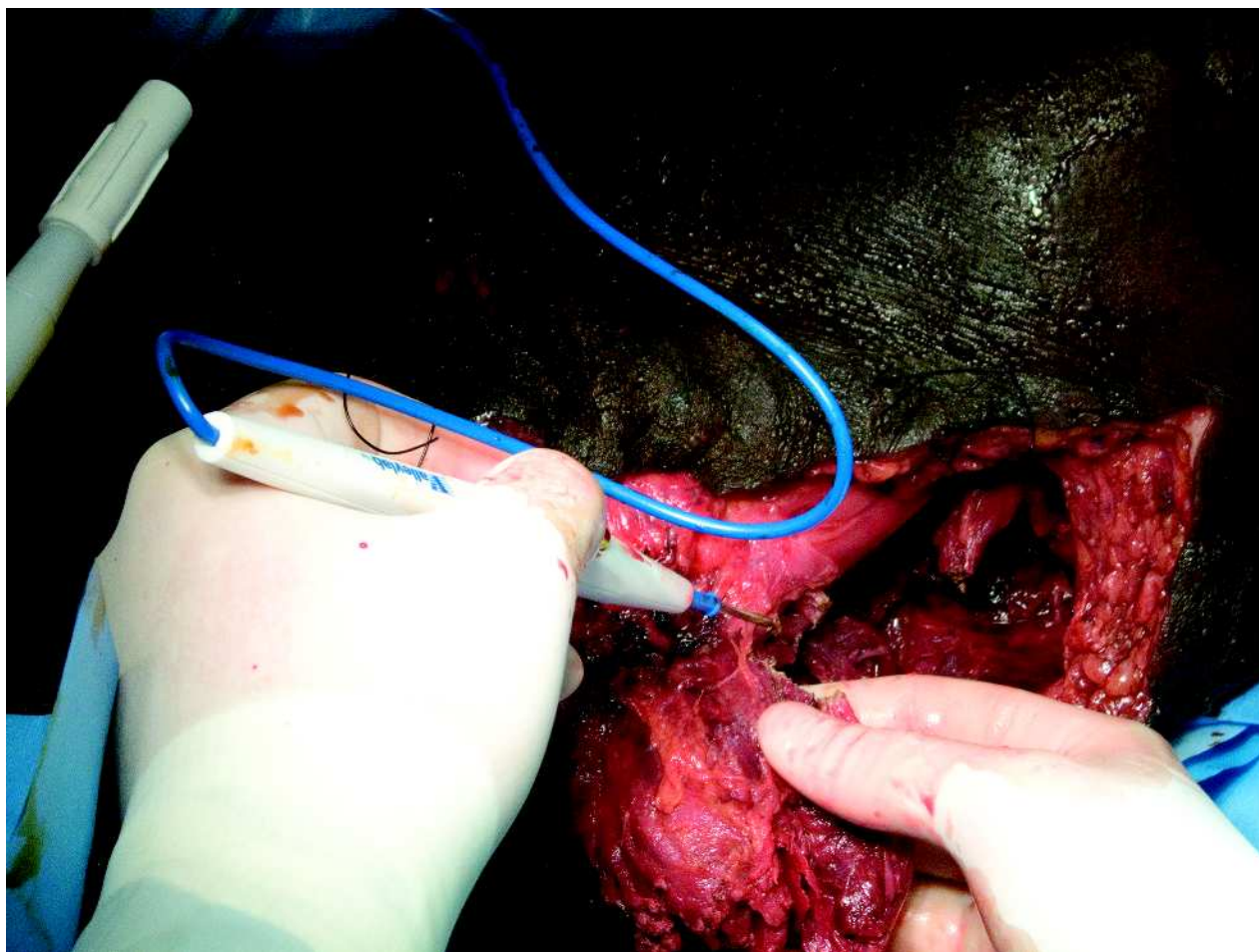
In mechanical debridement, a saline-moistened dressing is allowed to dry overnight and adhere to the dead tissue. When the dressing is removed, the dead tissue is pulled away too. This process is one of the oldest methods of debridement. It can be very painful because the dressing can adhere to living as well as nonliving tissue. Because mechanical debridement cannot select between good and bad tissue, it is an unacceptable debridement method for clean wounds where a new layer of healing cells is already developing.

## Debridement

### Definition

Debridement is the process of removing dead (necrotic) tissue or foreign material from and around a wound to expose healthy tissue.





**A surgeon using electrocautery to perform debridement of necrotic muscle.** (Barry Slaven, MD, PhD./Phototake. Reproduced by permission.)

### *Chemical debridement*

Chemical debridement makes use of certain enzymes and other compounds to dissolve necrotic tissue. It is more selective than mechanical debridement. In fact, the body makes its own enzyme, collagenase, to break down collagen, one of the major building blocks of skin. A pharmaceutical version of collagenase is available and is highly effective as a debridement agent. As with other debridement techniques, the area first is flushed with saline. Any crust of dead tissue is etched in a cross-hatched pattern to allow the enzyme to penetrate. A topical antibiotic is also applied to prevent introducing infection into the bloodstream. A moist dressing is then placed over the wound.

### *Autolytic debridement*

Autolytic debridement takes advantage of the body's own ability to dissolve dead tissue. The key to the technique is keeping the wound moist, which can

be accomplished with a variety of **dressings**. These dressings help to trap wound fluid that contains growth factors, enzymes, and immune cells that promote wound healing. Autolytic debridement is more selective than any other debridement method, but it also takes the longest to work. It is inappropriate for wounds that have become infected.

### *Biological debridement*

Maggot therapy is a form of biological debridement known since antiquity. The larvae of *Lucilia sericata* (greenbottle fly) are applied to the wound as these organisms can digest necrotic tissue and pathogenic bacteria. The method is rapid and selective, although patients are usually reluctant to submit to the procedure.

### **Diagnosis/Preparation**

The physician or nurse will begin by assessing the need for debridement. The wound will be examined,



## KEY TERMS

**Abscess**—A localized collection of pus buried in tissues or organs that may or may not discharge and usually results from an infectious process.

**Anaerobic**—Pertaining to a microorganism that either does not use oxygen or actually cannot live in the presence of oxygen.

**Antalgic**—Medication that alleviates pain.

**Bacteroides**—A family of anaerobic, rod-shaped bacteria. Its organisms are normal inhabitants of the oral, respiratory, intestinal, and urogenital cavities of humans, animals, and insects. Some species are infectious agents.

**Eschar**—A hardened dry crust that forms on skin exposed to burns or corrosive agents.

**Gangrene**—Death of tissue, usually in considerable mass and generally associated with loss of blood supply and followed by bacterial infection and decomposition.

**Gas gangrene**—A severe form of gangrene caused by *Clostridium* infection.

**Hypoxia**—Reduction of oxygen supply to tissues below physiological requirements despite adequate perfusion of the tissue by blood.

**Ischemic**—Tissue that has a low oxygen supply due to obstruction of the arterial blood supply or inadequate blood flow.

**Necrotic**—Affected with necrosis (cell death).

**Pressure ulcer**—Also known as a decubitus ulcer, pressure ulcers are open wounds that form when ever prolonged pressure is applied to skin covering bony outcrops of the body. Patients who are bed-ridden are at risk of developing pressure ulcers, commonly known as bedsores.

**Sepsis**—A severe systemic infection in which bacteria have entered the bloodstream.

frequently by inserting a gloved finger into the wound to estimate the depth of dead tissue and evaluate whether it lies close to other organs, bone, or important body features. The assessment addresses the following points:

- the nature of the necrotic or ischemic tissue and the best debridement procedure to follow
- the risk of spreading infection and the use of antibiotics
- the presence of underlying medical conditions causing the wound

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Debridement is performed by physicians such as plastic surgeons, dermatologists or surgeons, depending on the condition requiring the procedure. General physicians and surgeons are all trained in debridement techniques and they usually perform debridement procedures. Nurses specializing in wound care are prepared to perform conservative sharp wound debridement once they have satisfactorily completed didactic and clinical instruction in the sharp debridement procedure from an accredited agency, wound management specialty course, or an approved course in debridement.

Surgical debridement is usually performed on an outpatient basis or at the bedside. If the target tissue is deep or close to another organ, however, or if the patient is experiencing extreme pain, the procedure may be done in an operating room.

- the extent of ischemia in the wound tissues
- the location of the wound in the body
- the type of pain management to be used during the procedure

Before surgical or mechanical debridement, the area may be flushed with a saline solution, and an antalgic cream or injection may be applied. If the antalgic cream is used, it is usually applied over the exposed area some 90 minutes before the procedure.

## Aftercare

After surgical debridement, the wound is usually packed with a dry dressing for a day to control bleeding. Afterward, moist dressings are applied to promote wound healing. Moist dressings are also used after mechanical, chemical, and autolytic debridement. Many factors contribute to wound healing, which frequently can take considerable time. Debridement may need to be repeated.

## Risks

It is possible that underlying tendons, blood vessels or other structures may be damaged during the examination of the wound and during surgical debridement. Surface bacteria may also be introduced deeper into the body, causing infection.

## QUESTIONS TO ASK THE DOCTOR

- Why debride my wound?
- How long will it take to heal?
- Is there a risk of infection?
- Will there be a scar?
- Can I wash the wound?
- Will the procedure hurt?

### Normal results

Removal of dead tissue from pressure ulcers and other wounds speeds healing. Although these procedures cause some pain, they are generally well tolerated by patients and can be managed more aggressively. It is not uncommon to debride a wound again in a subsequent session.

### Alternatives

Adjunctive therapies include electrotherapy and low laser irradiation. However, at present, insufficient research has been completed to recommend their general use.

Not all wounds need debridement. Sometimes it is better to leave a hardened crust of dead tissue (eschar), than to remove it and create an open wound, particularly if the crust is stable and the wound is not inflamed. Before performing debridement, the physician will take a medical history with attention to factors that might complicate healing, such as medications being taken and smoking. The physician will also note the cause of the wound and the ways it has been treated. Some ulcers and other wounds occur in places where blood flow is impaired, for example, the foot ulcers that can accompany diabetes mellitus. In such cases, the physician or nurse may decide not to debride the wound because blood flow may be insufficient for proper healing.

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- Wound Care Institute. 1100 N.E. 163rd Street, Suite #101, North Miami Beach, FL 33162. (305) 919-9192. <<http://woundcare.org>>.

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Decubitus ulcers see **Bedsore**s

## Deep brain stimulation

### Definition

Deep brain stimulation (DBS) delivers a constant low electrical stimulation to a small region of the brain, through implanted electrodes connected to an implanted battery. It is used to partially restore



**Deep brain stimulation.** (PHOTOTAKE Inc. / Alamy)

normal movements in Parkinson's disease, essential tremor, and dystonia.

### Purpose

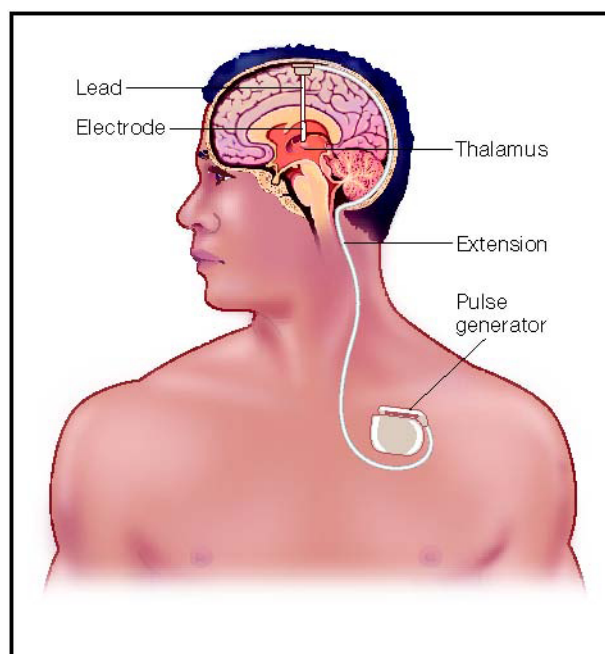
Parkinson's disease is due to degeneration of a group of cells called the substantia nigra. These cells interact with other brain regions to help control movement. The normal signals from the substantia nigra inhibit these other regions, and so when it degenerates, these regions become overactive. The electrical signals from the DBS electrodes mimic the inhibitory function of the substantia nigra, helping to restore more normal movements.

The substantia nigra normally releases the chemical dopamine, which exerts its inhibitory action on the globus pallidus interna (GPi) and the subthalamic nucleus (STN). For Parkinson's disease, deep brain stimulation is performed on these two centers. The target for DBS in dystonia is the GPi as well. Treatment of essential tremor usually targets the thalamus.

Each of these brain regions has two halves, which control movement on the opposite side of the body: right controls left, and left controls right. Unilateral DBS may be used if the symptoms are much more severe on one side. Bilateral DBS is used to treat symptoms on both sides.

### Demographics

Parkinson's disease affects approximately one million Americans. The peak incidence is approximately age 62, but young-onset PD can occur as early as age 40. Because young-onset patients live with their disease for so many more years, they are more likely to become candidates for surgery than older-onset patients. In addition, younger patients tend to do better and suffer fewer adverse effects of surgery. Approximately 5% of older PD patients receive one form or another of PD



(Illustration by Electronic Illustrators Group.)

surgery. Many more develop the symptoms for which surgery may be effective, but either develop them at an advanced age, making surgery inadvisable, or decide the risks of surgery are not worth the potential benefit, or do not choose surgery for some other reason.

Essential tremor is more common than Parkinson's disease, but rarely becomes severe enough to require surgery. Dystonia is a very rare condition, and the number of patients who have received DBS as of 2003 is under 100.

### Description

Deep brain stimulation relies on implanting a long thin electrode deep into the brain, through a hole in the top of the skull. In order to precisely locate the target area and to ensure the probe is precisely placed in the target, a "stereotactic frame" is used. This device is a rigid frame attached to the patient's head, providing an immobile three-dimensional coordinate system, which can be used to precisely track the location of the GPi or STN and the movement of the electrode.

For unilateral DBS, a single "burr hole" is made in the top of the skull. Bilateral DBS requires two holes. A strong topical anesthetic is used to numb the skin while this hole is drilled. Since there are no pain receptors in the brain, there is no need for deeper anesthetic. In addition, the patient must remain awake in order to report any sensory changes during the surgery. The electrode is placed very close to

several important brain structures. Sensory changes during electrode placement may indicate the electrode is too close to one or more of these regions.

Once the burr hole is made, the surgeon inserts the electrode. Small electric currents from the electrode are used to more precisely locate the target. This is harmless, but may cause twitching, light flashes, or other sensations. A contrast dye may also be injected into the spinal fluid, which allows the surgeon to visualize the brain's structure using one or more imaging techniques. The patient will be asked to make various movements to assist in determining the location of the electrode.

The electrode is connected by a wire to an implanted pulse generator. This wire is placed under the scalp and skin. A small incision is made in the area of the collarbone, and the pulse generator is placed there. This portion of the procedure is performed under **general anesthesia**.

### Diagnosis/Preparation

DBS for Parkinson's disease is considered as an option in a patient who is still responsive to levodopa (used to treat symptoms) but has developed motor complications. These include the rapid loss of benefit from a single dose (wearing off), unpredictable fluctuations in benefit (on-off), and uncontrolled abnormal movements (dyskinesias). Essential tremor patients who are candidates for surgery are those whose tremor is unsatisfactorily controlled by medications and whose tremor significantly impairs activities of daily living. Similar criteria apply for dystonia patients.

The patient who is a candidate for DBS discusses all the surgical options with his neurologist before deciding on deep brain stimulation. A full understanding of the risks and potential benefits must be understood before consenting to the surgery.

The patient will undergo a variety of medical tests, and one or more types of neuroimaging procedures, including MRI, CT scanning, **angiography** (imaging the brain's blood vessels) and ventriculography (imaging the brain's ventricles). On the day of the surgery, the stereotactic frame is fixed to the patient's head. A local anesthetic is used at the four sites where the frame's pins contact the head; there may nonetheless be some initial discomfort. A final MRI is done with the frame in place, to set the coordinates of the targeted area of the brain in relation to the frame.

The patient will receive a mild sedative to ease the anxiety of the procedure. Once the electrodes are positioned, the patient receives general anesthetic to implant the pulse generator.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Deep brain stimulation is performed by a neurosurgeon in a hospital.

### Aftercare

The procedure is lengthy, and the patient will require a short hospital stay afterward to recover from the surgery. Following the procedure itself, the patient meets several times with the neurologist to adjust the stimulation. The pulse generator is programmable, and can be fine-tuned to the patient's particular needs. This can provide a higher degree of symptom relief than lesioning surgeries, but requires repeated visits to the neurologist. Pulse generator batteries must be replaced every three to five years. This is done with a small incision as an outpatient procedure. Since the generator is in the chest area, no additional brain surgery is required.

The patient's medications are adjusted after surgery, with a reduction in levodopa likely in most patients who receive DBS of the subthalamic nucleus.

### Risks

Deep brain stimulation entails several risks. There are acute surgical risks, including hemorrhage and infection, and the risks of general anesthesia. The electrodes can be placed too close to other brain regions, which can lead to visual defects, speech problems, and other complications. These may be partially avoided by adjusting the stimulation settings after the procedure. Because a device is left implanted under the skin, there is the risk of breakage or malfunction, which requires surgical removal.

A patient with implanted electrodes must not receive diathermy therapy. Diathermy is the passage of radiowaves through the tissue to heat it, and is used as a physical therapy for muscle pain and other applications. Diathermy poses a risk of **death** in a patient with DBS electrodes.

Patients who are cognitively impaired may become more so after surgery, and cognitive impairment usually prevents a patient from undergoing surgery.

### Normal results

Deep brain stimulation improves the movement disorder symptoms of Parkinson's disease by 25–75%,



## QUESTIONS TO ASK THE DOCTOR

- How many electrode implantations has the neurosurgeon performed?
- What is his own rate of serious complications?
- Would pallidotomy be appropriate for me?
- How will my medications change after the operation?

depending on the care of the placement and the ability to find the optimum settings. These improvements are seen most while off levodopa; DBS does little to improve the best response to levodopa treatment. Levodopa dose will likely be reduced, leading to a significant reduction in dyskinesias.

### Morbidity and mortality rates

The rate of complications depends highly on the skill and experience of the **surgical team** performing the procedure. Rates from one of the most experienced teams, in a study of over 200 patients, were as follows.

Post-operative complications:

- asymptomatic intracranial bleed (10% of procedures)
- symptomatic intracranial bleed (2%)
- seizures (3%)
- headache (25%)
- infection (6%)

Device-related complications:

- lead replacements (9%)
- lead repositionings (8%)
- extension wire replacements (6%)
- implantable pulse generator replacements (17%), approximately half of which were due to malfunction

The risk of death is less than 1%.

### Alternatives

Patients who are candidates for deep brain stimulation have usually been judged to require surgery for effective treatment of their symptoms. Other surgical alternatives for Parkinson's disease include **pallidotomy** and **thalamotomy**, which destroy brain tissue to achieve the same effect as the stimulation. Pallidotomy is rarely performed for Parkinson's disease, unless tremor is the only debilitating symptom. It is common in essential tremor. DBS for dystonia is the only really promising

neurosurgical treatment for this condition. Some peripheral surgeries may be appropriate for selected patients.

### Resources

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#### ORGANIZATIONS

National Parkinson's Disease Foundation. Bob Hope Parkinson Research Center, 1501 N.W. 9th Avenue, Bob Hope Road, Miami, FL 33136 1494. (305) 547 6666. (800) 327 4545. Fax: (305) 243 4403. <http://www.parkinson.org>.

WE MOVE, Worldwide Education and Awareness for Movement Disorders. 204 West 84th Street, New York, NY 10024. (800) 437 MOV2, Fax: (212) 875 8389. <http://www.wemove.org>.

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Deep vein thrombosis see **Venous thrombosis prevention**

## Defecography

### Definition

Defecography is an imaging test in which x rays are taken of the rectum and anal canal during the course of defecation.

### Purpose

Defecography is used to evaluate the muscles needed for bowel evacuation and the surrounding tissues. It is used during the evaluation of a number of conditions, including:

- Intussusception
- **Rectal prolapse**
- Rectocele
- Enterocele
- Cystocele
- Vaginal prolapse
- Chronic constipation
- Fecal incontinence
- Anismus

### Precautions

Patients must carefully follow directions regarding when to stop eating and drinking, and when to begin their bowel prep. Patients who are diabetic may

## KEY TERMS

**Anismus**—Dysfunctional contraction or spasm of the muscle comprising the anal sphincter.

**Constipation**—Difficulty passing a bowel movement. May refer to infrequent passage of stool, or to a hard, dry stool requiring straining and physical effort in order to pass.

**Cystocele**—Sagging or bulging of the bladder through the front wall of the vagina.

**Enterocoele**—Sagging or bulging of an area of the intestine into the vagina.

**Fecal incontinence**—Involuntary passage of stool.

**Intussusception**—Telescoping of one part of the intestine or the rectum into the neighboring part.

**Rectal prolapse**—Sagging or bulging of the lining of the rectum into the rectum or actually through and out of the anal opening.

**Rectocele**—Sagging or bulging of the rectum through the back wall of the vagina.

**Vaginal prolapse**—Weakening of the supportive tissues of the uterus and vagina, such that the uterus and cervix bulge into the vaginal canal, or even out through the vaginal opening.

need to talk to their physician about adjusting their insulin schedule in response to fasting.

## Description

Patients who are undergoing defecography are asked to drink several glasses of water, along with a barium contrast solution, upon arrival at the testing site. An hour later, a barium paste will be inserted into the patient's rectum and (for women) into the vagina. Alternatively, some sites have an artificial stool preparation that can be used for this same purpose. The advantage of the artificial stool is in its greater textural similarity to natural stool.

The patient will be asked to sit on a special commode. The barium paste will show up on x rays taken with it in place. A variety of x-ray views will be taken while the patient is at rest, while they are squeezing the pelvic muscles, and while they are straining during evacuation of the barium paste from their rectum.

## Preparations

The patient is usually asked to stop eating and drinking for the two hours before they are scheduled

to have defecography. Two hours prior to the test, the patient may be asked to self-administer an enema. The enema is usually repeated fifteen minutes later.

## Aftercare

After the test, patients are asked to drink extra water, in order to rid all of the barium from their system. Normal diet and activity can usually be resumed directly following completion of the test.

## Risks

The greatest risk of this examination is one of embarrassment to the patient. Some patients find themselves unable to evacuate their bowels while under examination.

## Normal results

This test assesses how quickly and completely the rectum is emptied, the angle of the anus and rectum (compared to known normal values of the anorectal angle), and the degree to which the perineum descends during straining. Structural abnormalities can also be demonstrated during defecography, including vaginal and/or rectal prolapse, intussusception, and recto-, enter-, and cystocele. Dysfunctional contraction of the anal sphincter can also be identified during defecography.

## Resources

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## Defibrillation

### Definition

Defibrillation is a process in which an electrical device called a defibrillator sends an electric shock to the heart to stop an arrhythmia (irregular heartbeat), resulting in the return of a productive heart rhythm.

## Purpose

Defibrillation is performed to correct life-threatening arrhythmias of the heart, including ventricular fibrillation and cardiac arrest. In cardiac emergencies it should be performed immediately after identifying that the patient is experiencing an arrhythmia, indicated by lack of pulse and unresponsiveness. If an **electrocardiogram** is available, the arrhythmia can be displayed visually for additional confirmation. In non-life threatening situations, a physician can use atrial defibrillation to treat atrial fibrillation or flutter.

## Precautions

Defibrillation should not be performed on a patient who has a pulse or is alert, as this could cause a lethal heart rhythm disturbance or cardiac arrest. The paddles used in the procedure should not be placed on a woman's breasts or over an internal pacemaker.

Cardiac arrhythmias that prevent the heart from pumping blood to the body can cause irreversible damage to the major organs including the brain and heart. These arrhythmias include ventricular tachycardia, fibrillation, and cardiac arrest. About 10% of the ability to restart the heart is lost with every minute that the heart fibrillates. **Death** can occur in minutes unless a productive heart rhythm, able to generate a pulse, is restored through defibrillation. Because immediate defibrillation is crucial to the patient's survival, the American Heart Association has called for the integration of defibrillation into an effective emergency cardiac care system. The system should include early access, early **cardiopulmonary resuscitation**, early defibrillation, and early advanced cardiac care.

Defibrillators deliver a brief electric shock to the heart, which enables the heart's natural pacemaker to regain control and establish a productive heart rhythm. The defibrillator is an electronic device that includes defibrillator paddles and electrocardiogram monitoring.

During external defibrillation, the paddles are placed on the patient's chest, with a conducting gel ensuring good contact with the skin. When the heart can be visualized directly, during **thoracic surgery**, sterile internal paddles are applied directly to the heart. Direct contact with the patient is discontinued by all caregivers. If additional defibrillation is required, the paddles should be repositioned exactly to increase the likelihood of further shocks being effective in stopping the arrhythmia. The patient's pulse and/or electrocardiogram are continually monitored when defibrillation is not in progress. Medications to treat possible causes

## KEY TERMS

**Arrhythmia**—A cardiac rhythm different than normal sinus rhythm with a rate outside of the range of 60–120 beats per minute for an adult patient.

**Cardiac arrest**—A condition in which the heart has no discernable electrical activity to stimulate contraction, therefore no blood is pumped.

**Fibrillation**—Very independent rapid contraction of cardiac muscle fibers producing no productive contraction, therefore no blood is pumped.

**Intubation**—Placing a tube into the lungs through the trachea to provide forced respiration.

**Pacemaker**—A surgically implanted electronic device that sends out electrical impulses to regulate a slow or erratic heartbeat.

of the abnormal heart rhythm may be administered. Defibrillation continues until the patient's condition stabilizes or the procedure is ordered to be discontinued.

Early defibrillators, about the size and weight of a car battery, were used primarily in ambulances and hospitals. The American Heart Association now advocates public access defibrillation; this calls for placing automated external defibrillators (AEDs) in police vehicles, airplanes, and at public events, etc. The AEDs are smaller, lighter, less expensive, and easier to use than the early defibrillators. They are computerized to provide simple, verbal instructions to the operator and to make it impossible to deliver a shock to a patient whose heart is not fibrillating. The placement of AEDs is likely to expand to many public locations.

## Preparation

Once a patient is found in cardiac distress, without a pulse and non-responsive, and help is summoned, cardiopulmonary resuscitation (CPR) is begun and continued until the caregivers arrive and are able to provide defibrillation. Electrocardiogram leads are attached to the patient chest. Gel or paste is applied to the defibrillator paddles, or two gel pads are placed on the patient's chest. The caregivers verify lack of a pulse while visualizing the electrocardiogram, assure contact with the patient is discontinued, and deliver the electrical charge.

Atrial defibrillation is a treatment option that will be ordered for treatment of atrial fibrillation or flutter. The electrocardiogram will be monitored throughout the procedure. The paddles are placed on the patients

chest with conducting gel to ensure good contact between the paddles and skin. If the heart can be visualized directly during thoracic surgery, the paddles will be applied directly to the heart. The defibrillator is programmed to recognize distinct components of the electrocardiogram and will only fire the electrical shock at the correct time. Again, all direct contact with the patient is discontinued prior to defibrillation.

### Aftercare

After defibrillation, the patient's cardiac status, breathing, and **vital signs** are monitored with a **cardiac monitor**. Additional tests to measure cardiac damage will be performed, which can include a 12-lead electrocardiogram, a chest x-ray, and **cardiac catheterization**. Treatment options will be determined from the outcome of these procedures. The patient's skin is cleansed to remove gel and, if necessary, electrical burns are treated.

### Risks

Skin burns from the defibrillator paddles are the most common complication of defibrillation. Other risks include injury to the heart muscle, abnormal heart rhythms, and blood clots.

### Normal results

Defibrillation performed to treat life-threatening ventricular arrhythmias is most likely to be effective within the first five minutes, preventing brain injury and death by returning the heart to a productive rhythm able to produce a pulse. Patients will be transferred to a hospital critical care unit for additional monitoring, diagnosis, and treatment of the arrhythmia. Intubation may be required for respiratory distress. Medications to improve cardiac function and prevent additional arrhythmias, are frequently administered. Some cardiac function may be lost due to the actual defibrillation, but is also associated with the underlying disease.

Atrial defibrillation is successful at restoring cardiac output, alleviating shortness of breath, and decreasing the occurrence of clot formation in the atria.

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American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373 6300. <http://www.americanheart.org>

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Defibrillator, automatic see **Implantable cardioverter-defibrillator**

## Dental implants

### Definition

Dental implants are surgically fixed substitutes for roots of missing teeth. Embedded in the jawbone, they act as anchors for a replacement tooth, also known as a crown, or a full set of replacement teeth.

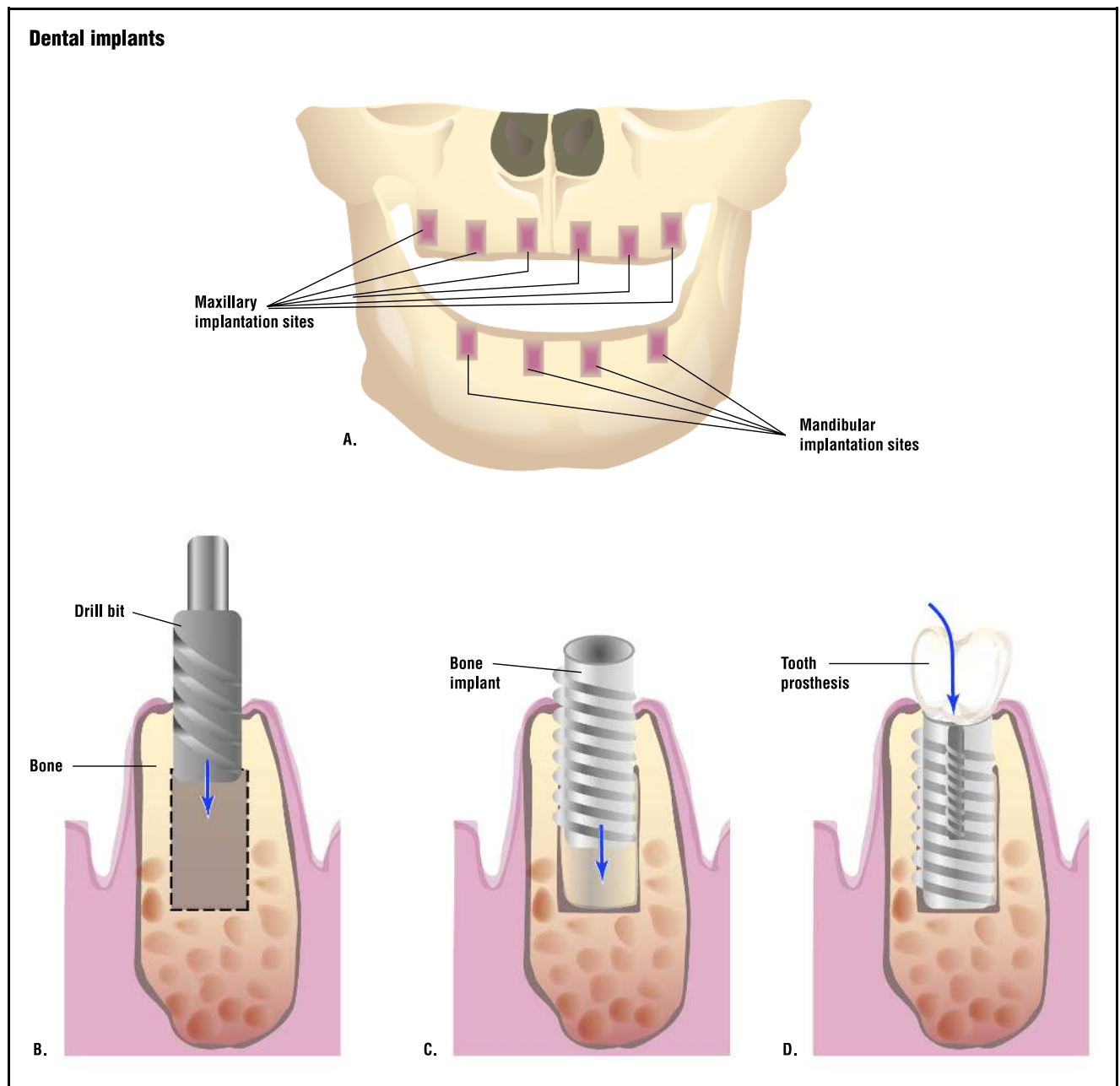
### Purpose

The purpose of dental implant surgery is to position metallic anchors in the jawbone so that they can receive the replacement teeth and hold them in place. Dental implants should be considered as an option for replacing failing or missing teeth, and often provide more predictable results than bridgework, resin bonded bridges, or endodontic treatment.

### Demographics

In 2000, the estimated number of dental implants placed in the United States was 910,000, and this number is expected to increase at a rate of about 18% per year through 2010. Dental implants are equally popular





**A dental drill is used to make a hole for the implant in the jawbone (B). The bone implant is secured into the drilled hole (C), and the tooth prosthesis is built onto the implant (D).** (Illustration by GGS Information Services. Cengage Learning, Gale.)

in Europe, especially in Germany where the procedure is reimbursed by the national healthcare system.

### Description

By replacing a lost tooth with a dental implant, the overall health and function of the surrounding teeth is maintained. The implant can prevent tooth

migration and loss of structure and will help avoid loss of bone from the jaw in that area. Further, implants reduce the impact of the lost tooth on surrounding teeth, as traditional bridge structures often require reduction (filing down) of the two flanking teeth to hold the bridge in place with a crown. Implanting avoids such alterations to the surrounding teeth when replacing a lost tooth.

## KEY TERMS

**Computed tomography (CT) scan**—A method of imaging both hard and soft tissue of the body used in placement of dental implants that are not within the bone.

**Crown**—An artificial replacement tooth.

**Endosteal implants**—Dental implants that are placed within the bone.

**Prosthetic tooth**—The final tooth that is held in place by the dental implant anchor.

**Resorbed**—Absorbed by the body because of lack of function. This happens to the jawbone after tooth loss.

When replacing dentures, implants can provide even more benefits. Implants do not slip nor do they have the potential of limiting the diet to easily chewed foods as can happen with poorly fitting dentures. If appropriate, implants are the method most able to surgically restore one or more missing teeth to their original conditions.

Under **local anesthesia**, the first step for most implant procedures is the exposure of the bone where the implant is to be made. This is followed by placement of the implant into the exposed jawbone. Implants that are placed in the bone are called endosteal implants and are made of titanium or a titanium alloy because this metal does not adversely interact with biological tissue. After placement of the implant, a cover screw is put in and the wound is closed with **stitches** and allowed to heal. In general, placements in the lower jaw need to heal about three months, while placements in the upper jaw need to heal about six months.

After healing, in a second surgical procedure, the implant is uncovered, the cover screw is removed, and a healing abutment or a temporary crown is placed in the implant. Temporary crowns are generally used for esthetic reasons, when the implant is in a place that is visible. Both healing abutments and temporary crowns allow the tissue around the implant to be trained to grow around the final prosthetic tooth.

After about two months, the soft tissue will be healed enough to receive the final prosthetic tooth. Impressions are used to make custom abutments that take into account the neck morphology of the implant. The prosthetic tooth is sometimes attached to a gold cylinder that can be screwed into the abutment or it

## WHO PERFORMS THIS PROCEDURE AND WHERE IS IT PERFORMED?

Implants can be done by dentists, periodontists, or oral surgeons. The procedure is done in the dental professional's office.

can be directly cemented onto the abutment. This multi-stage process, where the two surgical procedures are separated by a lengthy healing time, has proven to provide excellent stability in the final implant. Single-step surgical implants are available, but some stability of the final implant is often lost by eliminating the healing step.

## Preparation/Diagnosis

At the first appointment, the dentist or oral surgeon performs a thorough examination to determine whether implants are appropriate to replace the missing teeth. Often, x rays are necessary to discover the state of the jawbone, particularly if the teeth have been lost for some time. This information is used to determine if implants are appropriate and, if so, what particular type of implant would be best for the clinical situation.

There are two solutions commonly used if the initial examination indicates that the bone in the area where the implant is to occur is too resorbed to support the implant. The first is **bone grafting**. This involves undergoing a procedure that moves bone from one place in the body to another to enlarge the bone structure at the implant site. Often, bone can be moved from one place in the mouth to another. Sometimes a graft from a donor, or an animal, or artificial bone can be used if bone from the patient is not available. Grafting usually is done four to eight months before the implant procedure to allow the graft a chance to heal before it is disturbed with the implant process.

A second solution is the use of subperiosteal implants that ride above the bone but beneath the gum. These types of implants are not placed in the bone. A computed tomography (CT) scan is commonly used to obtain a model of the bone structure and then the implant fixture is molded to precisely fit the bone model.

## Risks

The greatest risk following the surgical procedures is that the implant will fail. For implants placed

## QUESTIONS TO ASK YOUR DENTIST

- What are the expected benefits of dental implants and what are the chances of receiving these benefits?
- What are the expected risks of dental implants and what are the chances of suffering from these risks?
- How many procedures like this have you done previously and can I talk to any of these patients?

within the bone, most failures occur within the first year and then occur at a rate of less than 1% per year thereafter. Recent research has indicated that tobacco use by the patient and use of a single-stage implant procedure are two risk factors that increase failure rate.

### Normal results

Overall, the success rate for all implants runs from 90–95%. Most failed implants can be replaced with a second attempt.

### Resources

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## Dermabrasion

### Definition

Dermabrasion is a procedure to improve the appearance of the skin, most commonly of the face. It involves the mechanical removal of the top layer, using a high-speed rotary wheel.

### Purpose

Originally developed as a means of treating acne scars, dermabrasion can be used to treat many kinds of skin problems, including scars from other types of wounds, wrinkles, skin coloration abnormalities, and other more serious conditions such as rhinophyma, a disfiguring form of rosacea that affects the nose. Although the treatment is not a cure, in that the scar or other abnormality cannot be entirely removed, dermabrasion does soften the edges of the scar or other abnormality and can radically improve its appearance.

Dermabrasion is often used in combination with other **plastic surgery** techniques, such as chemical peels, excisions, punch grafting, and CO<sub>2</sub> laser resurfacing, to achieve an overall smoothing of various skin abnormalities, particularly of the face.

### Demographics

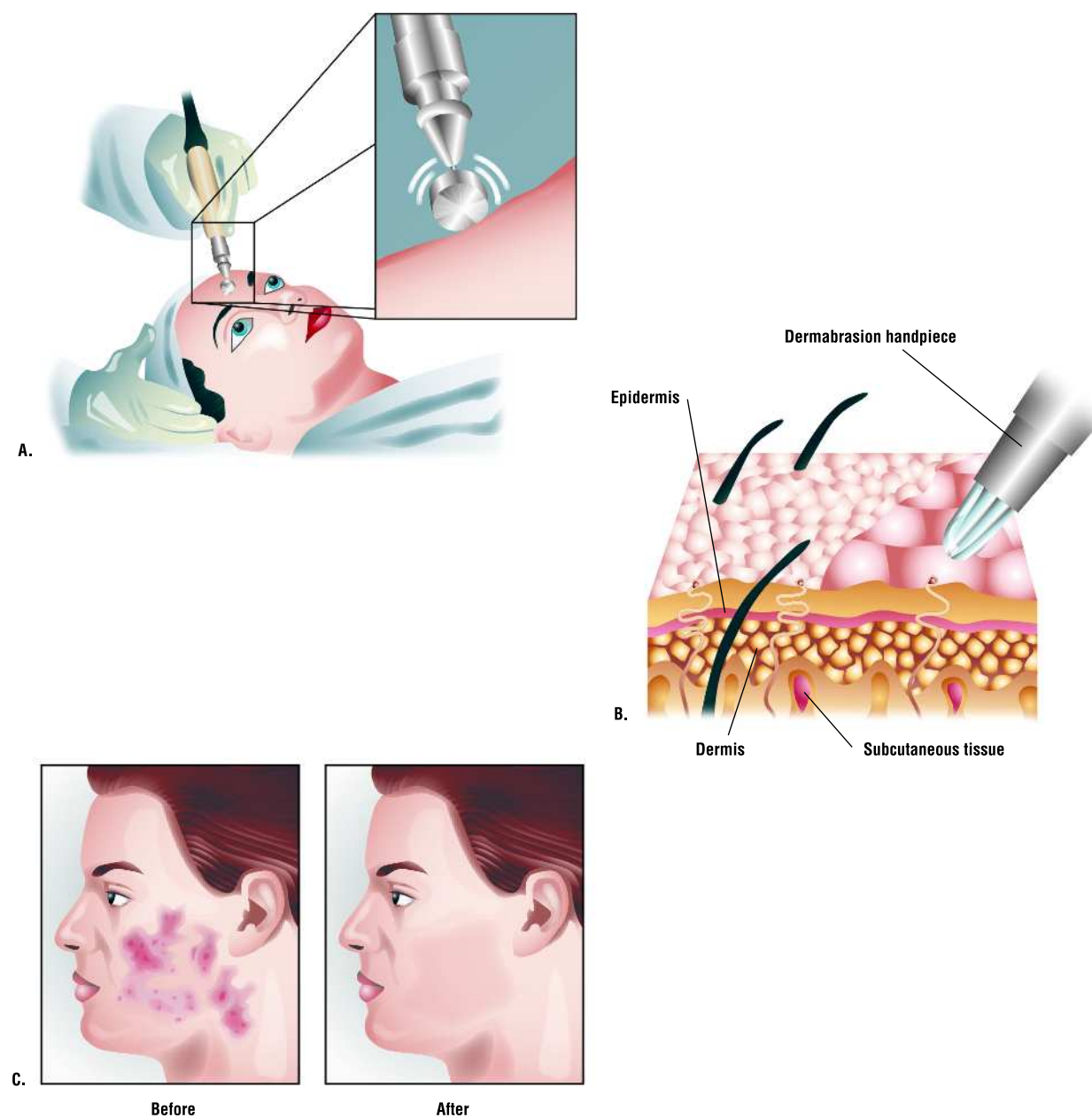
Dermabrasion is a technique that has been used in dermatology for over 100 years. Although used much less often since the advent of laser resurfacing, dermabrasion continues to be a viable treatment that has been reported to have quicker healing times, similar rates of complications, and is more effective in eliminating some types of lesions, particularly surgical scars. According to the American Society for Aesthetic Plastic Surgery, there were about 30,604 dermabrasion procedures performed in 2006.

### Description

Dermabrasion is commonly performed using a handheld engine that can reach rotational speeds of 18,000–35,000 rpm. Rapid planing of the skin is achieved through the combination of this rotational speed, the abrading attachment, and pressure applied by the operator. Because of the importance of the skill of the operator, patients should select doctors with significant experience with the procedure.

There are three types of abrading attachments in common use: diamond fraises, wire brushes, and serrated wheels. Diamond fraises are stainless steel wheels

## Dermabrasion



**A doctor performs dermabrasion with a high-speed rotary wheel (A). The tool takes off the top layers of the skin (B) to improve the appearance of wrinkles or scars (C).** (Illustration by GGS Information Services. Cengage Learning, Gale.)

that have diamond chips of varying coarseness bonded to its surface. Cylinder and pear-shaped diamond fraises are also used for work in various locations. The wire brush is a wheel with wires attached at various angles. In experienced hands, it is the most effective attachment for deep scars. The serrated wheel or

diamond fraise is often used to soften the edges of skin removed with a wire brush.

Before the procedure begins, medication is often given to relax the patient and reduce pain. For small areas, local anesthetic nerve blocks are often used to



## KEY TERMS

**Chemical peel**—A skin treatment that uses the application of chemicals, such as phenol or trichloroacetic acid (TCA), to remove the uppermost layer of skin.

**Cryoanesthesia**—The use of the numbing effects of cold as a surgical anesthetic. For dermabrasion, this involves the spraying of a cold-inducing chemical on the area being treated.

**Epithelium**—The cellular covering of the body. This covering is disturbed during dermabrasion and heals.

**Gentian violet**—An antibacterial, antifungal dye that is commonly applied to the skin during dermabrasion.

**Keloid**—An abnormal type of scarring that involves progressive enlargement, elevated edges, and irregular shapes because of excessive collagen formation during healing.

**Laser skin resurfacing**—The use of laser light to remove the uppermost layer of skin. Two types of lasers commonly used in this manner are CO<sub>2</sub> and erbium.

**Punch grafting**—A method of treating a deep scar involving excision of the damaged area, followed by the suturing in of similarly shaped punch of skin that is often taken from behind the ear.

**Rosacea**—A disease of the skin marked by constant flushing and acne-like lesions.

numb the area being treated. Alternatively, topical cryoanesthesia (numbing the skin using cold) can be used. This is done by spraying a cold-inducing agent on the skin. Sometimes the skin is pre-chilled with ice to increase the anesthetic effect.

During the procedure, patients lie on their backs on the surgical table, eyes covered with disposable eye patches. The area being treated is parted with Gentian violet, a stain that will help gauge how deep the treatment is going. A gloved and gowned assistant holds the skin taut while each section of the face is abraded using the handheld engine. The surgeon works in sections to avoid obvious lines of demarcation in the final results. If the entire face is to be dermabraded, laser is commonly used for the lower eyelids and lip as less than satisfactory results often occur in these areas.

## Diagnosis/Preparation

Because there are several different skin-surfacing techniques now available, the initial meetings with the

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

This procedure should be performed by a dermatological or plastic surgeon with experience in dermabrasion. It is done in an outpatient suite. Hospitalization is not required.

dermatological or plastic surgeon must ensure that dermabrasion is the technique of choice for the particular skin abnormality and location that is being treated. Although controversial, some studies have reported abnormal scarring in patients previously treated with 13 cis-retinoic acid (Accutane); consequently, many surgeons will require a six-month break from the medication before performing dermabrasion. A second contraindication for dermabrasion is HIV or hepatitis infection, as small droplets of blood becomes aerosolized (distributed within the air) during the treatment, creating a risk for the doctor and other staff.

Finally, even if there is no patient history of cold sores, it is important that antiviral medicine is administered to anyone undergoing the procedure, as an outbreak after dermabrasion can be very severe and spread beyond the mouth to other areas of the face.

## Aftercare

After the procedure, any treated areas are dressed for healing. For example, a dressing that is primarily water held on a mesh support, called Vigilon, can be used to cover the wound. It is changed daily for about five days, and then the wound is left open to the air. This kind of treatment speeds the restoration of the epithelium, the cellular covering of the body. Using this technique, healing occurs in 5–7 days.

Generally, the patient is given pain medication, **antibiotics**, and anti-swelling medication during recovery. Antiviral drugs are also continued. Patients should avoid the sun during the healing process.

## Risks

The most common complication of the procedure is the formation of keloid, a type of abnormal scar that results from excessive collagen production. Because this type of scarring tends to be associated with darker skin types, patients with this kind of skin should approach dermabrasion with caution. Other potential complications include abnormal pigmentation of the

## QUESTIONS TO ASK THE DOCTOR

- What characteristics of my skin abnormality suggest using dermabrasion to treat it?
- Would laser or chemical treatments be an option?
- What is the expected cosmetic outcome for the treatment in my case?

treated skin, persistent redness of the skin, and a localized dilation of small groups of blood vessels called telangiectasia. Finally, the formation of milia, bumps that form due to obstruction of the sweat glands, although this can be treated after healing with retinoic acid.

### Normal results

Normal results include significant improvement in the appearance of the skin's surface after healing of the skin. It should be emphasized, however, that many scars will not be completely removed and the change in appearance occurs due to a softening of the edges of the abnormality, not elimination. If a patient cannot tolerate a residual presence of the scar or other abnormality, the treatment should not be used.

### Morbidity and mortality rates

The morbidity and mortality rate of this cosmetic procedure is extremely low.

### Alternatives

A variety of other skin-resurfacing techniques are available and include chemical (phenol or trichloroacetic acid [TCA]) peels, and laser (CO<sub>2</sub> and erbium) resurfacing.

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Diabetes surgery see **Islet cell transplantation**

Dialysis, kidney see **Kidney dialysis**

Differential count see **White blood cell count and differential**

## Dilatation and curettage

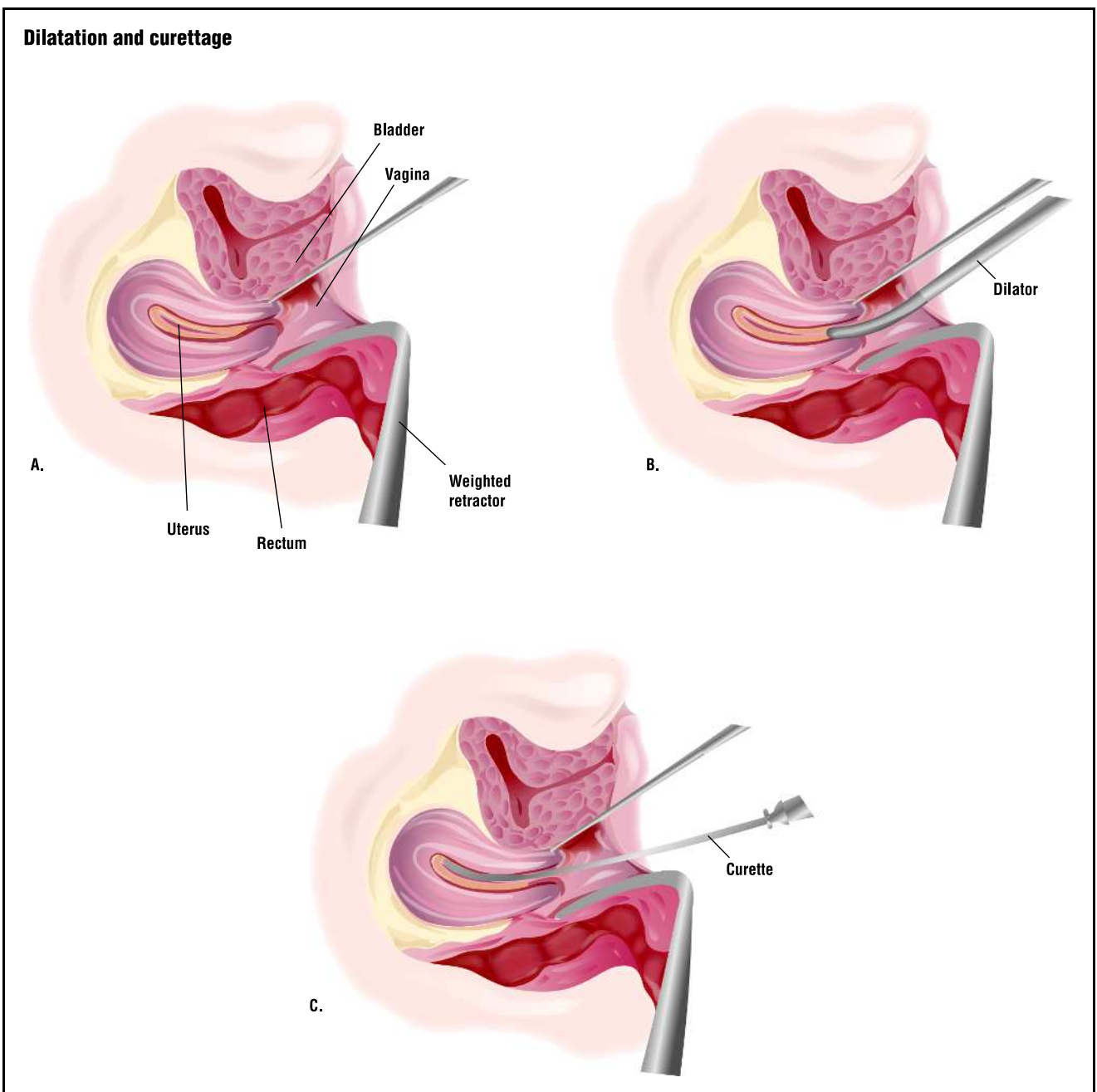
### Definition

Dilatation and curettage (D & C) is a gynecological procedure in which the cervix is dilated (expanded) and the lining of the uterus (endometrium) is scraped away.

### Purpose

D & C is used to diagnose and treat heavy or irregular bleeding from the uterus. Possible reasons for abnormal uterine bleeding include:

- Hormonal imbalance. Often women with abnormal bleeding are first treated with hormones in an attempt to normalize bleeding. D & C may be used to determine the cause of bleeding if hormone treatment is ineffective.
- Endometrial polyps. Polyps are benign growths that may protrude from the uterus by a stem or stalk, usually to the endometrium or cervix. D & C may be used to diagnose polyps or to remove them.
- Uterine fibroids. Also called leiomyomas, fibroids are benign growths in the smooth muscle of the uterus. Abnormal bleeding is often the only symptom of fibroids. D & C is often used to diagnose fibroids and may be used to scrape away small tumors; additional surgery may be needed to remove more extensive growths.
- Endometrial hyperplasia (EH). EH is a condition where the endometrium grows excessively, becoming too thick and causing abnormal bleeding. Tissue samples procured during D & C can be assessed for early signs of cancer.
- Cancer. D & C may be used to obtain tissue for microscopic evaluation to rule out cancer. Women over the age of 40 are at an increased risk of developing endometrial cancer.



For a D&C, the patient lies on her back, and a weighted retractor is placed in the vagina (A). A dilator is used to open the cervix (B), and a curette is used to scrape the inside of the uterus (C). (Illustration by GGS Information Services. Cengage Learning, Gale.)

- Miscarriage, incomplete abortion, or childbirth. Abnormal bleeding may result if some of the products of pregnancy remain in the uterus after a miscarriage or induced abortion, or if parts of the placenta are not expelled naturally after childbirth. These retained products can be scraped out by D & C.

### Description

D & C is usually performed under **general anesthesia**, although local or epidural anesthesia can also be used. **Local anesthesia** lessens risk and costs, but the woman will feel cramping during the procedure. The type of anesthesia used often depends on the reason for the D & C.

## KEY TERMS

**Endometrial polyps**—Growths in the lining of the uterus (endometrium) that may cause bleeding and can develop into cancer.

**Epidural anesthesia**—A type of anesthesia that is injected into the epidural space of the spinal cord to numb the nerves leading to the lower half of the body.

**Uterine fibroid**—A non-cancerous tumor of the uterus that can range from the size of a pea to the size of a grapefruit. Small fibroids require no treatment, but those causing serious symptoms may need to be removed.

During the procedure, which takes only minutes to perform, the doctor inserts an instrument called a speculum to hold open the vaginal walls, and then stretches the opening of the uterus (the cervix) by inserting a series of tapering rods, each thicker than the previous one, or by using other specialized instruments. This process of opening the cervix is called dilation.

Once the cervix is dilated, the physician inserts a spoon-shaped surgical device called a curette into the uterus. The curette is used to scrape away the uterine lining. One or more small tissue samples from the lining of the uterus or the cervical canal are sent for analysis by microscope to check for abnormal cells.

Although simpler, less expensive techniques such as a vacuum aspiration are quickly replacing the D & C as a diagnostic method, it is still often used to diagnose and treat a number of conditions.

### Diagnosis/Preparation

If general anesthesia will be used, the patient will be instructed to refrain from eating and drinking for at least eight hours before the procedure. The doctor may order blood and/or urine tests to scan for certain abnormalities. Because opening the cervix can be painful, sedatives may be given before the procedure begins. Deep breathing and other relaxation techniques may help ease cramping during cervical dilation.

### Aftercare

A woman who has had a D & C performed in a hospital can usually go home the same day or the next day. Many women experience backache and mild

cramps after the procedure, and may pass small blood clots for a day or so. Vaginal staining or bleeding may continue for several weeks.

Most women can resume normal activities almost immediately. Patients should avoid sexual intercourse, douching, and tampon use for at least two weeks to prevent infection while the cervix is closing and to allow the endometrium to heal completely.

### Risks

The primary risk after the procedure is infection. A woman should report to her doctor if she experiences any of the following symptoms:

- fever
- heavy bleeding
- severe cramps
- foul-smelling vaginal discharge

D & C is a surgical operation that has certain risks associated with general anesthesia such as pulmonary aspiration and failed intubation. Rare complications include perforation of the uterus (which usually heals on its own) or puncture of the bowel or bladder (which requires further surgery to repair).

Extensive scarring of the uterus may occur after over-aggressive scraping during D & C, leading to a condition called Asherman's syndrome. The major symptoms of Asherman's syndrome are light or absent menstrual periods, infertility, and recurrent miscarriages. Scar tissue can be removed with surgery in most women, although approximately 20–30% of women will remain infertile after treatment.

### Normal results

Removal of the uterine lining will normally cause no side effects, and may be beneficial if the lining has thickened so much that it causes heavy periods. The uterine lining soon grows again normally, as part of the menstrual cycle.

### Morbidity and mortality rates

D & C has been associated with a 4–10% rate of postoperative complications.

### Alternatives

There are a number of alternatives to D & C, depending on the reason for doing the procedure. Examples of procedures that allow doctors alternative ways of evaluating, sampling, or treating disorders of the inner lining of the uterus include:



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

D & C is generally performed by an obstetrician/gynecologist, a medical doctor who has completed specialized training in the areas of women's general health, pregnancy, labor and childbirth, prenatal testing, and genetics. Samples of the uterine lining may be sent to a pathologist for analysis. A pathologist is a medical doctor who has completed specialized training in the diagnosis of diseases from microscopic analysis of cells and tissues.

The health of the patient and the type of anesthesia used determines where a D & C is performed. The procedure is generally done in a hospital or an outpatient setting.

- Expectant management of spontaneous abortion. D & C is the most commonly used method of treatment for incomplete abortion; one study showed that more than 90% of women who visited hospital emergency rooms for incomplete spontaneous abortion were treated by D & C. Recent studies, however, have shown that expectant management (i.e., no active intervention) is a viable option for women who do not wish to undergo surgery and who are in otherwise good health. Up to 72% of women indicated that that expectant management of incomplete abortion was preferable to medical or surgical intervention.
- Endometrial biopsy. This procedure is similar to D & C in that a curette is used to obtain a sample of endometrial tissue. Little or no cervical dilation is necessary, however, because the curette used in endometrial biopsy is narrower. The cervix is numbed with a local anesthetic, but the patient will still experience cramping.
- Vacuum scraping. A thin plastic tube attached to a suction machine is passed through the cervix and scraped along the endometrium. Vacuum scraping has been shown to have similar success in diagnosing uterine cancer as D & C. Local anesthesia is also used for this procedure.
- Hysteroscopy. A thin telescope called a hysteroscope is inserted through the cervix and used to view the inside of the uterus after it has been expanded with a liquid or gas. The view afforded by the hysteroscope can help to diagnose abnormal growths, accumulation of scar tissue, or other conditions.
- Hysterectomy. A total hysterectomy permanently removes the uterus and cervix. This procedure is

## QUESTIONS TO ASK THE DOCTOR

- Why is D & C recommended for my condition?
- Where will the procedure be performed?
- What alternative therapies are available to me?
- What are my options in terms of anesthesia during the procedure?
- What risks are involved with the procedure?

generally recommended only if a woman no longer desires to have children and no other forms of treatment have been successful. Most hysterectomies are done to treat uterine fibroids and endometriosis (a condition in which the endometrium grows outside of the uterus).

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## Discharge from the hospital

### Definition

Discharge from the hospital is the point at which the patient leaves the hospital and either returns home or is transferred to another facility such as a rehabilitation center or to a nursing home. Discharge involves the medical instructions that the patient will need to fully recover. Discharge planning is a service that considers the patient's needs after the hospital stay and may involve several different services such as visiting nursing care, physical therapy, and home blood drawing.

### Description

Hospitalization is often a short-term event, so planning for discharge may begin shortly after admission. The physicians, nurses, and case managers involved in a patient's care are part of an assessment team that keeps in mind the patient's preadmission level of functioning, and whether the patient will be able to return home following the current hospital admission. Information that could affect the discharge plan should be noted in the patient's medical record so

that it will be taken into account when discharge is being scheduled. The primary questions include:

- Can this patient return to his or her preadmission situation?
- Has there been a change in the patient's ability to care for him- or herself?
- Is the patient in need of services to be able to care for him- or herself?
- Which services will the patient need?
- Are there mental health needs that must be met?
- Does the patient agree with the discharge plan?

While a person has been in the hospital, physicians other than the primary-care physician have been in charge of the patient's care. Good discharge planning involves clear communication between the hospital physician(s) and the primary care physician. This may be done by telephone and/or in writing. The information to be conveyed includes:

- a summary of the hospital stay
- a list of test and surgeries performed, with results
- a list of test results still pending
- a list of tests needed after discharge, such as a repeat chest x ray
- a list of medications the patient is being discharged with, including the dosage and frequency
- a copy of the patient's discharge instructions
- when the patient should see the primary-care physician for a follow-up appointment
- the plan for outpatient treatment, such as home intravenous antibiotics or parenteral nutrition, to ensure that responsibility for this treatment has been clearly transferred and that the primary care physician accepts the treatment responsibility
- discharge instructions to the patient on activity level, diet, and wound care

Before leaving the hospital, the patient will receive discharge instructions that should include:

- an explanation of the care the patient received in the hospital
- a list of medications the patient will be taking (the dosage, times, and frequency)
- a list of potential side effects of any newly prescribed medications
- a prescription for any newly prescribed medications
- when to see the primary-care physician for a follow-up appointment
- home-care instructions, such as activity level, diet, restrictions on bathing, wound care, as well as when

## KEY TERMS

**Ombudsman**—A patient representative who investigates patient complaints and problems related to hospital service or treatment. He or she may act as a mediator between the patient, the family, and the hospital.

**Parenteral nutrition**—The administration of liquid nutrition through an intravenous catheter placed in the patient's vein.

the patient can return to work or school, or resume driving

- signs of infection or worsening condition, such as pain, fever, bleeding, difficulty breathing, or vomiting
- an explanation of any services the patient will now be receiving, such as visiting nurse care, including contact information

The term discharge planning may be used to refer to the service provided to help patients arrange for services such as rehabilitation, physical therapy, occupational therapy, visiting nurses, or nursing **home care**. This service may be provided by a case manager or by the hospital's social service department. The patient may request this service, or the physician may make the request in the form of a referral to the department. The patient will need to be evaluated to see what services he or she requires, as well as what services he or she qualifies for (such as Meals on Wheels), or what services the patient's insurance will cover. The patient may be discharged to the home with a visit from a visiting nurse taking place later the same day to assess the patient's need for these services and to make arrangements for him or her in the home. A person may be discharged home only when certain equipment, such as a hospital-style bed and oxygen, has been delivered to the home. If a patient feels he or she is being discharged before he or she is ready, the patient can file a complaint with the hospital's ombudsman.

A follow-up from the hospital staff, either physician, nurse, or case manager, should take place within two weeks of discharge to review the results of any tests that were done in the hospital that came in after the patient was discharged, to remind the patient of the follow-up appointment with the physician, to see if the patient has any questions about any new medications that were added in the hospital, and to be sure that no problems arose after discharge that have not been addressed. Such follow-up calls help to ensure a successful recovery.

A patient may experience a complication or an adverse event, an injury that happens because of medical management, as a result of care received in the hospital. In the February 2003 issue of *The Annals of Internal Medicine*, researchers reported how often these adverse events arose, and how severe they were. Four hundred patients were interviewed by telephone a few weeks after discharge. Seventy-six patients had suffered an adverse event during the two-week period after discharge, such as a new or worsening symptom, medication-related problems, or the need for an unexpected visit to the doctor. Of that number, 23 were determined to have been caused by error, and 24 were found to have adverse events that could have been made less severe by better care. Of all the events, about 66% were drug related and 17% were related to procedures. Three percent of the patients studied suffered permanent disability.

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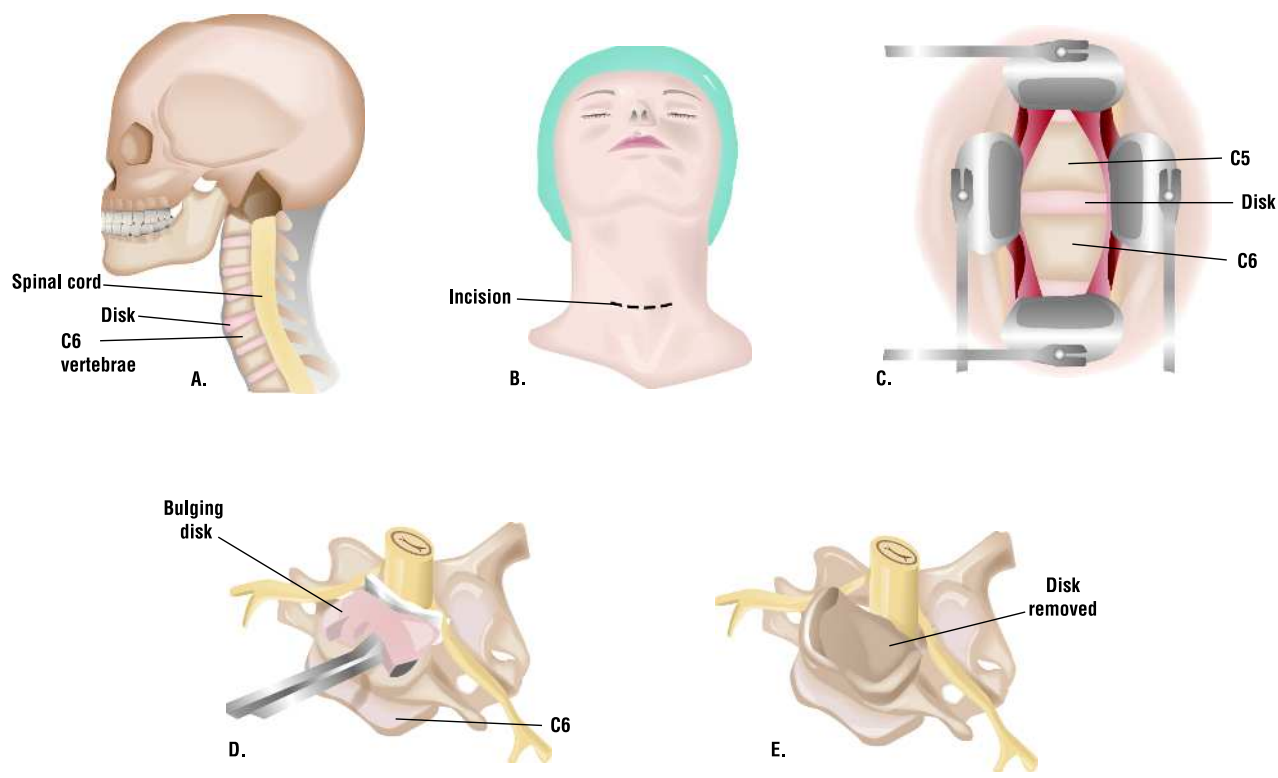
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## Disk removal

### Definition

Disk removal is one of the most common types of back surgery. Discectomy (also called discectomy) is the removal of an intervertebral disk, the flexible plate that connects any two adjacent vertebrae in the spine. Intervertebral disks act as shock absorbers, protecting the brain and spinal cord from the impact produced by the body's movements.

### Disk removal (anterior cervical)



In the anterior cervical disk removal, an incision is made into the patient's neck (B). The cervical disk, which may be herniated, is visualized (C). It is removed completely (D and E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

### Purpose

Removing the intervertebral disk is performed after completion of unsuccessful conservative treatment for back pain that has been present for at least six weeks. Surgery is also performed if there is pressure on the lumbosacral nerve roots that causes weakness, bowel dysfunction, or bladder dysfunction.

As a person ages, the disks between vertebrae degenerate and dry out, and tears form in the fibers holding them in place. Eventually, the disk can develop a blister-like bulge, compressing nerves in the spine and causing pain. This is called a "prolapsed" (or herniated) disk. If such a disk presses on a nerve root and causes muscle weakness, or problems with the bladder or bowel, immediate disk removal surgery may be needed.

The goal of the surgery is to relieve all pressure on nerve roots by removing the pulpy material from the disk, or the entire disk. If it is necessary to remove material from several nearby vertebrae, the spine may

become unstable. In this case, the surgeon will perform a **spinal fusion**, removing all disks between two or more vertebrae, and roughening the bones so that the vertebrae heal together. Bone strips taken from the patient's leg or hip may be used to help hold the vertebrae together. Spinal fusion decreases pain, but decreases spinal mobility.

### Demographics

Approximately 150,000 Americans undergo disk removal each year in the United States.

### Description

The surgery is performed under **general anesthesia**. The surgeon cuts an opening into the vertebral canal, and moves the dura and the bundle of nerves called the "cauda equina" (horse's tail) aside, which exposes the disk. If a portion of the disk has moved out from between the vertebrae and into the nerve canal, it is simply removed. If the disk itself has



## KEY TERMS

**Cauda equina**—A bundle of nerve roots in the lower back (lumbar region) of the spinal canal that controls the leg muscles and functioning of the bladder, intestines, and genitals.

**Computed tomography (CT) scan**—A special type of x ray that produces detailed images of structures inside the body.

**Discectomy (or discectomy)**—The surgical removal of a portion of an intervertebral disk.

**Dura**—The strongest and outermost of three membranes that protect the brain, spinal cord, and nerves of the cauda equina.

**Fusion**—A union, joining together; e.g., bone fusion.

**Herniated disk**—A blister-like bulging or protrusion of the contents of the disk out through the fibers that normally hold them in place. Also called ruptured disk, slipped disk, or displaced disk.

**Intervertebral disk**—Cylindrical elastic-like gel pads that separate and join each pair of vertebrae in the spine.

**Laminectomy**—An operation in which the surgeon cuts through the covering of a vertebra to reach a herniated disk in order to remove it.

**Magnetic resonance imaging (MRI)**—A test that provides pictures of organs and structures inside the body by using a magnetic field and pulses of radio wave energy to detect tumors, infection, and other types of tissue disease or damage, or conditions affecting blood flow. The area of the body being studied is positioned inside a strong magnetic field.

**Myelogram**—The film produced by myelography; a graphic representation of the differential count of cells found in a stained representation of bone marrow.

**Percutaneous**—Denoting the passage of substances through unbroken skin; also refers to passage through the skin by needle puncture, including introduction of wires and catheters by the Seldinger technique.

**Vertebra**—The bones that make up the back bone (spine).

become fragmented and partially displaced, or is not fragmented but bulges extensively, the surgeon removes the damaged part of the disk and the part that lies in the space between the vertebrae.

There are minimally invasive surgical techniques for disk removal, including microdiscectomy. In this procedure, the surgeon uses a magnifying instrument or special microscope to view the disk. Magnification makes it possible to remove a herniated disk with a smaller incision, causing less damage to nearby tissue. Video-assisted arthroscopic microdiscectomy has exhibited good results with less use of narcotics and a shortened period of disability. Newer forms of discectomy are still in the research stage, and are not yet widely available. These include laser discectomy and automated percutaneous discectomy.

Total disk replacement research in the United States is underway. Products under investigation include the ProDisc (made by Spine Solutions, Inc.), and the SB Charite III (made by Link Spine Group, Inc.). In these clinical studies, a significant number of patients who received artificial disk implants report a reduction in back and leg pain; 92.7% state they are satisfied or extremely satisfied with the procedure.

### Diagnosis/Preparation

The physician will obtain x rays and neuroimaging studies, including a computed tomography (CT) scan, myelogram, and magnetic resonance imaging (MRI); and clinical exams to determine the precise location of the affected disk.

An hour before surgery, the patient is given an injection to dry up internal fluids and encourage drowsiness.

### Aftercare

After the operation, the patient is lying flat and face down when he or she awakens. This position must be maintained for several days, except for occasional positional changes to avoid **bedsores**. There may be slight pain or stiffness in the back area.

Patients usually leave the hospital on the fourth or fifth day after surgery. They must:

- Avoid sitting for more than 15–20 minutes.
- Use a reclined chair.
- Avoid bending at the waist, twisting, or lifting heavy objects.

## WHO PERFORMS THIS PROCEDURE AND WHERE IS IT PERFORMED?

Disk removal is performed by an orthopedic surgeon or neurosurgeon in a hospital setting.

- Begin gentle walking (indoors or outdoors), and gradually increase exercise. Exercise should be continued for the next four weeks.
- Begin stationary biking or gentle swimming after two weeks.
- Sleep on a firm mattress.
- Slow down if they experience more than minor pain in the back or leg.
- Refrain from sitting in one place for an extended period of time (e.g., long car ride).

Patients should be able to resume normal activities in four to six weeks.

### Risks

All surgery carries some risk due to heart and lung problems or the anesthesia itself, but this risk is generally very small. (The risk of **death** from general anesthesia for all types of surgery, for example, is only approximately one in 1,600 surgeries.)

The most common risk of the surgery is infection, which occurs in 1–2% of cases. Rarely, the surgery damages nerves in the lower back or major blood vessels in front of the disk. Occasionally, there may be some residual paralysis of a leg or bladder muscle after surgery, but this is the result of the disk problem that necessitated the surgery, not the operation itself.

### Normal results

In properly evaluated patients, there is a very good chance that disk removal will be successful in easing pain. The surgery can relieve pain in 90% of cases; however, there are some people who do not achieve pain relief. This depends on a number of factors, including the length of time that they had the condition requiring surgery. Disk surgery has a “good to excellent” result in 87% of patients over age 60. The surgery can relieve both back and leg pain, especially the latter.

### Alternatives

Prior to disk removal surgery, a patient usually undergoes treatment with medical or physical therapy.

## QUESTIONS TO ASK THE DOCTOR

- Is disk removal the only option available?
- What results are anticipated?
- How many disk removal surgeries has the surgeon performed?
- What are the risks?

Disk removal surgery may be indicated if these treatments are ineffective, or if emergency symptoms (i.e., bladder and bowel dysfunction) develop.

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National Institutes of Health. 9000 Rockville Pike, Bethesda, MD 20892. (301) 496 4000. Email: NIHInfo@OD.NIH.GOV. <http://www.nih.gov/>.  
 North American Spine Society. 22 Calendar Court, 2nd Floor, LaGrange, IL 60525. (877) Spine Dr. E mail: info@spine.org. <http://www.spine.org>.

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Diskectomy see **Disk removal**

## Diuretics

**Definition**

Diuretics are drugs that help to reduce the amount of water in the body. They are sometimes called water pills.

**Purpose**

Diuretics are used to treat the buildup of excess fluid in the body. Medical conditions such as congestive heart failure, liver disease, kidney disease, and hormonal imbalances can cause fluid to accumulate and tissues to swell (edema). Certain medications can also cause water retention. When there is too much fluid in the body, blood pressure increases and the heart must work harder to pump. Therefore, diuretics are also often the first drug prescribed to treat high blood pressure (hypertension). They are the least expensive drug that effectively treats hypertension in many people.

When blood enters the kidney, water, waste products, and dissolved charged particles (ions) such as sodium (Na) and potassium (K) are filtered out of the blood and into special tubules in the kidneys. As they travel through these tubules, some water and particles are reabsorbed, and the rest are excreted as urine. In general, diuretics work by increasing the amount of ions and water that are excreted, thus increasing urine output and reducing the fluid load

of the body. This, in turn, lowers blood pressure and reduces tissue swelling so that the heart does not have to work as hard.

Diuretics also may be used in surgery to reduce blood pressure and swelling. For example, mannitol, an osmotic diuretic, may be used to reduce swelling in the brain in some neurosurgical procedures.

**Description**

There are several classes of diuretics. Each class works in a slightly different way, although the end function of all diuretics is to eliminate excess water from the body. The different classes of diuretics include:

- Loop diuretics include bumetanide (Bumex), furosemide (Lasix), torsemide (Cemadex), and ethacrynic acid (Edecrin). They get their name from the loop-shaped part of the kidney tubules (the loop of Henle) where they have their effect.
- Thiazide and thiazide-like diuretics include such commonly used diuretics as hydrochlorothiazide (HydroDIURIL, Esidrix), chlorothiazide (Diuril), and chlorthalidone (Hygroton).
- Potassium-sparing diuretics help the body retain potassium while losing sodium and water. With many diuretics, potassium is lost from the body along with sodium. Too little potassium can cause serious health problems, because potassium plays a critical role in many metabolic functions. Examples of potassium-sparing diuretics are spironolactone (Aldactone), amiloride (Midamor) and triamterene (Dyrenium).
- Osmotic diuretics keep water from being reabsorbed in the kidney. Mannitol, which is given by intravenous drip, is commonly used to reduce cerebral edema (swelling of the brain). Glycerol is also an osmotic diuretic. Osmotic diuretics are used under special circumstances and are not routinely given to control high blood pressure.
- Carbonic anhydrase inhibitors cause water loss through the kidneys by changing the acidity of urine, but their most common use is in treatment of glaucoma, an eye disease caused by increased pressure in the eye. Acetazolamide (Diamox), dichlorophenamide (Daranide), and methazolamide (Nepatazane) are often given by mouth, even though they primarily treat an eye condition.

In addition, some drugs contain combinations of two diuretics. The brands Dyazide and Maxzide, for example, contain the thiazide diuretic hydrochlorothiazide along with the potassium-sparing diuretic triamterene.

## KEY TERMS

**Lupus erythematosus**—A chronic autoimmune disease that affects the skin, joints, and certain internal organs.

**Pancreas**—A gland located near the liver, the pancreas produces enzymes and fluids that help to breakdown food. It also produces the hormone insulin that the body must have to utilize sugar (glucose).

**Potassium**—A mineral found in whole grains, meat, legumes, and some fruits and vegetables. Potassium is important for many body processes, including proper functioning of nerves and muscles.

**Triglyceride**—A substance formed in the body from the breakdown of fat in the diet. Triglycerides are the main fatty materials in the blood. Triglyceride levels are important in the diagnosis and treatment of many diseases, including high blood pressure, diabetes, and heart disease.

Some nonprescription (over-the-counter, OTC) medicines and herbal remedies also function as diuretics. However, the drugs described here cannot be bought without a physician's prescription. They are available in tablet, capsule, liquid, and injectable forms.

### Recommended dosage

The recommended dosage depends on the type of diuretic, the condition it treats, and the individual's size, age, and health. Patients should check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage and then take the medicine exactly as directed.

### Precautions

Seeing a physician regularly while taking a diuretic is important. The physician may order blood work and will do a **physical examination** to make sure the diuretic is working as it should without unwanted side effects.

For patients taking a class of diuretic that can cause large amounts of potassium to be excreted, physicians may recommend adding potassium-rich foods such as bananas to the diet, and they may suggest taking a daily potassium supplement. If the physician recommends any of these measures, the patient must make sure to closely follow the directions. The patient should not make other significant diet changes

or take any dietary supplements without checking with the physician. People who are taking potassium-sparing diuretics should not add potassium to their diets, as too much potassium may be harmful.

Patients taking potassium-sparing diuretics should know the signs of too much potassium and should check with a physician as soon as possible if any of these symptoms occur, including:

- irregular heartbeat
- breathing problems
- numbness or tingling in the hands, feet, or lips
- confusion or nervousness
- unusual tiredness or weakness
- weak or heavy feeling in the legs

Patients taking diuretics that cause potassium loss should know the signs of too little potassium and should check with a physician as soon as possible if they have any of these symptoms, including:

- fast or irregular heartbeat
- weak pulse
- nausea or vomiting
- dry mouth
- excessive thirst
- muscle cramps or pain
- unusual tiredness or weakness
- mental or mood changes

People who become ill with gastrointestinal diseases while taking diuretics may lose too much water or potassium if they have severe vomiting and diarrhea.

Diuretics drugs make some people feel light-headed, dizzy, or faint when they get up after sitting or lying down. Older people are especially likely to have this problem. Drinking alcohol, exercising, standing for long periods, or being outdoors in hot weather may make the problem worse. To lessen this problem, a person should get up gradually and hold onto something for support if possible. The patient should avoid or limit the amount of alcohol he or she drinks and be careful in hot weather or when exercising or standing for a long time.

People who take a diuretic should tell the health-care professional before having surgical or dental procedures, medical tests, or emergency treatment.

### Special conditions

People who have certain medical conditions or who are taking certain other drugs may encounter problems if they take diuretics. Before taking diuretic



drugs, they should be sure to let the physician know about these conditions.

**ALLERGIES.** Anyone who has had unusual reactions to diuretics or **sulfonamides** (sulfa drugs) in the past should let the physician know. The physician should also be told about any allergies to foods, dyes, preservatives, or other substances.

**PREGNANCY.** Diuretics will not help the swelling of hands and feet that some women experience during pregnancy. Pregnant women should not use diuretics unless prescribed by their obstetrician or other physician. Although studies have not been done on pregnant women, studies of laboratory animals show that some diuretics can cause harmful effects when taken during pregnancy.

**BREASTFEEDING.** Some diuretics pass into breast milk, but no reports exist of problems in nursing babies whose mothers use this medicine. However, thiazide diuretics may decrease the flow of breast milk. Women who are breastfeeding and need to use a diuretic should check with the physician.

**OTHER MEDICAL CONDITIONS.** Side effects of some diuretics may be more likely in people who have had a recent heart attack or who have liver disease or severe kidney (renal) disease. Other types of diuretics may not work properly in people with liver disease or kidney disease. Diuretics may worsen certain medical conditions such as gout, kidney stones, pancreatitis, lupus erythematosus, and hearing problems. In addition, people with diabetes should be aware that a diuretic may increase blood sugar levels. People with heart or blood vessel disease should know that some diuretics increase cholesterol or triglyceride levels. The risk of an allergic reaction to certain diuretics is greater in people with bronchial asthma. Before using diuretics, people with any of these medical conditions should make their physicians aware of their medical history. Also, people who have trouble urinating or who have high blood levels of potassium may not be able to take diuretics and should discuss these conditions with their physician before using them.

### Side effects

Some people feel unusually tired when they first start taking diuretics. This effect usually becomes less noticeable over time, as the body adjusts to the medicine. Other side effects, such as loss of appetite, nausea, vomiting, stomach cramps, diarrhea, and dizziness, usually lessen or go away as the body adjusts to the diuretic drug. These problems usually do not need

medical attention unless they continue or interfere with normal activities.

Some diuretics make the skin more sensitive to sunlight. Even brief exposure to sun can cause severe sunburn, itching, a rash, redness, or other changes in skin color. While being treated with this medicine, the person should avoid being in direct sunlight; wear a hat and tightly woven clothing that covers the arms and legs; use a sunscreen with a skin protection factor (SPF) of at least 15; protect the lips with a sun-block lipstick; and not use tanning beds, tanning booths, or sunlamps. People with fair skin may need to use a sunscreen with a higher SPF.

Because diuretics increase urine output, people who take this medicine may need to urinate more often, even during the night. Healthcare professionals can help patients schedule their doses to avoid interfering with their sleep or regular activities.

### Interactions

Diuretics may interact with other drugs, herbs, or dietary supplements. When this occurs, the effects of one or both of the drugs become either more or less effective or the risk of side effects may increase. Anyone who takes a diuretic should inform the healthcare providers about all other prescription and over-the-counter drugs, herbs, and dietary supplements that he or she is taking in order to avoid harmful interactions.

Some common drugs that may interact with diuretics include:

- Angiotensin-converting enzyme (ACE) inhibitors such as benazepril (Lotensin), captopril (Capoten), and enalapril (Vasotec), which are used to treat high blood pressure. Taking these drugs with potassium-sparing diuretics may cause levels of potassium in the blood to be too high, increasing the chance of side effects.
- Cholesterol-lowering drugs such as cholestyramine (Questran) and colestipol (Colestid). Taking these drugs with combination diuretics such as Dyazide and Maxzide may keep the diuretic from working. The person should take the diuretic at least one hour before or four hours after the cholesterol-lowering drug.
- Cyclosporine (Sandimmune), a drug that suppresses the immune system. Taking this medicine with potassium-sparing diuretics may increase the chance of side effects by causing levels of potassium in the blood to be too high.
- Potassium supplements, other drugs or supplements containing potassium, or salt substitutes that contain

potassium. Taking these with potassium-sparing diuretics may lead to too much potassium in the blood, increasing the chance of side effects.

- Lithium, used to treat bipolar disorder (manic-depressive illness). Using this medicine with potassium-sparing diuretics may allow lithium to build up to poisonous levels in the body.
- Digitalis, also called digoxin (Lanoxin) or digitoxin. Using this medicine with combination diuretics such as triamterene-hydrochlorothiazide (Dyazide, Maxzide) increases the chance of irregular heartbeat.

The list above does not include every drug or herb that may interact with diuretics. The patient should check with a physician or pharmacist before combining diuretics with any other prescription or over-the-counter drugs, herbal medicines, or dietary supplements.

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Diverticulectomy see **Meckel's diverticulectomy**

## Diverticulitis

### Definition

Diverticulitis is a condition in which tiny outpouchings of the colon (large intestine) become inflamed and infected. These outpouchings are called

diverticuli; the term that describes the presence of many of these diverticuli is "diverticulosis." Together, these conditions are referred to as diverticular disease.

### Demographics

People can have diverticulosis without having any symptoms, and not all people with diverticulosis go on to develop diverticulitis. About 10% of people over 40 have diverticulosis; of these, about 10-25% will eventually develop diverticulitis in one or more of the diverticular pouches.

### Description

Although the cause of diverticular disease is not completely understood, a low-fiber diet is thought to be an important factor. People who live in industrialized countries where low-fiber diets are prevalent (the United States, Great Britain, Australia) have higher rates of diverticular disease than do individuals living in arts of the world where higher-fiber diets are common (such as Asia). Low-fiber diets often result in some degree of constipation, requiring straining during defecation. This straining causes increased pressure in the colon, which may result in the development of diverticuli. When a bit of stool blocks the diverticulum, bacteria within the pouch may have the opportunity to grow, resulting in the infection of diverticulitis.

While some people can have diverticulosis without any recognizable symptoms, other people have clear-cut discomfort related to the condition, including bloating, cramps, and constipation. Diverticulitis causes more severe symptoms, such as

- Severe abdominal pain and cramping
- Fever and chills
- Nausea and vomiting
- Bleeding
- Fistula formation (most commonly between the colon and the bladder)
- Intestinal obstruction

Severe complications of untreated diverticulitis can result in a walled off, pus-filled area of infection called an abscess. Perforation of the diverticular pouch, may also occur, resulting in leakage of intestinal contents into the abdomen, and peritonitis (a severe and life-threatening infection of the lining of the abdominal cavity).

### Diagnosis/Preparations

Asymptomatic cases of diverticulosis are often diagnosed during medical exams (such as colonoscopy)

## KEY TERMS

**Colostomy**—A temporary or permanent diversion in which the colon opens to the outside of the body through a hole (stoma). Stool is collected outside of the body in a bag attached to the colostomy.

**Fistula**—An abnormal connection between two organs, or between an organ and the outside of the body.

**Stoma**—An opening in the body fashioned by a surgeon.

done for screening or other purposes. Diverticular disease can also be diagnosed with **barium enema** or **CT scan**. If bleeding is suspected, a radionuclide angiogram may be ordered, in order to evaluate the extent of bleeding.

### Treatment

Treatment of diverticulosis starts with increasing fiber in the diet. However, once diverticulitis sets in, dietary interventions are insufficient. Diverticulitis must be treated with hospitalization, intravenous **antibiotics** (such as ampicillin, piperacillin, ciprofloxacin, and cefoxitin), nasogastric tube and suction to remove accumulating gastric juices (in the case of intestinal obstruction), and bowel rest (taking nothing by mouth or staying on a liquid diet until the intestine has healed sufficiently).

In some cases, surgical intervention will be required. Surgery may utilize a traditional open incision (**laparotomy**) or may be achieved through minimally invasive, laparoscopic techniques (**laparoscopy**), using several tiny incisions, a lighted fiberoptic scope, and miniaturized surgical instruments. The section of the colon with the infected diverticuli will be removed (bowel resection). In uncomplicated cases of diverticulosis, the two remaining ends of intestine will be attached to each other, restoring an intact gastrointestinal tract.

When severe inflammation and infection are present, however, the remaining ends cannot be rejoined immediately. The remaining end of the colon closest to the rectum will be closed off temporarily. The end of the colon that is continuous with the small intestine will be brought to the surface of the abdomen and connected up with a temporary stoma (hole) through the abdomen. This allows stool to exit through this **colostomy**, into a special bag that can be put over the stoma to catch the feces. After a few months, a second operation will be performed to close the stoma and reattach the ends of the colon to each other.

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DNR order see **Do not resuscitate order (DNR)**

## Do not resuscitate (DNR) order

### Definition

A do not resuscitate (DNR) order is a kind of advanced medical directive allowed by a 1991 federal law. The law expanded the notion of patient autonomy to situations in which patients may not be able to make crucial medical decisions due to incapacitation. A DNR order instructs medical personnel not to perform life-saving **cardiopulmonary resuscitation** (CPR) or other procedures to restart the heart or breathing once it has ceased. By law, the DNR directive must be offered as an option to patients by health providers in and, in some states, outside a hospital setting. Once signed, the DNR directive must be placed in the patient's chart.

### Purpose

With such advanced cardiopulmonary techniques as CPR, it is possible to keep almost any patient's heart and lungs functioning, independent of how terminal or hopeless his or her medical condition becomes. The DNR program is designed to help people in the final stages of a terminal illness or those who are suffering from intractable pain the option for deciding against life-saving measures that may only prolong their pain and inevitable **death**. The option of deciding against life-saving measures is considered to be a formal part of patient autonomy and is respected as an ethical subset of medical **informed consent**.

### Description

DNR orders affect a small group of patients and are designed to avoid the suffering of a terminal illness or other serious conditions that are medically irreversible. The order actually authorizes medical treatment to be

## KEY TERMS

**Advanced medical directive**—A legal document drafted by a patient, in advance, ordering specific medical procedures to be offered or withheld if they are incapacitated.

**Cardiopulmonary resuscitation (CPR)**—A set of medical procedures used in an emergency to restart the heart and lungs.

**Medical agent**—A designated representative for the patient who, in advance, is legally empowered to carry out their wishes with respect to medical care.

**Medical surrogate**—Another name for a medical agent or person legally designated to represent the patient with medical providers.

withheld. It is included with the medical orders in the medical chart, and with it, hospital and pre-hospital personnel are restricted from using CPR techniques and other measures to revive the patient.

Some states allow DNR orders only in hospital settings. Other states allow DNR orders to be honored by emergency responders working outside the hospital setting. Over half of the states in the United States have pre-hospital DNR orders. A physician must sign the pre-hospital DNR directives. The state's emergency medical service (EMS) department or state medical association administers the programs. In some states, the DNR may be called a pre-hospital medical care directive or a comfort care-only document.

A DNR order can be revoked at any time in any way that effectively communicates the patient's desire. It can come from the patient in the form of a letter or document. It can come from the patient telling an emergency provider to disregard the order. The revocation can be invoked by removing any bracelet or medallion that indicates DNR status. It can be communicated by the designated health agent or patient representative who has the power to express the patient's wishes to health providers. Some states maintain a registry for individuals with DNR orders. It is important to find out about a state's service for DNR and its particular legal forms and requirements. Many patients who die in a hospital have had a DNR order.

## Preparation

Do not resuscitate orders are a part of advanced medical directives. Advanced directives are legal documents that place limits on medical treatment, guide medical providers on the wishes and options of the patient,

and help family members and providers make decisions in accordance with the patient's wishes. Advanced directives are prepared in advance and may include a **living will** that details the patient's wishes should he or she become incapacitated. A DNR order is a very specific order that medical treatment be withheld, especially CPR. Finally, a medical agent or a person with a durable medical **power of attorney** is usually appointed to carry out all wishes of the patient and to make sure that specific wishes, like DNR, are honored.

An advanced directive for withholding resuscitation can be prepared by requesting a form from the physician, by writing down that wish, by having a lawyer draft a living will, or by using computer software for legal documents. States differ in the respect of whether the documents must be cosigned or notarized. Crucial to the effort is that the physician be told of the wishes of the patient.

## Normal results

DNR law varies from state to state, but the common features include:

- Formal documents that providers or responders can readily recognize in charts or on display in the home.
- DNR bracelets or medallions that the patient wears and providers are trained to recognize.
- DNR must be signed by a physician before responders or other providers may honor them.
- Once in effect, DNR orders include only certain life-preserving procedures, like CPR. Comfort treatment is not withheld, and the alleviation of pain is still pursued by providers.
- Physicians or other providers who are unwilling to carry out the order (for moral or professional reasons) are required to transfer the care of the patient to another provider who will carry out the DNR order.

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Dopamine see **Adrenergic drugs**

Doppler echocardiography see

**Echocardiography**

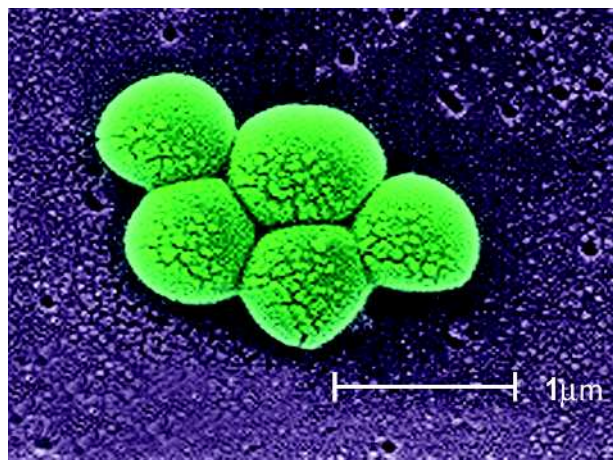
Doxycycline see **Tetracyclines**

Dressings see **Bandages and dressings**

## Drug-resistant organisms

### Definition

Drug-resistant organisms include bacteria and other pathogens that are not affected by one or more pharmaceutical products. Stated differently, one or more drugs are no longer able to control or kill a particular bacterium or pathogen.



Methicillin-resistant staph bacteria. (Scott Camazine / Alamy)

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

- Testing of an organism for drug-resistance is done by a medical technologist or a clinical microbiologist.
- Treatment of drug-resistant organism is typically ordered by a specialist in infectious diseases and administered by a nurse.

### Purpose

With the possible exception of being used as a biological weapon, there is no desired purpose for a drug-resistant organism.

### Demographics

In the 1940s, penicillin resistance to *staphylococcus aureus* was first reported. Other strains of pathogens have become drug resistant since that time. The rate of drug resistance is increasing more rapidly than the number of new drugs that are being discovered.

### Description

Drug-resistant organisms are pathogens that have become immune to the effects of one or more drugs that once controlled or eliminated them. One common mechanism for creating drug resistance is inadequate treatment. People discontinue use of a drug before all pathogens have been eliminated. Those that remain tend to be harder and more difficult to kill. Over time, the remaining pathogens are likely to mutate and acquire immunity to a drug used to treat them.

Some pathogens have become resistant to more than one drug. Tuberculosis is an example of a pathogen that has become resistant to multiple drugs.

Examples of drug-resistant organisms include the following:

- MRSA—methicillin-resistant *Staphylococcus aureus*
- MRSE—methicillin-resistant *Staphylococcus epidermitis*
- VRE—vancomycin-resistant *enterococcus*
- PRSP—penicillin-resistant *Streptococcus pneumonia*
- TB—*mycobacterium tuberculosis*

## QUESTIONS TO ASK YOUR DOCTOR

- Is an organism drug-resistant?
- Are alternative drugs available for treatment?
- What is the cost of alternative drugs?
- What are the side-effects of alternative drugs?

### Diagnosis/Preparation

Drug-resistant organisms are identified by isolation and drug susceptibility testing. These procedures are conducted in a clinical laboratory by a medical technologist or a clinical microbiologist.

### Aftercare

Appropriate treatment after being exposed to a drug-resistant organism is to administer a different drug to which an organism or pathogen is sensitive.

The Centers for Disease Control and Prevention recommend that the following steps be taken after possible contact or exposure to a drug-resistant organism:

- Washing one's hands with soap and hot water
- Wearing disposable gloves if contact with body fluids contaminated with drug-resistant organisms is likely to occur; wash hands after removing the gloves
- Towels and bedding used by persons with a drug-resistant organism should be regularly changed
- Towels used by caregivers should be washed in hot water or discarded after use

### Risks

Healthy persons have a low risk for contracting drug-resistant organisms. Centers for Disease Control and Prevention guidelines permit (but do not encourage) casual touching or brief hugging of persons with drug-resistant organisms. Washing hands with hot water and soap after casual contact with a person infected with drug-resistant organism is strongly encouraged.

The following risk factors increase the likelihood of becoming infected with a drug-resistant organism:

- Having a serious or severe illness such as diabetes mellitus
- Having chronic renal failure
- Experiencing open skin lesions or a dermatitis

## KEY TERMS

**MDR**—Multiple drug-resistance

**XTB**—Extreme drug-resistant tuberculosis

- Having been recently catheterized or undergone renal dialysis
- Having been previously treated for a drug-resistant organism
- Being over age 65
- Taking a steroid or other drug that can suppress the immune system
- Being hospitalized for more than 10 days

### Normal results

An alternate drug, if available, must be found when an organism becomes drug-resistant.

### Morbidity and mortality rates

Alternative drugs may have unwanted side-effects.

Accurate morbidity and mortality data are not generally available.

### Alternatives

Alternatives may or may not be available. They may have unwanted side-effects or be more expensive than the drug to which a pathogen has become resistant.

An alternate drug, if available, must be found when an organism becomes drug-resistant.

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## ORGANIZATIONS

- American Academy of Family Physicians. 11400 Tomahawk Creek Parkway, Leawood, KS 66211–2672. (913) 906–6000. E mail: [fp@aafp.org](mailto:fp@aafp.org). <http://www.aafp.org>.
- American Academy of Pediatrics. 141 Northwest Point Boulevard, Elk Grove Village, IL 60007–1098. (847) 434–4000, Fax: (847) 434–8000. E mail: [kidsdoc@aap.org](mailto:kidsdoc@aap.org). <http://www.aap.org/default.htm>.
- American College of Physicians. 190 N. Independence Mall West, Philadelphia, PA 19106–1572. (800) 523–1546, x2600, or (215) 351–2600. <http://www.acponline.org>.

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Drugs used in labor see **Uterine stimulants**

Durable medical power of attorney see **Power of attorney**

Dying see **Death and dying**

# E

## Ear, nose, and throat surgery

### Definition

Ear, nose, and throat surgery is the surgical treatment of diseases, injuries, or deformations of the ears, nose, throat, head, and neck areas.

### Purpose

The purpose of surgery to the ears, nose, throat, head, and neck is to treat an abnormality, such as a defect or disease, in these anatomical areas. An anatomical deformity is a change that usually occurs during embryological development, leaving the affected person with the apparent defect. A disease in this area usually develops later in life, such as head and neck cancer. Additionally, the specialty known as otorhinolaryngology (ears [*oto*], nose [*rhino*], and throat [*laryn*], referring to the larynx or throat) also includes surgical intervention for diseases in the head and neck regions. Most ears, nose, and throat (ENT) surgeons in the United States are referred to as otolaryngologist and the specialty as otolaryngology. Ear surgery is usually performed to correct specific causes of hearing loss. Nose surgery can include different types of procedures necessary to treat sinus problems, like sinus surgery. Throat surgery can include complicated procedures such as cancer of the larynx resulting in a **laryngectomy**, or more simple procedures such as surgical removal of the adenoids, known as an **adenoidectomy**, or tonsils, known as a **tonsillectomy**. Head and neck surgery may be necessary to remove a tumor or reconstruct an area after disfigurement from trauma or injury.

### Demographics

Ears, nose, and throat surgery comprises many different types of surgical procedures and spans over all age groups regardless of gender or ethnicity.

Pediatric otolaryngology, a subspecialty, is the branch that treats ENT problems for infants and children.

### Description

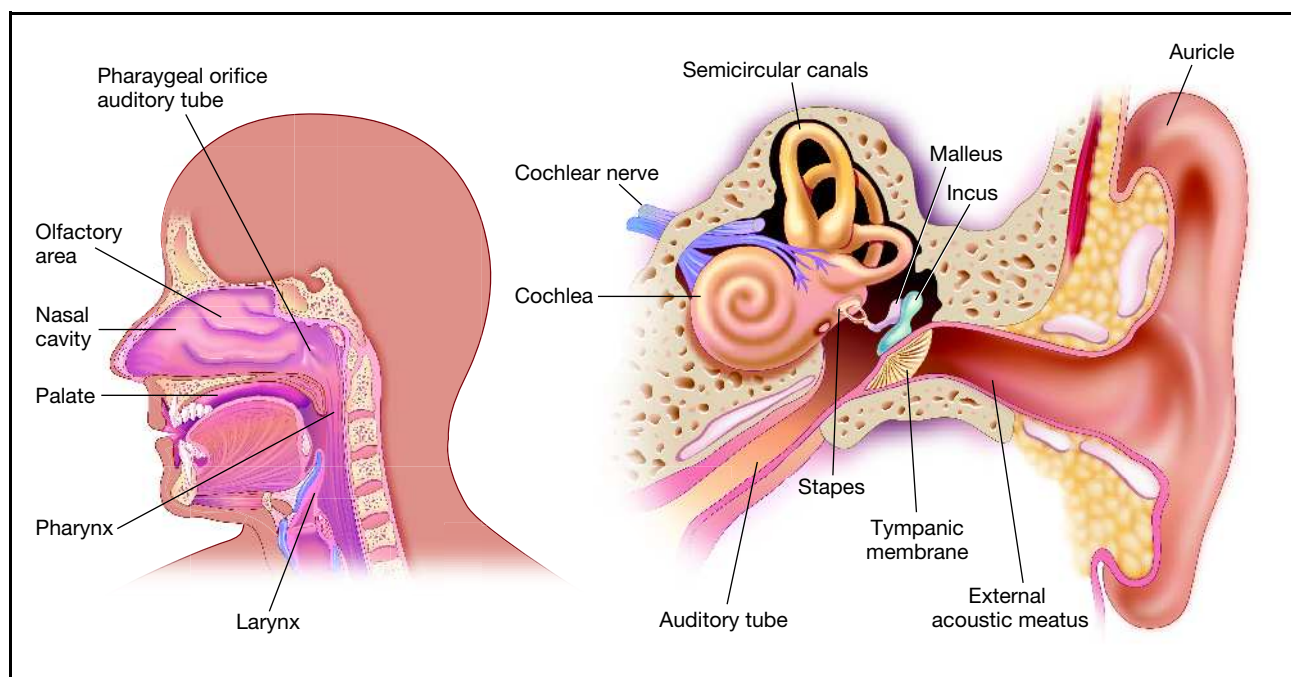
ENT surgery is the oldest surgical specialty in the United States, and it is one of the most elaborate fields of surgical specialty services, using advanced technology and a broad range of procedures that also includes major **reconstructive surgery** to correct deformity or injury. **Cosmetic surgery** can include surgical procedures to improve wrinkles in the face, contours of the nose and ears, chin augmentation, and **hair transplantation**.

Typically, ear surgery corrects defects causing hearing loss or impairment. Such procedures include **stapedectomy**, the removal of all or part of a bone in the middle ear called the stapes; **tympanoplasty**, or reconstruction of the ear drum; and **cochlear implants**, which is implantation of a device to stimulate nerve ends within the inner portion of the ear to enable hearing. Surgery of the ear also includes myringotomy, or insertion of ear tubes to drain fluid in persons with chronic ear infections.

Common surgical procedures of the throat include removal of tonsils (tonsillectomy) or adenoids (adenoidectomy). The tonsils, found on either side and in back of the throat, and adenoids, which are higher up the throat behind the nose, are masses of lymph tissue that play an active role in body defenses to fight infection. The tonsils and adenoids can get chronically infected, in which case surgical removal is usually indicated to relieve breathing problems and infection recurrence. Furthermore, chronic inflammation of the adenoids can cause repeated middle ear infections that can ultimately impair hearing.

Surgery of the nose can include procedures that treat sinus diseases. Advanced endoscopic surgery for sinus and nasal disorders can eliminate the need for external incisions and greater surgical precision. Other common surgical procedures include correction of a





(Illustration by Electronic Illustrators Group.)

deviated nasal septum (**septoplasty**) and for chronic nasal obstruction (congestion).

Surgery of the neck region can commonly include **tracheotomy**, a surgical procedure in which an opening is made in the trachea or windpipe. Tracheotomy is indicated for a person who is unable to deliver enough oxygen to the lungs. ENT surgeons also perform complicated surgical procedures for the treatment of malignant head and neck cancers. In addition to **tumor removal**, when indicated, ENT surgeons may perform an operation called **radical neck dissection**, during which the ENT will remove cancer that has spread via lymphatic vessels to regional neck lymph nodes. Neck dissection is also useful since specimens can be removed for pathological examination, which can provide important information concerning metastasis, or spread, and can direct the treatment plan (i.e., radiation therapy and/or chemotherapy may be recommended for aggressive cancers). ENT surgeons also treat sleep-related disorders such as sleep apnea and excessive snoring; a procedure called laser-assisted uvula palatoplasty (LAUP) will remove tissue to allow for unobstructed airflow.

Other ENT procedures include surgical reconstruction of ear deformities (otoplasties), special surgery for diseases in the inner ear, and skull-based surgeries (neuro-otology). As well, ENT surgeons can surgically treat abnormalities near the eye, perform oral surgery for treatment of dental and jaw

injury, and remove skin cancer within the head and neck region. ENT surgeons also perform special surgical techniques that can preserve nerve and blood vessel function (**microsurgery**) and reconstruction of bone and soft tissue.

### Diagnosis/Preparation

A careful history and **physical examination** of the ears, nose, throat, head, and neck is a standard approach during initial consultation. Different instruments with light sources, like an otoscope for ear examinations, enable ENT surgeons to quickly visualize the ears, nose, and throat. Visualization of these areas can reveal the severity of the disease or deformity. The head and neck area is inspected and the neck and throat area is typically felt with the surgeon's hands, a technique known as palpation. Special technological advancements have enabled ENT surgeons to further visualize deep internal anatomical structures. Nasal endoscopy allows visualization of the upper airway to detect anatomical problems related to sinuses. Videostroboscopy can be used to visualize the vocal cords, and triple endoscopy (laryngoscopy, esophagoscopy, and **bronchoscopy**) can diagnose and stage head and neck cancers. Preparation before surgery is fairly standardized and includes blood work-up and instructions to have nothing to eat or drink after midnight of the night before the procedure.

## KEY TERMS

**Cancer staging**—A surgical procedure to remove a lymph node and examine the cells for cancer. It determines the extent of the cancer and how far it has spread.

## Aftercare

The aftercare for ENT surgery depends on the procedure and state of the health of the patient. The aftercare for a patient who is 60 years old with head/neck cancer is more extensive than a tonsillectomy performed in a young adolescent or child. Generally, aftercare should be directed toward **wound care** and knowledge gained from the surgeon specifically detailing the expected length of average convalescence. Wound care, such as cleansing and dressing changes, and postoperative follow-up with the ENT surgeon is essential. Medications for pain may be prescribed. Patients stay in the hospital for eight to 10 hours for the effects of anesthesia to subside for same-day surgical procedures like a tonsillectomy, or they may be admitted for a few days for more complicated procedures, such as those related to cancer treatment. Aftercare and convalescence may take longer for complicated procedures such as advanced cancer, temporal-bone surgery for nerve disorders that can affect balance, or for tumors.

## Risks

The risk of ENT surgery depends on the procedure and the health status of the patient. Some procedures do not have much risk, while complications for other procedures can carry considerable risk. For example, the risk of a complicated operation such as neck dissection could result in loss of ear sensation, since the nerve that provides the feeling of sensation is commonly severed during the procedure.

## Normal results

There will be a cure or an improvement of the primary disease. Ear surgery should help individuals hear well. Throat surgery can help remove chronically inflamed tonsils, adenoids, polyps, or cancer. Nose surgery for deviated septums or nasal congestion will improve breathing problems and help a person breathe more easily and effectively through the nose. Neck surgery can help remove diseased tissue and prevent

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The procedure is usually performed in a hospital that has an ENT department. The ENT surgeon receives one year of general surgical training and five years of training in the disease of and the surgery of the ears, nose, throat, head, and neck. Most surgeons are board certified. Some ENT surgeons obtain a further one to two years of advanced training in one of the seven areas of subspecialty that includes otology/neuro-otology; pediatric otolaryngology; head and neck area; facial plastic and reconstructive surgery; rhinology (treatment of diseases of the sinuses and nose); laryngology (treatment of throat diseases); and allergy. The department typically provides other professional clinical services during diagnosis and treatment, such as speech-language pathologists and hearing specialists. Larger medical centers may also have one or two medical researchers on staff.

further spread of cancer. Surgery for sleep apnea will remove redundant tissue that blocks airways and obstructs normal airflow.

## Morbidity and mortality rates

Outcome and disease progression vary for each disease state. There are no general statistics for all ENT procedures. Some procedures are generally correlated with excellent morbidity, such as over 90% success rates for all cases receiving tympanoplasty, and no mortality, while others may be associated with poor outcome and much illness, like advanced head/neck cancer.

## Alternatives

Usually, surgery is indicated when benefit from surgery is a clear-cut primary intervention or when medical, or conservative treatment has failed to provide sustained symptomatic improvement. A person diagnosed with cancer may not have an alternative conservative treatment, depending on the stage of their cancer; however, a person with sinus problems may be treated conservatively with **antibiotics**, saline nasal spray wash, steroid nasal spray, and/or antihistamine spray before indication or necessity for surgery. There are many other services that the ENT surgeon uses to treat specific diseases, including audiology services for

## QUESTIONS TO ASK THE DOCTOR

- What can I expect in the postoperative period?
- What are the aftercare recommendations for my specific surgical procedure?
- What are the expected normal results for my procedure?
- What medications will I be given to relieve any postoperative discomfort?
- Are there any side effects that I should expect in the postoperative period?

diagnostic and therapeutic purposes, like hearing aids, and services to treat disorders of speech and voice.

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American Academy of Otolaryngology Head and Neck Surgery, One Prince Street, Alexandria, VA, 22314 3357, (703) 836 4444, <http://www.entnet.org>.

American Hearing Research Foundation, 8 S. Michigan Avenue, Suite 814, Chicago, IL, 60603, (312) 726 9670, <http://www.americanhearing.org/>.

American Speech Language Hearing Association, 2200 Research Boulevard, Rockville, MD, 20850 3289, (800) 638 8255, <http://www.asha.org>.

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Ear surgery see **Otoplasty**

Ear tubes see **Myringotomy and ear tubes**

Eardrum repair see **Tympanoplasty**

ECCE see **Extracapsular cataract extraction**

ECG see **Electrocardiography**

## Echocardiography

### Definition

Echocardiography is a noninvasive diagnostic test that uses **ultrasound** waves to produce an moving image of the heart.

### Purpose

Echocardiography is one of the most widely used diagnostic tests for heart disease. Ultrasound waves generated by a device placed on the skin rebound or echo off the heart and are processed by a computer. The resulting image can show the size, shape, and movement of the heart's valves and chambers, as well as the flow of blood through the heart.

Echocardiography may reveal abnormalities such damage to the heart tissue from a heart attack or as a poorly functioning heart valve. Echocardiography is especially useful for assessing disorders of the heart valves. It not only allows doctors to evaluate the condition of the heart valves, but also can show abnormalities in the pattern of blood flow. For example, echocardiography can show the backward flow of blood through heart valves that remain partially open and should be fully closed.

By assessing the motion of the heart wall, echocardiography can help detect the presence and assess the severity of coronary artery disease, as well as help determine whether chest pain is related to heart disease. Additionally, echocardiography can help detect hypertrophic cardiomyopathy, a condition in which



**Echocardiography.** (Yoav Levy/Phototake. Reproduced by permission.)

the walls of the heart thicken in an attempt to compensate for heart muscle weakness.

Echocardiography is also used to evaluate heart murmurs (abnormal heart sounds), determine the causes of congestive heart failure, assess enlarged hearts, hearts with septal defects (holes between pumping chambers), and to monitor the heart in patients with diseases that may affect heart function (e.g., lupus erythematosus, lung diseases). The biggest advantage to echocardiography is that it is noninvasive (it does not involve breaking the skin or entering body cavities), and it has no known risks or side effects. It also gives a more detailed picture of the heart than other imaging techniques. Echocardiography is often used in conjunction with other diagnostic tests for the heart such as **electrocardiography**.

Echocardiography is usually performed in the cardiology department at a hospital, but may also be performed in a cardiologist's office or an outpatient imaging center. Because the ultrasound scanners used to perform echocardiography are portable (handheld) or mobile, echocardiography can be performed in a hospital emergency department or at the bedside of patients who cannot be moved.

### Description

Echocardiography creates an image of the heart using ultra-high-frequency sound waves—sound waves that are too high in frequency to be heard by the human ear. The technique is very similar to ultrasound scanning commonly used to visualize the fetus during pregnancy.

An echocardiography examination generally lasts 15–30 minutes. The patient lies bare-chested on an examination table. A special gel is spread over the chest to help the transducer make good contact and to slide smoothly over the skin. The transducer, also called a probe, is a small handheld device at the end of a flexible cable. The transducer is placed against the chest and directs ultrasound waves into the chest. Some of the waves get echoed (or reflected) back to the transducer. Since different tissues and blood reflect ultrasound waves differently, these returning sound waves can be translated into a meaningful image of the heart that is displayed on a monitor and recorded. The patient does not feel the sound waves, and the entire procedure is painless.

Occasionally, variations of the echocardiography test are used. For example, Doppler echocardiography employs a special transducer that allows technicians to measure and analyze the direction and speed of blood flow through blood vessels and heart valves. This makes it especially useful for detecting and evaluating backflow through the heart valves. By assessing the speed of blood

## KEY TERMS

**Lupus erythematosus**—A chronic autoimmune disease that affects the skin, joints, and certain internal organs.

flow at different locations around an obstruction, it can also help to precisely locate the obstruction.

An **exercise** echocardiogram, or stress echo, is an echocardiogram performed during exercise, when the heart muscle must work harder to supply blood to the body. This allows doctors to detect heart problems that might not be evident when the body is at rest and needs less blood. For patients who are unable to exercise, certain drugs can be used to mimic the effects of exercise by dilating the blood vessels and making the heart beat faster.

A transesophageal is done when it is difficult to get a clear picture of the heart using standard **electrocardiogram** techniques (e.g., interference from internal scar tissue, obesity). A transducer is attached to an endoscope, a thin tube that is threaded down the throat after it has been numbed. This position allows a clearer picture of the heart.

During the examination, a trained sonographer takes measurements and, using the ultrasound scanner's computer, make calculations, including measuring blood flow speed. Most ultrasound scanners are equipped with videotape recorders or digital imaging/archiving devices to record the real-time examination, and with medical image printers to print out hard copies of still images. Information from the echocardiogram is then evaluated by a cardiologist.

### Preparation

The patient removes any clothing and jewelry above the waist.

### Aftercare

No special measures need to be taken following echocardiography. The procedure is painless.

### Risks

There are no known complications associated with the use of echocardiography. There is a slight risk of having a heart attack during an exercise echocardiogram, due to the stress put on the heart during the test, mostly for patients with a history of heart attack or other risk factors.



## Normal results

A normal echocardiogram shows a normal heart structure and the normal flow of blood through the heart chambers and heart valves. However, a normal echocardiogram does not rule out the possibility certain types of heart disease.

An echocardiogram may show a number of abnormalities in the structure and function of the heart, including:

- thickening of the wall of the heart muscle (especially the left ventricle)
- abnormal motion of the heart muscle
- blood leaking backward through the heart valves
- decreased blood flow through a heart valve due to narrowing of the valve (stenosis)

## Resources

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Ectopic pregnancy treatment see

**Salpingostomy**

EECP see **Enhanced external counterpulsation**

EEG see **Electroencephalography**

EKG see **Electrocardiography**

Elective abortion see **Abortion, induced**

## Elective surgery

### Definition

An elective surgery is a planned, non-emergency surgical procedure. It may be either medically required (e.g., cataract surgery), or optional (e.g., breast augmentation or implant) surgery.

### Purpose

Elective surgeries may extend life or improve the quality of life physically and/or psychologically. Cosmetic and reconstructive procedures, such as a facelift (rhytidectomy), tummy tuck (**abdominoplasty**), or **nose surgery (rhinoplasty)**, may not be medically indicated, but they may benefit the patient in terms of raising self-esteem. Other procedures, such as cataract surgery, improve functional quality of life even though they are not medically necessary.

Some elective procedures are necessary to prolong life, such as an **angioplasty**. However, unlike **emergency surgery** (e.g., **appendectomy**), which must be performed immediately, a required elective procedure can be scheduled at the patient's and surgeon's convenience.

### Demographics

According to the National Center for Health Statistics of the U.S. Centers for Disease Control and Prevention (CDC), in 2005 over 44 million inpatient surgical procedures were performed in the United States. Heart disease and delivery surgeries were the most frequently performed types of surgery. Statistically, women were more likely to have surgery, accounting for 59% of inpatient procedures. This data includes both emergency and elective procedures.

### Description

There are hundreds of elective surgeries in modern medical practice, spanning all the systems of the body. Several major categories of common elective procedures include:

- Plastic surgery. Cosmetic or reconstructive surgery that improves appearance and, in some cases, physical function.
- Refractive surgery. Laser surgery for vision correction.
- Gynecological surgery. Either medically necessary or optional surgery (e.g., hysterectomy, tubal ligation).

## KEY TERMS

**ACL reconstruction**—Repairing a tear of the anterior cruciate ligament (ACL) of the knee using arthroscopy and/or open surgery.

**Anaphylactic shock**—A potentially fatal allergic reaction to a substance that causes a severe drop in blood pressure, swelling of the respiratory tract with associated breathing problems, rash, and possible convulsions.

**Bariatric surgery**—Weight loss surgery, such as gastric bypass.

**Hemorrhage**—Major, abnormal blood loss either from a surface wound or from internal trauma.

**Tubal ligation**—A surgical sterilization procedure that involves ligating, or blocking and/or tying, the fallopian tubes so eggs can no longer descend from the ovaries to the uterus. Also referred to as getting one's tubes tied.

- Exploratory or diagnostic surgery. Surgery to determine the origin and extent of a medical problem, or to biopsy tissue samples.
- Cardiovascular surgery. Nonemergency procedures to improve blood flow or heart function, such as angioplasty or the implantation of a pacemaker.
- Musculoskeletal system surgery. Orthopedic surgical procedures, such as hip replacement and ACL reconstruction.

## Diagnosis/Preparation

In some cases, insurance companies may require a **second opinion** before approving payment on elective surgical procedures. Anyone considering an elective surgery should review their coverage requirements with their health insurance carrier before scheduling the procedure.

Diagnostic and/or radiological testing may be performed to confirm the diagnosis or assist the surgeon in planning the surgical procedure. Typically, a complete medical history, **physical examination**, and laboratory tests (e.g., **urinalysis**, **chest x ray**, blood work, and **electrocardiogram**) are administered as part of the preoperative evaluation.

Other preoperative preparations will depend on the surgery itself. If a general anesthetic is to be used, dietary restrictions may be placed on the patient prior to the operation. If blood loss is expected during the procedure,

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

An elective surgical procedure is typically performed by a surgeon or qualified physician in either an inpatient, hospital environment or an outpatient, ambulatory center. Some simple, minimally invasive procedures may be performed in a doctor's office. The type of elective surgery will mandate the qualifications and background of the surgeon or physician who performs it. For example, the removal of a mole or a skin biopsy may be performed in a doctor's office by a dermatologist, while gastric bypass surgery is performed in a hospital setting by a bariatric surgeon.

advance banking of blood by the patient (known as autologous donation) may be recommended.

## Aftercare

Recovery time and **postoperative care** will vary by the elective procedure performed. Patients should receive complete, written postoperative care instructions prior to returning home after surgery, and these instructions should be explained completely to them by the physician or nursing staff.

## Risks

The risks for an elective surgery will vary by the type of procedure performed. In general, by their invasive nature most surgeries carry a risk of infection, hemorrhage, and circulatory problems such as shock or thrombosis (clotting within the circulatory system). The anesthesia used may also present certain risks for complications such as anaphylactic shock (an allergic reaction).

## Normal results

Elective surgical results depend on the type of procedure performed. Optimal results for an elective procedure should be discussed with the patient's health care team prior to surgery. In some cases, the "normal" results from a surgery may only be temporary (i.e., follow-up surgery may be required at a later date), while other results are life long. For example, a facelift may eventually require a second procedure as a patient ages, whereas a **tubal ligation** offers permanent results.

## QUESTIONS TO ASK THE DOCTOR

- What type of anesthesia will be used for this procedure?
- What will my recovery time be?
- What postoperative restrictions will I face after surgery?
- Can the surgery be done as an outpatient procedure?
- How long can I safely wait to have the surgery?
- How many procedures of this nature have you performed? What is your success rate?
- What are the costs involved with both the surgery and necessary postoperative care?

### Morbidity and mortality rates

Success, morbidity, and mortality rates also depend on the elective procedure itself. A physician and/or surgeon should be able to provide a patient with statistical information on success rates for a specific elective surgery.

### Alternatives

The alternatives available for a particular surgery will depend on the purpose of the procedure. For example, other birth control options would be an alternative to any elective surgery for the purpose of sterilization (i.e., tubal ligation, **vasectomy**, **hysterectomy**). Other elective surgeries may not have a treatment alternative other than foregoing the surgery and living with the medical consequences. As part of **informed consent**, a patient's physician should review all possible treatment options, surgical and otherwise, before scheduling elective surgery.

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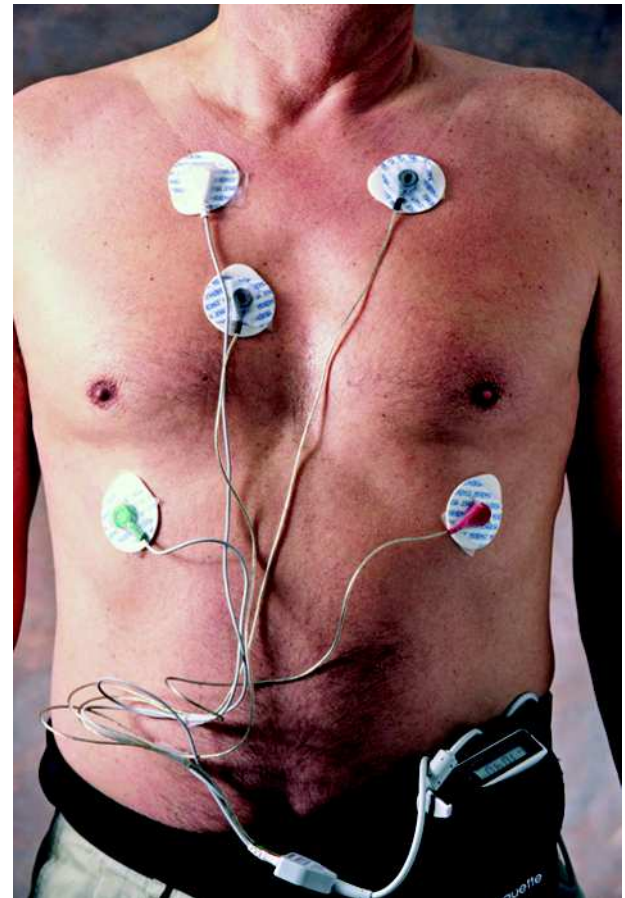
American College of Surgeons. 633 N. St. Clair Drive, Chicago, IL 60611. 1 312 202 5001. Email: [postmaster@facs.org](mailto:postmaster@facs.org). <http://www.facs.org> (accessed March 19, 2008).

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## Electrocardiogram

### Definition

An electrocardiogram is a test that detects and records electrical activity of the heart. It is also called an EKG or ECG.



Electrocardiogram. (bphoto / Alamy)

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

- An electrocardiogram is made by a physician, physician's assistant, nurse, emergency medical technician or other allied health professional that has appropriate training.

### Purpose

An electrocardiogram is used to detect and locate the source of heart irregularities.

### Description

Electrical impulses are generated by specialized tissues in the heart called the sinoatrial node. These electrical impulses cause the muscles of the heart to contract generating heartbeats. The sinoatrial node is located in the right atrium. The electrical impulses travel from the right atrium to the left ventricle, causing the muscle to contract as they travel through the heart. As the heart contracts, it pumps blood out to the rest of the body. The electrical impulses can be detected by sensors. An electrocardiogram is a paper record of the electrical activity in the heart.

An electrocardiogram records how fast the heart beats. By recording many heartbeats in succession, the pattern and regularity of heartbeats can be observed. An electrocardiogram records the strength and timing of the electrical impulses as they travel through each portion of the heart.

Many diseases of the heart cause changes in the pattern of electrical impulses that are generated. Recordings of these electrical impulses can help to diagnose many different heart problems. These include the following conditions.

- Interrupted or stopped heart beats (a heart attack)
- Changes in the flow of blood to the muscles of the heart
- Irregularities in heartbeats (either too fast or too slow)
- Changes in the force of pumping by the heart or the volume of blood pumped
- Changes in the thickness of heart muscles
- Changes in the size of any of the four chambers in the heart
- Evidence of birth defects in the heart
- Diseases affecting heart valves
- Changes in the speed of electrical impulses

## QUESTIONS TO ASK YOUR DOCTOR

- Why is an electrocardiogram being obtained?
- Who will interpret the electrocardiogram?

Electrocardiogram recordings can assist in diagnosing a heart attack. Changes can be detected by comparing EKG tracings that are made at different times.

### Preparation

An electrocardiogram requires minimal preparation. All drugs (prescription, over the counter, and herbal products) that have been used in the previous 24 to 48 hours should be disclosed. This is necessary as many such products can affect electrocardiograms.

Jewelry and clothing that contains metal should be removed.

Areas on the arms, legs, and chest where electrodes (small metal discs) are placed are cleaned. They may be shaved to provide a clean, smooth surface for attaching the electrode.

Disposable electrodes that require no preparation are most commonly used. These are attached to skin on the chest, arms and a leg. These are connected to the electrocardiogram recorder by wires.

Electrocardiograms only record electrical impulses generated by the body.

### Precautions

Other than removing metal, no other precautions are needed prior to having an EKG test.

### Side effects

The only known side effect of an electrocardiogram is slight pulling of skin when the electrodes are removed.

### Interactions

Since an electrocardiogram only records and does not generate any electrical impulses, it does not interact with any bodily system or drugs.



## KEY TERMS

**Sinoatrial node**—Specialized tissue in the right atrium that initiates electrical activity in the heart

### Resources

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- American Academy of Pediatrics. 141 Northwest Point Boulevard, Elk Grove Village, IL 60007 1098. (847) 434 4000; Fax: (847) 434 8000. E mail: kidsdoc@aap.org. <http://www.aap.org/default.htm>.
- American College of Physicians. 190 N Independence Mall West, Philadelphia, PA 19106 1572. (800) 523 1546, x2600, or (215) 351 2600. <http://www.acponline.org>.
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## Electrocardiography

### Definition

Electrocardiography is a commonly used, noninvasive procedure for recording electrical changes in the heart. The record, which is called an **electrocardiogram** (ECG or EKG), shows the series of waves that relate to the electrical impulses that occur during each beat of the heart. The results are printed on paper and/or displayed on a monitor to provide a visual representation of heart function. The waves in a normal record are named P, Q, R, S, and T, and follow in alphabetical order. The number of waves may vary, and other waves may be present.

### Purpose

Electrocardiography is a starting point for detecting many cardiac problems, including angina pectoris, stable angina, ischemic heart disease, arrhythmias (irregular heartbeat), tachycardia (fast heartbeat), bradycardia (slow heartbeat), myocardial infarction (heart attack), and certain congenital heart conditions. It is used routinely in physical examinations and for monitoring a patient's condition during and after surgery, as well as in the intensive care setting. It is the basic measurement used in **exercise** tolerance tests (i.e., stress tests) and is also used to evaluate symptoms such as chest pain, shortness of breath, and palpitations.

### Demographics

According to the U.S. Centers for Disease Control (CDC), nearly 23 million EKG procedures were performed in doctor's offices in the year 2000.

Men are more likely to experience heart attacks than women, although a woman's risk of heart attack rises after menopause. African-Americans, Hispanics, and Native Americans are all at greater risk for cardiovascular disease than Caucasians, in part because of the higher incidence of diabetes mellitus (a major risk factor for cardiovascular disease) in these populations.

## KEY TERMS

**Ambulatory monitoring**—ECG recording over a prolonged period during which the patient can move around.

**Arrhythmia or dysrhythmia**—Abnormal rhythm in hearts that contract in an irregular way.

**ECG or EKG**—A record of the waves that relate to the electrical impulses produced at each beat of the heart.

**Ectopic beat**—Abnormal heart beat arising elsewhere than from the sinoatrial node.

**Electrodes**—Tiny wires in adhesive pads that are applied to the body for ECG measurement.

**Fibrillation**—Rapid, uncoordinated contractions of the upper or the lower chambers of the heart.

**Lead**—Name given the electrode when it is attached to the skin.

**Reperfusion therapy**—Restoration of blood flow to an organ or tissue; following a heart attack, quickly opening blocked arteries to reperfuse the heart muscles to minimize damage.

## Description

The patient disrobes from the waist up, and electrodes (tiny wires in adhesive pads) are applied to specific sites on the arms, legs, and chest. When attached, these electrodes are called leads; three to 12 leads may be employed for the procedure.

Muscle movement may interfere with the recording, which lasts for several beats of the heart. In cases where rhythm disturbances are suspected to be infrequent, the patient may wear a small Holter monitor in order to record continuously over a 24-hour period. This is known as ambulatory monitoring.

Special training is required for interpretation of the electrocardiogram. To summarize in the simplest manner the features used in interpretations, the P wave of the electrocardiogram is associated with the contraction of the atria—the two chambers of the heart that receive blood from the veins. The QRS series of waves, or QRS complex, is associated with ventricular contraction, with the T wave coming after the contraction. The ventricles are the two chambers of the heart that receive blood from the atria and that send the blood into the arteries. Finally, the P-Q or P-R interval gives a value for the time taken for the electrical impulse to travel from the atria to the ventricle (normally less than 0.2 seconds).

## Diagnosis/Preparation

Patients are asked not to eat for several hours before a **stress test**. Before the leads are attached, the skin is cleaned to obtain good electrical contact at the electrode positions and, occasionally, shaving the chest may be necessary.

Heart problems are diagnosed by the pattern of electrical waves produced during the EKG, and an abnormal rhythm can be called dysrhythmia. The cause of dysrhythmia is ectopic beats. Ectopic beats are premature heartbeats that arise from a site other than the sinus node—commonly from the atria, atrio-ventricular node, or the ventricle. When these dysrhythmias are only occasional, they may produce no symptoms or simply a feeling that the heart is turning over or “flip-flopping.” These occasional dysrhythmias are common in healthy people, but they also can be an indication of heart disease.

The varied sources of dysrhythmias provide a wide range of alterations in the form of the electrocardiogram. Ectopic beats display an abnormal QRS complex. This can indicate disease associated with insufficient blood supply to the heart muscle (myocardial ischemia). Multiple ectopic sites lead to rapid and uncoordinated contractions of the atria or ventricles. This condition is known as fibrillation. When the atrial impulse fails to reach the ventricle, a condition known as heart block results.

## Aftercare

To avoid skin irritation from the salty gel used to obtain good electrical contact, the skin should be thoroughly cleaned after removal of the electrodes.

## Risks

The EKG is a noninvasive procedure that is virtually risk-free for the patient. There is a slight risk of heart attack for individuals undergoing a stress test EKG, but patients are carefully screened for their suitability for this test before it is prescribed.

Risk factors for heart disease include obesity, hypertension (high blood pressure), high triglycerides and total blood cholesterol, low HDL (“good”) cholesterol, tobacco smoking, and increased age. People who have diabetes mellitus (either type 1 or type 2) are also at increased risk for cardiovascular disease.

## Normal results

When the heart is operating normally, each part contracts in a specific order. Contraction of the muscle is triggered by an electrical impulse. These electrical impulses travel through specialized cells that form a

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The electrocardiograph is conducted by a fully trained technologist and may be done in the cardiologist's office, a testing facility, or at a hospital patient's bedside. The technologist, or perhaps a nurse or nurse practitioner, will take the patient's medical history, educate them about the procedure they are about to undergo, and help them relax. The results of the electrocardiograph will be interpreted by a qualified physician, usually a cardiologist.

conduction system. Following this pathway ensures that contractions will occur in a coordinated manner.

When the presence of all waves is observed in the electrocardiogram, and these waves follow the order defined alphabetically, the heart is said to show a normal sinus rhythm, and impulses may be assumed to be following the regular conduction pathway.

In the normal heart, electrical impulses—at a rate of 60–100 times per minute—originate in the sinus node. The sinus node is located in the first chamber of the heart, known as the right atrium, where blood reenters the heart after circulating through the body. After traveling down to the junction between the upper and lower chambers, the signal stimulates the atrioventricular node. From here, after a delay, it passes by specialized routes through the lower chambers or ventricles. In many disease states, the passage of the electrical impulse can be interrupted in a variety of ways, causing the heart to perform less efficiently.

The heart is described as showing arrhythmia or dysrhythmia when time intervals between waves, or the order or the number of waves do not fit the normal pattern described above. Other features that may be altered include the direction of wave deflection and wave widths.

### Morbidity and mortality rates

According to the American Heart Association, cardiovascular disease is the number one cause of **death** in the United States. It is also the leading cause of death among people with diabetes.

### Alternatives

Electrocardiography is the gold standard for detecting heart conditions involving irregularities in electrical conduction and rhythm. Other tests that may be used in

## QUESTIONS TO ASK THE DOCTOR

- Why has an EKG been prescribed for me?
- When will I get the results of my EKG?
- Should I take my prescription and over-the-counter medications as normal before my EKG or stress test?
- Should I refrain from eating before my stress test?

conjunction with an EKG include an echocardiogram (a sonogram of the heart's pumping action) and a stress test—an EKG that is done in conjunction with treadmill or other supervised exercise to observe the heart's function under stress—may also be performed.

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## Electroencephalography

### Definition

Electroencephalography, or EEG, is a neurological test that involves attaching electrodes to the head of a person to measure and record electrical activity in the brain over time.

## Purpose

The EEG, also known as a brain wave test, is a key tool in the diagnosis and management of epilepsy and other seizure disorders. It is also used to assist in the diagnosis of brain damage and diseases such as strokes, tumors, encephalitis, mental retardation, and sleep disorders. An EEG may also be used to monitor brain activity during surgery to assess the effects of anesthesia. It is also used to determine brain status and brain **death**.

## Demographics

The number of EEG tests performed each year can only be estimated. It is not a reportable event and is used in the diagnostic workup for a number of disorders. The number of EEG tests per year is estimated to be in the range of 10–25 million.

## Description

Before an EEG begins, a nurse or technologist attaches approximately 16–21 electrodes to a person's scalp using an electrically conductive, washable paste. The electrodes are placed on the head in a standard pattern based on head circumference measurements. Depending on the purpose for the EEG, implantable, or invasive, electrodes are occasionally used. Implantable electrodes include sphenoidal electrodes, which are fine wires inserted under the zygomatic arch, or cheekbone. Depth electrodes, or subdural strip electrodes, are surgically implanted into the brain and are used to localize a seizure focus in preparation for epilepsy surgery. Once in place, even implantable electrodes do not cause pain. The electrodes are used to measure the electrical activity in various regions of the brain over the course of the test period.

For the test, a person lies on a bed, padded table, or comfortable chair and is asked to relax and remain still while measurements are being taken. An EEG usually takes no more than one hour, although long-term monitoring is often used for diagnosis of seizure disorders. During the test procedure, a person may be asked to breathe slowly or quickly. Visual stimuli such as flashing lights or a patterned board may be used to stimulate certain types of brain activity. Throughout the procedure, the electroencephalography unit makes a continuous graphic record of the person's brain activity, or brain waves, on a long strip of recording paper or computer screen. This graphic record is called an electroencephalogram. If the display is computerized, the test may be called a digital EEG, or dEEG.

## KEY TERMS

**Encephalitis**—Inflammation of the brain.

**Fast Fourier transfer**—A digital processing of the recorded signal resulting in a decomposition of its frequency components.

**Ictal EEG**—An EEG done to determine the type of seizure characteristic of a person's disorder. During this EEG, seizure medicine may be discontinued in an attempt to induce a seizure during the testing period.

**Sphenoidal electrodes**—Fine wire electrodes that are implanted under the cheek bones, used to measure temporal seizures.

**Subdural electrodes**—Strip electrodes that are placed under dura mater (the outermost, toughest, and most fibrous of the three membranes [meninges] covering the brain and spinal cord). They are used to locate foci of epileptic seizures prior to epilepsy surgery.

**Zygomatic arch**—Cheekbone. A quadrilateral bone forming the prominence of the cheek. It articulates (touches or moves) with the frontal, sphenoid, and maxillary, and temporal bones.

The sleep EEG uses the same equipment and procedures as a regular EEG. Persons undergoing a sleep EEG are encouraged to fall asleep completely rather than just relax. They are typically provided a bed and a quiet room conducive to sleep. A sleep EEG lasts up to three hours, or up to eight or nine hours if it is a night's sleep.

In an ambulatory EEG, individuals are hooked up to a portable cassette recorder. They then go about normal activities and take normal rest and sleep for a period of up to 24 hours. During this period, individuals and their family members record any symptoms or abnormal behaviors, which can later be correlated with the EEG to see if they represent seizures.

An extension of the EEG technique, called quantitative EEG (qEEG), involves manipulating the EEG signals with a computer using the fast Fourier transform algorithm. The result is then best displayed using a colored gray scale transposed onto a schematic map of the head to form a topographic image. The brain map produced in this technique is a vivid illustration of electrical activity in the brain. This technique also has the ability to compare the similarity of the signals between different electrodes, a measurement known as



spectral coherence. Studies have shown the value of this measurement in diagnosis of Alzheimer's disease and mild closed-head injuries. The technique can also identify areas of the brain having abnormally slow activity when the data are both mapped and compared to known normal values. The result is then known as a statistical or significance probability map (SPM). This allows differentiation between early dementia (increased slowing) or otherwise uncomplicated depression (no slowing).

### Diagnosis/Preparation

An EEG is generally performed as one test in a series of neurological evaluations. Rarely does the EEG form the sole basis for a particular diagnosis.

Full instructions should be given to individuals receiving an EEG when they schedule their test. Typically, individuals taking medications that affect the central nervous system, such as anticonvulsants, stimulants, or antidepressants, are told to discontinue their prescription for a short time prior to the test (usually one to two days). However, such requests should be cleared with the treating physician. EEG test candidates may be asked to avoid food and beverages that contain caffeine, a central nervous system stimulant. They may also be asked to arrive for the test with clean hair that is free styling products to make attachment of the electrodes easier.

Individuals undergoing a sleep EEG may be asked to remain awake the night before their test. They may be given a sedative prior to the test to induce sleep.

### Aftercare

If an individual has suspended regular medication for the test, the EEG nurse or technician should advise as to when to begin taking it again.

### Risks

Being off certain medications for one to two days may trigger seizures. Certain procedures used during EEG may trigger seizures in persons with epilepsy. Those procedures include flashing lights and deep breathing. If the EEG is being used as a diagnostic for epilepsy (i.e., to determine the type of seizures an individual is experiencing) this may be a desired effect, although the person needs to be monitored closely so that the seizure can be aborted if necessary. This type of test is known as an ictal EEG.

### Normal results

In reading and interpreting brain wave patterns, a neurologist or other physician will evaluate the type of brain waves and the symmetry, location, and consistency of brain wave patterns. Brain wave response to certain stimuli presented during the EEG test (such as flashing lights or noise) will also be evaluated.

The four basic types of brain waves are alpha, beta, theta, and delta, with the type distinguished by frequency. Alpha waves fall between 8 and 13 Hertz (Hz), beta are above 13 Hz, theta between 4 and 7 Hz, and delta are less than 4 Hz. Alpha waves are usually the dominant rhythm seen in the posterior region of the brain in older children and adults, when awake and relaxed. Beta waves are normal in sleep, particularly for infants and young children. Theta waves are normally found during drowsiness and sleep and are normal in wakefulness in children, while delta waves are the most prominent feature of the sleeping EEG. Spikes and sharp waves are generally abnormal; however, they are common in the EEG of normal newborns.

Different types of brain waves are seen as abnormal only in the context of the location of the waves, a person's age, and one's conscious state. In general, disease typically increases slow activity, such as theta or delta waves, but decreases fast activity, such as alpha and beta waves.

Not all decreases in wave activity are abnormal. The normal alpha waves seen in the posterior region of the brain are suppressed merely if a person is tense. Sometimes the addition of a wave is abnormal. For example, alpha rhythms seen in a newborn can signify seizure activity. Finally, the area where the rhythm is seen can be telling. The alpha coma is characterized by alpha rhythms produced diffusely, or, in other words, by all regions of the brain.

Some abnormal beta rhythms include frontal beta waves that are induced by sedative drugs. Marked asymmetry in beta rhythms suggests a structural lesion on the side lacking the beta waves. Beta waves are also commonly measured over skull lesions, such as fractures or burr holes, in activity known as a breach rhythm.

Usually seen only during sleep in adults, the presence of theta waves in the temporal region of awake, older adults has been tentatively correlated with vascular disease. Another rhythm normal in sleep, delta rhythms, may be recorded in the awake state over localized regions of cerebral damage. Intermittent delta rhythms are also an indication of damage of the relays between the deep gray matter and the cortex of

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Electroencephalography is often administered by specially trained technicians who are supervised by a neurologist or other physician with specialized training in administering and interpreting the test. Because of the equipment involved, an EEG is usually administered in a hospital setting. It may be conducted in a professional office.

the brain. In adults, this intermittent activity is found in the frontal region whereas in children, it is in the occipital region.

The EEG readings of persons with epilepsy or other seizure disorders display bursts, or spikes, of electrical activity. In focal epilepsy, spikes are restricted to one hemisphere of the brain. If spikes are generalized to both hemispheres of the brain, multifocal epilepsy may be present. The EEG can be used to localize the region of the brain where the abnormal electrical activity is occurring. This is most easily accomplished using a recording method, or montage, called an average reference montage. With this type of recording, the signal from each electrode is compared to the average signal from all the electrodes. The negative amplitude (upward movement, by convention) of the spike is observed for the different channels, or inputs, from the various electrodes. The negative deflection will be greatest as recorded by the electrode that is closest in location to the origin of the abnormal activity. The spike will be present but of reduced amplitude as the electrodes move farther away from the site producing the spike. Electrodes distant from the site will not record the spike occurrence.

A final variety of abnormal result is the presence of slower-than-normal wave activity, which can either be a slow background rhythm or slow waves superimposed on a normal background. A posterior dominant rhythm of 7 Hz or less in an adult is abnormal and consistent with encephalopathy (brain disease). In contrast, localized theta or delta rhythms found in conjunction with normal background rhythms suggest a structural lesion.

### Morbidity and mortality rates

There are few adverse conditions associated with an EEG test. Persons with seizure disorders may induce seizures during the test in reaction to flashing

## QUESTIONS TO ASK THE DOCTOR

- How many EEG procedures has the technician performed?
- What preparations are being made to treat an induced seizure?
- Is the supervising physician appropriately certified to interpret an EEG?

lights or by deep breathing. Mortality from an EEG has not been reported.

### Alternatives

There are no equivalent tests that provide the same information as an EEG.

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- American Board of Registration for Electroencephalographic Technologists. P.O. Box 916633, Longwood, FL 32791-6633.
- American Board of Registration of Electroencephalographic and Evoked Potential Technologists, Inc. <http://www.abret.org>.
- American Society of Electroneurodiagnostic Technologists Inc. 204 W. 7th Carroll, IA 51401. (712) 792-2978. <http://www.aset.org/>.
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## Electrolyte tests

### Definition

Electrolytes are positively and negatively charged molecules, called ions, that are found within the body's cells and extracellular fluids, including blood plasma. A test for electrolytes includes the measurement of sodium, potassium, chloride, and bicarbonate. These ions are measured to assess renal (kidney), endocrine (glandular), and acid-base function, and are components of both renal function and comprehensive metabolic biochemistry profiles. Other important electrolytes routinely measured in serum or plasma include calcium and phosphorus. These are measured together because they are both affected by bone and parathyroid diseases, and often move in opposing directions. Magnesium is another electrolyte that is routinely measured. Like calcium, it will cause tetany (uncontrolled muscle contractions) when levels are too low in the extracellular fluids.

### Purpose

Tests that measure the concentration of electrolytes are needed for both the diagnosis and management of renal, endocrine, acid-base, water balance, and many other conditions. Their importance lies in part with the serious consequences that follow from the relatively small changes that diseases or abnormal conditions may cause. In short, diagnosis and management of a patient with an electrolyte disturbance is best served by measuring all four electrolytes.

### Description

Sodium levels are directly related to the water concentration in blood plasma. Since water will often follow sodium, loss of sodium leads to dehydration, and retention of sodium leads to edema (swelling,

water retention). Conditions that promote increased sodium, called hypernatremia, do so without promoting an equivalent gain in water. Such conditions include diabetes insipidus (water loss by the kidneys), Cushing's disease, and hyperaldosteronism (increased sodium reabsorption).

Many other conditions, such as congestive heart failure, cirrhosis of the liver, and renal disease result in renal retention of sodium, but an equivalent amount of water is retained as well. This results in a condition called total body sodium excess, which causes hypertension and edema, but not an elevated serum sodium concentration. Low serum sodium, called hyponatremia, may result from Addison's disease, excessive diuretic therapy, the syndrome of inappropriate secretion of antidiuretic hormone (SIADH), burns, diarrhea, vomiting, and cystic fibrosis. In fact, the diagnosis of cystic fibrosis is made by demonstrating an elevated chloride concentration (greater than 60 mmol/L) in sweat.

Potassium is the electrolyte used as a hallmark sign of renal failure. Like sodium, potassium is freely filtered by the kidney. In renal failure, the combination of decreased filtration and decreased secretion combine to cause increased plasma potassium. Hyperkalemia is the most significant and life-threatening complication of renal failure. Hyperkalemia is also commonly caused by hemolytic anemia (release from hemolysed red blood cells), diabetes insipidus, Addison's disease, and digitalis toxicity. Frequent causes of low serum potassium include alkalosis, diarrhea and vomiting, excessive use of thiazide **diuretics**, Cushing's disease, intravenous fluid administration, and SIADH.

The reference range for potassium is 3.6-5.0 mmol/L (or mEq/L). Potassium is often a STAT (needed immediately) test because values below 3.0 mmol/L (or mEq/L) are associated with arrhythmia (irregular heartbeat), tachycardia (rapid heartbeat), and cardiac arrest, and values above 6.0 mmol/L (or mEq/L) are associated with bradycardia (slow heartbeat) and heart failure. Abnormal potassium cannot be treated without reference to bicarbonate, which is a measure of the buffering capacity of the plasma. Sodium bicarbonate and dissolved carbon dioxide act together to resist changes in blood pH. For example, an increased plasma bicarbonate indicates a condition called metabolic alkalosis, which results in blood pH that is too high. This may cause hydrogen ions to shift from the cells into the extracellular fluid in exchange for potassium. As potassium moves into the cells, the plasma concentration falls. The low plasma potassium, called hypokalemia, should not be treated

by administration of potassium, but by identifying and eliminating the cause of the alkalosis. Administration of potassium would result in hyperkalemia (too much potassium) when the acid-base disturbance is corrected.

Sodium measurements are very useful in differentiating the cause of an abnormal potassium result. Conditions such as the overuse of diuretics (drugs that promote lower blood pressure) often result in low levels of both sodium and potassium. On the other hand, Cushing's disease (adrenocortical over-activity) and Addison's disease (adrenocortical under-activity) drive the sodium and potassium in opposing directions. Chloride levels will follow sodium levels except in the case of acid-base imbalances, in which chloride may move in the opposing direction of bicarbonate.

Calcium and phosphorus are measured together because they are both likely to be abnormal in bone and parathyroid disease states. Parathyroid hormone causes resorption of these minerals from bone. However, it promotes intestinal absorption and renal reabsorption of calcium, and renal excretion of phosphorus. In hyperparathyroidism, serum calcium will be increased and phosphorus will be decreased. In hypoparathyroidism and renal disease, serum calcium will be low but phosphorus will be high. In vitamin D dependent rickets (VDDR), both calcium and phosphorus will be low; however, calcium is normal while phosphorus is low in vitamin D resistant rickets (VDRR).

Differential diagnosis of an abnormal serum calcium is aided by the measurement of ionized calcium (i.e., calcium not bound by protein). Only the ionized calcium is physiologically active, and the level of ionized calcium is regulated by parathyroid hormone (PTH) via negative feedback (high ionized calcium inhibits secretion of PTH). While hypoparathyroidism, VDDR, renal failure, hypoalbuminemia, hypovitaminosis D, and other conditions may cause low total calcium, only hypoparathyroidism (and alkalosis) will result in low ionized calcium. Conversely, while hyperparathyroidism, malignancies (those that secrete parathyroid hormone-related protein), multiple myeloma, antacids, hyperproteinemia, dehydration, and hypervitaminosis D cause an elevated total calcium, only hyperparathyroidism, malignancy, and acidosis cause an elevated ionized calcium.

Serum magnesium levels may be increased by hemolytic anemia, renal failure, Addison's disease, hyperparathyroidism, and magnesium-based antacids. Chronic alcoholism is the most common cause of a low serum magnesium owing to poor nutrition. Serum magnesium is also decreased in

## KEY TERMS

**Arrhythmia**—Abnormal rhythm of the heartbeat.

**Bradycardia**—Slow heart beat, usually under 60 beats per minute.

**Hyperkalemia**—An abnormally high concentration of potassium in the blood.

**Hypocalcemia**—An abnormally small concentration of calcium in the blood.

**Hypokalemia**—An abnormally small concentration of potassium in the blood.

**Tachycardia**—Rapid heart beat, generally over 100 beats per minute.

**Tetany**—Inappropriately sustained muscle spasms.

diarrhea, hypoparathyroidism, pancreatitis, Cushing's disease, and with excessive diuretic use. Low magnesium can be caused by a number of **antibiotics** and other drugs and by administration of intravenous solutions. Magnesium is needed for secretion of parathyroid hormone, and therefore, a low serum magnesium can induce hypocalcemia (too little calcium). Magnesium deficiency is very common in regions where the water supply does not contain sufficient magnesium salts. Magnesium acts as a calcium channel blocker, and when cellular magnesium is low, high intracellular calcium results. This leads to hypertension, tachycardia, and tetany.

### *Measurement of electrolytes*

Electrolytes are measured by a process known as potentiometry. This method measures the voltage that develops between the inner and outer surfaces of an ion selective electrode. The electrode (membrane) is made of a material that is selectively permeable to the ion being measured. This potential is measured by comparing it to the potential of a reference electrode. Since the potential of the reference electrode is held constant, the difference in voltage between the two electrodes is attributed to the concentration of ion in the sample.

### **Precautions**

Electrolyte tests are performed on whole blood, plasma, or serum, usually collected from a vein or capillary.

Special procedures are followed when collecting a sweat sample for electrolyte analysis. This procedure, called pilocarpine iontophoresis, uses electric current



applied to the arm of the patient (usually an infant) in order to convey the pilocarpine to the sweat glands where it will stimulate sweating. Care must be taken to ensure that the collection device (macroduct tubing or gauze) does not become contaminated and that the patient's parent or guardian understands the need for the electrical equipment employed.

### Preparation

Usually no special preparation is necessary by the patient. Samples for calcium and phosphorus and for magnesium should be collected following an eight-hour fast.

### Aftercare

Discomfort or bruising may occur at the puncture site, or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Applying warm packs to the puncture site relieves discomfort.

### Risks

Minor temporary discomfort may occur with any blood test, but there are no complications specific to electrolyte testing.

### Normal results

Electrolyte concentrations are similar whether measured in serum or plasma. Values are expressed as mmol/L for sodium, potassium, chloride, and bicarbonate. Magnesium results are often reported as milliequivalents per liter (meq/L) or in mg/dL. Total calcium is usually reported in mg/dL and ionized calcium in mmol/L. Since severe electrolyte disturbances can be associated with life-threatening consequences such as heart failure, shock, coma, or tetany, alert values are used to warn physicians of impending crisis. Typical reference ranges and alert values are cited below:

- serum or plasma sodium: 135–145 mmol/L; alert levels: less than 120 mmol/L and greater than 160 mmol/L
- serum potassium: 3.6–5.4 mmol/L (plasma, 3.6–5.0 mmol/L); alert levels: less than 3.0 mmol/L and greater than 6.0 mmol/L
- serum or plasma chloride: 98–108 mmol/L
- sweat chloride: 4–60 mmol/L
- serum or plasma bicarbonate: 18–24 mmol/L (as total carbon dioxide, 22–26 mmol/L); alert levels: less than 10 mmol/L and greater than 40 mmol/L

- serum calcium: 8.5–10.5 mg/dL (2.0–2.5 mmol/L); alert levels: less than 6.0 mg/dL and greater than 13.0 mg/dL
- ionized calcium: 1.0–1.3 mmol/L
- serum inorganic phosphorus: 2.3–4.7 mg/dL (children, 4.0–7.0 mg/dL); alert level: less than 1.0 mg/dL
- serum magnesium: 1.8–3.0 mg/dL (1.2–2.0 meq/L or 0.5–1.0 mmol/L)
- ionized magnesium: 0.53–0.67 mmol/L
- osmolality (calculated) 280–300 mosm/Kg

### Resources

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## Electrophysiology study of the heart

### Definition

An electrophysiology study (EPS) of the heart is a test performed to analyze the electrical activity of the heart. The test uses cardiac catheters and sophisticated computers to generate **electrocardiogram** (EKG) tracings and electrical measurements with exquisite precision from within the heart chambers.

### Purpose

Heart disease is the leading killer in the United States, accounting for more than 50% of all annual deaths. The normal function of the heart depends on

its electrical activity, and the effect of this activity on each of its cells. When a heart is diseased, impaired electrical activity is often the factor that leads to sudden **death**, thus the need for EPS tests.

An EPS can be performed solely for diagnostic purposes or to pinpoint the exact location of electrical signals (cardiac mapping) in conjunction with a therapeutic procedure called catheter ablation (tissue removal). A cardiologist may recommend an EPS when the standard EKG, Holter monitor, event recorder, **stress test**, echocardiogram, or angiogram cannot provide enough information to evaluate an abnormal heart rhythm (arrhythmia).

An EPS offers more detailed information about the heart's electrical activity than many other non-invasive tests because electrodes are placed directly *on* heart tissue. This placement allows the electrophysiologist to determine the specific location of an arrhythmia and, often, to correct it during the same procedure. This corrective treatment is considered a permanent cure; in many cases, the patient may not need to take heart medications.

EPS may be helpful in assessing:

- certain tachycardias (fast heartbeats) or bradycardias (slow heartbeats) of unknown cause
- patients who have been resuscitated after experiencing sudden cardiac arrest
- various symptoms of unknown cause, such as chest pain, shortness of breath, fatigue, or syncope (dizziness/fainting)
- response to anti-arrhythmic therapy

### Precautions

Pregnant patients should not undergo EPS because the study requires exposure to radiation, which may harm the growing baby. Patients who have coronary artery disease may need to be treated prior to EPS. EPS is contraindicated in patients with an acute myocardial infarction, as the infarct may be extended with rapid pacing. The test is also contraindicated for patients who are uncooperative.

### Description

The rhythmic pumping action of the heart, which is essentially a muscle, is the result of electrical impulses traveling throughout the walls of the four heart chambers. These impulses originate in the sinoatrial (SA) node (specialized cells situated in the right atrium, or top right chamber of the heart). Normally, the SA node, acting like a spark plug, spontaneously generates the impulses, which travel through specific

## KEY TERMS

**Ablation**—Removal or destruction of tissue, such as by burning or cutting.

**Angiogram**—X ray of a blood vessel after special x-ray dye has been injected into it.

**Bradycardia**—Relatively slow heart action, usually considered as a rate under 60 beats per minute.

**Cardiac catheter**—Long, thin, flexible tube, which is threaded into the heart through a blood vessel.

**Cardiologist**—Doctor who specializes in diagnosing and treating heart diseases.

**Echocardiogram**—Ultrasound image of the heart.

**Electrocardiogram**—Tracing of the electrical activity of the heart.

**Electrode**—A medium, such as platinum wires, for conducting an electrical current.

**Electrophysiology**—Study of how electrical signals in the body relate to physiologic function.

**Event recorder**—A small machine, worn by a patient usually for several days or weeks, that is activated by the patient to record his or her EKG when a symptom is detected.

**Fibrillation**—Rapid, random contraction (quivering).

**Holter monitor**—A small machine worn by a patient usually for 24 hours, that continuously records the patient's EKG during usual daily activity.

**Stress test**—Recording a patient's EKG during exercise.

**Supraventricular tachycardia (SVT)**—A fast heartbeat that originates above the ventricles.

**Tachycardia**—Fast heartbeat.

**Thrombophlebitis**—Venous inflammation with the formation of thrombus (a clot in the cardiovascular system).

pathways throughout the atria to the atrioventricular (AV) node. The AV node is a relay station sending the impulses to more specialized muscle fibers throughout the ventricles (the lower chambers of the heart). If these pathways become damaged or blocked or if extra (abnormal) pathways exist, the heart's rhythm may be altered (too slow, too fast, or irregular), which can seriously affect the heart's pumping ability.

To undergo EPS, the patient is placed on a table in the EPS lab and connected to various monitors. Sterile technique is maintained. A minimum of two catheters

are inserted into the right femoral (thigh) vein in the groin area. Depending on the type of arrhythmia, the number of catheters used and their route to the heart may vary. For certain tachycardias, two additional catheters may be inserted in the left groin and one in the internal jugular (neck) vein or in the subclavian (below the clavicle) vein. The catheters are about 0.08 in (2 mm) in diameter, about the size of a spaghetti noodle. The catheters used in catheter ablation are slightly larger.

With the help of fluoroscopy (x rays on a television screen), all catheters are guided to several specific locations in the heart. Typically, four to 10 electrodes are located on the end of the catheters, which have the ability to send electrical signals to stimulate the heart (called pacing) and to receive electrical signals from the heart, but not at the same time (just as a walkie-talkie cannot send and receive messages at the same time).

First, the electrodes are positioned to receive signals from inside the heart chambers, which allows the doctor to measure how fast the electrical impulses travel in the patient's heart at that time. These measurements are called the patient's baseline measurements. Next, the electrodes are positioned to pace. That is, the EPS team tries to induce (sometimes in combination with various heart drugs) the arrhythmia that the patient has previously experienced so the team can observe it in a controlled environment, compare it to the patient's clinical or spontaneous arrhythmia, and decide how to treat it.

Once the arrhythmia is induced and the team determines that it can be treated with catheter ablation, cardiac mapping is performed to locate the precise origin and route of the abnormal pathway. When this is accomplished, the ablating electrode catheter is positioned directly against the abnormal pathway, and high radio-frequency energy is delivered through the electrode to destroy (burn) the tissue in this area.

Pediatric patients present challenges for EPS. In 2001, an analysis of 45 children who underwent EPS was conducted. The researchers concluded that success rates and the prevention of complications in children may be increased by using **ultrasound** guidance for access to the internal jugular vein for coronary sinus cannulation (insertion of a tube for the transport of fluid) during EPS. Access was successfully obtained in all 45 of the patients without major complications using this technique.

### Diagnosis/Preparation

The following preparations are made for an EPS:

### WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The relatively simple EPS is performed in a special laboratory under controlled clinical circumstances by cardiologists, nurses, and technicians with special training in electrophysiology.

- Blood tests usually are ordered one week prior to the test.
- The patient may be advised to stop taking certain medications, especially cardiac medications, that may interfere with the test results.
- The patient fasts for six to eight hours prior to the procedure. Fluids may be permitted until three hours before the test.
- The patient undergoes conscious sedation (awake but relaxed) during the test.
- A local anesthetic is injected at the site of catheter insertion.
- Peripheral pulses are marked with a pen prior to catheterization. This permits rapid assessment of pulses after the procedure.

### Aftercare

The patient needs to rest flat in bed for several hours after the procedure to allow healing at the catheter insertion sites. The patient often returns home either the same day or the next day. Someone should drive the patient home. To minimize bleeding and pain, the patient is advised to keep the extremity in which the catheter was placed immobilized and straight for several hours after the test.

### Risks

EPS and catheter ablation are considered low-risk procedures. There is a risk of bleeding and/or infection at the site of catheter insertion. Blood clot formation may occur and is minimized with anticoagulant medications administered during the procedure. Vascular injuries causing hemorrhage or thrombophlebitis are possible. Cardiac perforations are also possible. If the right internal jugular vein is accessed, the potential for puncturing the lung with the catheter exists and could lead to a collapsed lung.

Because ventricular tachycardia or fibrillation (lethal arrhythmias) may be induced in the patient,

## QUESTIONS TO ASK THE DOCTOR

- What is the purpose of the EPS test?
- How do I prepare for cardiac electrophysiology?
- Will it hurt?
- How is the test performed?
- How long will it take?
- Are there any risks involved?

the EPS lab personnel must be prepared to defibrillate the patient as necessary.

Patients should notify their health care provider if they develop any of these symptoms:

- numbness or tingling in the extremities
- heavy bleeding
- change in color and/or temperature of extremities
- loss of function in extremities

### Normal results

Normal EPS results show that the heart initiates and conducts electrical impulses within normal limits.

Abnormal results include confirmation of arrhythmias, such as:

- supraventricular tachycardias
- ventricular arrhythmias
- accessory pathways
- bradycardias

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Electrosurgery see **Curettage and electrosurgery**

Emergency airway puncture see **Cricothyroidotomy**

## Emergency surgery

### Definition

Emergency surgery is nonelective surgery performed when the patient's life or well-being is in direct jeopardy. Largely performed by surgeons specializing in emergency medicine, this surgery can be conducted for many reasons but occurs most often in urgent or critical cases in response to trauma, mass casualties, cardiac events, poison episodes, brain injuries, and pediatric medicine.

### Purpose

Most surgery is elective and is performed after a diagnosis based on a history and **physical examination** of the patient, with differential test results and the development of strategies for management of the condition. With emergency surgery, the **surgical team** as



well as the surgeon may have less information about the patient than would ordinarily be required and must work under time-dependent conditions to save a patient's life, help avoid critical injury or systemic deterioration of the patient, or alleviate severe pain. Because of the unique conditions for urgent acute surgery, operations are usually performed by a surgical team specially trained for management of a critical or life-threatening event.

Acute surgical emergencies include:

- invasive resuscitation for acute respiratory failure, pulmonary embolism, and pulmonary obstructions
- injuries resulting from blasts, explosions, or the release of dangerous chemicals, as in terrorist attacks, industrial accidents, pipeline leaks, or aviation accidents
- injuries resulting from buildings collapsing as a result of earthquakes, tornadoes, or hurricanes
- blunt or penetrating injuries to the head, chest, or abdomen, largely from automobile accidents and gunshot wounds
- injuries resulting in the loss or amputation of body parts (teeth, fingers, ears, toes, etc.) from human or animal bites, knife wounds, industrial accidents, etc.
- burns
- cardiac events, including heart attacks, cardiac shock, and cardiac arrhythmia
- aneurysms
- brain injuries and other neurological conditions
- complications of pregnancy
- abdominal disorders, including perforated ulcer, appendicitis, and peritonitis

## Description

Emergency surgery can take place in any hospital or battlefield setting. However, trauma centers or trauma sections of hospitals handle most emergency surgeries. Forty-one states have ACS-verified trauma centers as of 2008, some states with better systems than others. There is an additional ACS-verified trauma center in Landstuhl, Germany.

One major difficulty remaining in the early 2000s is that trauma centers are unevenly distributed across the United States. A study published in the *Journal of the American Medical Association* reported in 2005 that 26.7% and 27.7% of the population of the United States had access to level I or II trauma centers by helicopter only within time periods of 45 and 60 minutes, respectively; and 1.9% and 3.1% of Americans had access only by helicopter to level I or II centers from trauma centers or base helipads outside

their home states within those time periods. Most of these people live in rural areas. By contrast, 69.2% of people in the United States living in large cities can get to a level I or level II trauma center within 45 minutes, and 84.1% can reach a trauma center within 60 minutes.

Trauma centers in the United States are classified by the American College of Surgeons (ACS) as levels I, II, III, and IV, respectively. A level I trauma center, the most advanced of the trauma center system, is equipped to get the patient to surgery beginning with trained first responders. The system relies on available operating rooms, readily available laboratory personnel, anesthesiologists, x-ray and blood bank access, intensive care nurses, and ward nurses—all trained to take the patient to the **operating room** within 60 minutes of the incident. If patients are in surgery within an hour, they have a 25% chance of survival. Level I trauma centers also carry on research and maintain programs on trauma prevention.

Level II trauma centers work in collaboration with level I centers. They provide 24-hour availability of all essential specialties, personnel, and equipment but are not required to have research or residency programs. Level III centers do not have the full range of specialists, but have resources for emergency resuscitation, surgery, and intensive care of most trauma patients; they also have transfer agreements with level I and level II centers for the care of severely injured patients. Level IV centers stabilize and treat patients in remote areas where no other emergency care is available.

## Diagnosis/Preparation

Emergency surgery follows a path from resuscitation and stabilization of the patient with a patient management team, to preparation of the patient for surgery, to postoperative and recovery procedures—all designed to deal quickly with the life-threatening situation. There is often little time or possibility for extensive diagnosis or the gathering of a patient history. Decisions are made quickly about surgery, often without family members present. The possibility of emergency surgery due to trauma, injury, emergency medical conditions, and cardiac events make it wise for all patients to have a **living will** detailing their medical care wishes and to carry it with them at all times.

Emergency surgery related to situations in which there are mass casualties, as in aviation disasters, railroad collisions, factory explosions, terrorist attacks, or such natural disasters as earthquakes, is often performed on site rather than in a trauma center, as there

## KEY TERMS

**Aneurysm**—A bulge in the wall of a blood vessel caused by the weakening of the vessel wall. Aneurysms can be fatal if the affected blood vessel bursts.

**Arrhythmia**—An abnormal heart rhythm.

**Embolism**—The obstruction of a blood vessel by an air bubble or foreign particle.

**First responder**—A term used to describe the first medically trained responder to arrive on scene of an emergency, accident, natural or human-made disaster, or similar event. First responders may be police officers, fire fighters, emergency medical services personnel, or bystanders with some training in first aid.

**Peritonitis**—Inflammation of the layer of tissue that lines the inside of the abdominal cavity.

**Trauma centers**—Specialized hospital facilities that are equipped to deal with emergency life-threatening conditions.

**Triage**—Prioritizing the needs of patients according to the urgency of their need for care and their likelihood of survival.

may not be time to transport survivors to a hospital. In these situations, first responders typically carry out triage, which is the sorting out and giving medical assistance to patients in order to maximize the number of survivors. In most cases, triage involves focusing efforts on those whose survival depends on receiving prompt care rather than on those who will survive without immediate treatment and those who are past help. In mass casualty situations, survivors may need to be treated for burns, decontaminated from dangerous chemicals, or taken outside the immediate danger zone before surgical interventions can be carried out.

## Normal results

Mortality rates are high for emergency surgeries. For instance, the rupture of an abdominal aneurysm results in **death** in about 50% of cases due to kidney failure from shock or disrupted blood supply. An untreated aneurysm is always fatal. Certain gastrointestinal disorders require emergency surgery, including bleeding in the digestive tract, obstructions, appendicitis, and peritonitis (inflammation of the lining of the abdomen). Pediatric emergency surgery includes birth defects of the heart. One in 120 infants is born with a heart defect requiring surgery to unblock the flow of blood or to treat a malformed aortic valve. Heart attacks are

very effectively treated with emergency surgery depending upon the part of the heart affected, on whether there is arterial blockage, and on the patient's overall health. Arrhythmias can develop as well as stroke. The first 48 hours are the most crucial with cardiac events and whether there is immediate medical and surgical attention. Many cardiac surgeries result in bypass procedures, with a higher death rate associated with bypass surgery done on an emergency basis. Women have emergency heart bypass operations more often than men, probably due to lack of earlier cardiac care.

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Endarterectomy, carotid see **Carotid endarterectomy**

Endarterectomy, peripheral see **Peripheral endarterectomy**

Endocardial resection see **Myocardial resection**

## Endolymphatic shunt

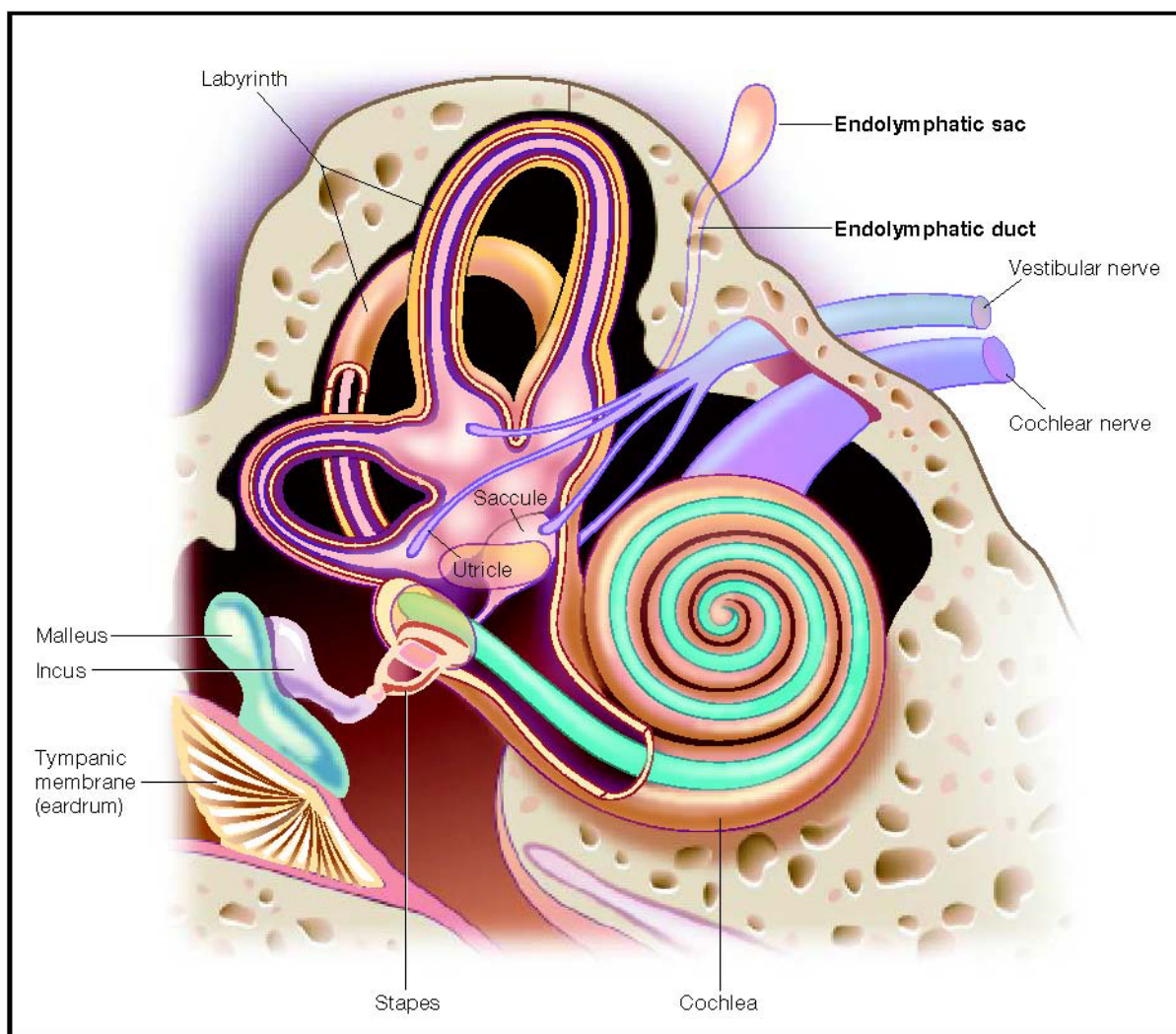
### Definition

An endolymphatic shunt is a surgical procedure in which a very small silicone tube is placed in the membranous labyrinth of the inner ear to drain excess fluid.

### Purpose

An endolymphatic shunt is placed as part of the treatment of Ménière's disease, a disorder of the inner ear whose causes are still unknown. Ménière's disease is characterized by the following symptoms:

- a rise in the level of endolymphatic fluid in the labyrinth of the inner ear
- hearing loss that comes and goes



(Illustration by Electronic Illustrators Group.)



- a sensation that the environment or oneself is revolving or spinning (vertigo)
- ringing, buzzing, or hissing noises in the ears (tinnitus)
- a feeling that the ears are blocked or plugged

Endolymphatic shunt surgery is one of the surgical procedures available to treat Ménière's disease, which is also known as endolymphatic hydrops. The surgery is based on the theory that the disorder causes the inner ear to become overloaded with fluid and that draining this fluid will relieve the symptoms. The fluid is drained by opening the endolymphatic sac, a pouch located next to the mastoid bone at the end of the endolymphatic duct. The endolymphatic duct is a canal that leads to the inner ear.

### Demographics

According to the National Institute on Deafness and Other Communication Disorders (NIDCD), there were an estimated three to five million cases of Ménière's disease in the United States in 1998, with nearly 100,000 new cases diagnosed annually. In most cases only one ear is affected, but as many as 15–40% of patients are affected in both ears. The onset of Ménière's disease occurs most often in adults between the ages of 20 and 50. Men and women are affected in equal numbers.

### Description

An endolymphatic shunt is placed with the patient under **general anesthesia**. The operation takes about two hours to perform. The patient is usually positioned lying on the back with the head turned to one side and the affected ear lying uppermost. The head is immobilized and supported with a pad or brace. The operation itself begins with opening the mastoid bone and identifying the endolymphatic sac. To find the sac, the surgeon removes the bony cover of the sigmoid sinus, which is an S-shaped cavity behind the mastoid bone. The surgeon leaves intact a small rectangle of thin bone called Bill's Island (named for Dr. William House). The sigmoid sinus is then collapsed with gentle pressure. The surgeon exposes the endolymphatic sac and makes an incision in it in order to insert the shunt.

### Diagnosis/Preparation

The diagnosis of Ménière's disease is based on the patient's medical history, a **physical examination**, and the results of hearing tests, balance tests, an electronystagmogram, and imaging studies. An MRI or CT scan is performed to rule out a tumor as the cause of the patient's symptoms. A hearing test (audiogram) identifies the hearing loss that is typical of Ménière's disease. Balance function tests are administered to assess the patient's vertigo.

## KEY TERMS

**Bony labyrinth**—A series of cavities contained in a capsule inside the temporal bone of the skull. The endolymph-filled membranous labyrinth is suspended in a fluid inside the bony labyrinth.

**Electronystagmogram**—A test that involves the graphic recording of eye movements.

**Endolymph**—The watery fluid contained in the membranous labyrinth of the inner ear.

**Endolymphatic sac**—The pouch at the end of the endolymphatic duct that connects to the membranous labyrinth of the inner ear.

**Mastoid**—A large bony process at the base of the skull behind the ear. It contains air spaces that connect with the cavity of the middle ear.

**Membranous labyrinth**—A complex arrangement of communicating membranous canals and sacs, filled with endolymph and suspended within the cavity of the bony labyrinth.

**Ménière's disease**—Also known as idiopathic endolymphatic hydrops, Ménière's disease is a disorder of the inner ear. It is named for Prosper Ménière (1799–1862), a French physician.

**Shunt**—A channel through which blood or another body fluid is diverted from its normal path by surgical reconstruction or the insertion of a synthetic tube.

**Sigmoid sinus**—An S-shaped cavity on the inner side of the skull behind the mastoid process.

**Tinnitus**—A sensation of ringing, buzzing, roaring, or clicking noises in the ear.

**Vertigo**—An illusory feeling that either one's self or the environment is revolving. It is usually caused either by diseases of the inner ear or disturbances of the central nervous system.

The patient is prepared for surgery by having the hair removed and the skin shaved over an area of at least 1.5 in (3.8 cm) around the site of the incision. A mild solution of soap and water is commonly used to cleanse the outer ear and surrounding skin.

### Aftercare

The operated ear is covered with a Glasscock dressing, which is a special dressing applied to keep pressure on the site to reduce swelling. There is usually some tenderness and discomfort in the operated ear and the throat (from the breathing tube inserted during



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

An endolymphatic shunt is performed in a hospital or ambulatory surgery center on an outpatient basis. It is done by an otolaryngologist, who is a surgeon specializing in disorders of the ear, nose, and throat.

surgery), which can be controlled by such analgesic medications as meperidine (Demerol) or oxycodone (Percocet).

### Risks

There are few risks associated with endolymphatic shunt surgery. The operation is considered the first-line surgical treatment for Ménière's disease precisely because it is very safe. The chance of hearing loss from the procedure is about 0.5%.

### Normal results

Endolymphatic shunt surgery relieves the vertigo associated with Ménière's disease, with restoration of hearing dependent on the severity of the disease. The patient's ear may protrude slightly shortly after surgery but usually returns to its original position within two to three weeks after the operation. Numbness around the ear is a common complication that may last for several months.

### Morbidity and mortality rates

Endolymphatic shunt surgery is considered a low-morbidity procedure. It has been reported to achieve complete or substantial control of vertigo in 81% of patients, with significant improvement in hearing in about 20%. Overall, there is a 60% chance of curing the vertigo, a 20% chance that the attacks will remain at the same level of severity, and a 20% chance that the attacks will get worse. The patient's vertigo usually improves even if hearing does not improve.

### Alternatives

#### *Nonsurgical alternatives*

There are several nonsurgical treatments recommended for patients with Ménière's disease:

- Vestibular suppressants. These are drugs designed to control vertigo attacks; they include meclizine (Antivert), diazepam (Valium), and dimenhydrinate (Dramamine).

## QUESTIONS TO ASK THE DOCTOR

- What are the alternatives to an endolymphatic shunt procedure?
- Will I regain my hearing if I have this surgery?
- Can I expect improvement in any of the other symptoms of Ménière's disease?
- How long will it take to recover from the surgery?
- How many endolymphatic shunts do you perform each year?

- Diuretics. Medications that increase the body's output of urine can also help reduce the frequency of vertigo attacks in some patients by lowering the amount of fluid in the body.
- Dietary changes. Although the benefits of a low salt diet have not been confirmed by formal scientific research, many patients with Ménière's disease have noted that their symptoms improve when they restrict their salt intake.
- Steroids. Prednisone and other steroids have been used to treat patients in the early stages of Ménière's disease. Their use in this disorder, however, is still considered experimental as of 2003.

### *Surgical*

Surgical alternatives to the placement of an endolymphatic shunt include:

- Selective vestibular neurectomy. In this procedure, the surgeon cuts the vestibular nerve, which relays balance, position and movement signals from the inner ear to the brain. Vestibular neurectomy prevents the transmission of faulty information from the affected ear and eliminates attacks of vertigo in many patients.
- Labyrinthectomy. In this procedure, the membranous labyrinth of the inner ear is removed. Labyrinthectomy is more successful than other surgeries in eliminating vertigo, but the patient suffers complete and permanent loss of hearing in the operated ear.

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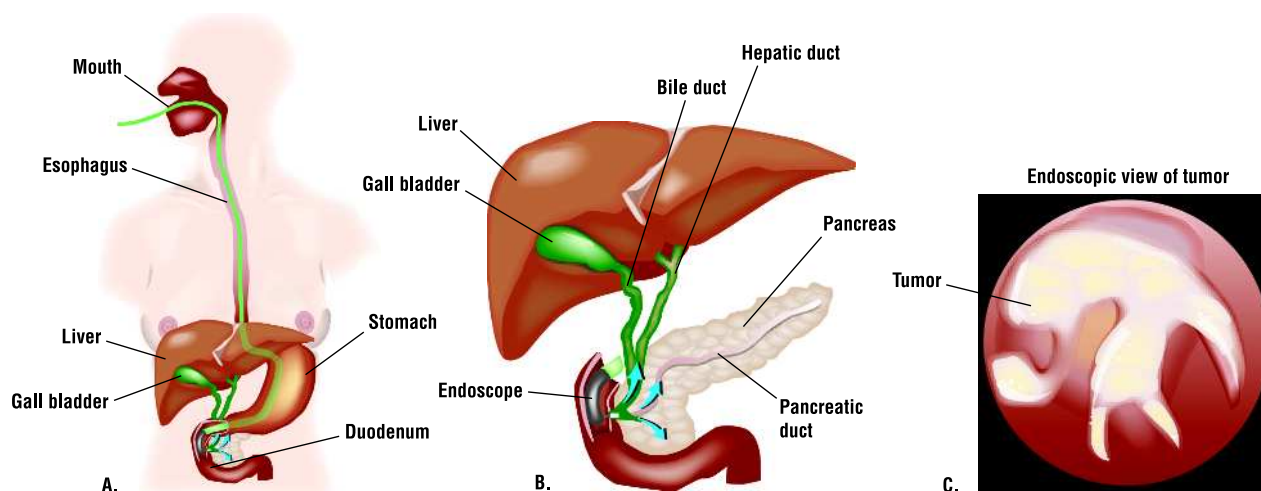
Endometriosis surgery see **Laparoscopy for endometriosis**

## Endoscopic retrograde cholangiopancreatography

### Definition

Endoscopic retrograde cholangiopancreatography (ERCP) is an imaging technique used to diagnose diseases of the pancreas, liver, gallbladder, and bile ducts. It combines endoscopy and x-ray imaging.

### Endoscopic retrograde cholangiopancreatography



In endoscopic retrograde cholangiopancreatography, an endoscope is introduced into the patient’s mouth and fed through the esophagus, stomach, and duodenum (small intestine) (A). A dye is released into the ducts (B). A series of x rays is taken, and a tumor may be visible with the endoscope (C). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## Purpose

ERCP is used in the management of diseases that affect the gastrointestinal tract, specifically the pancreas, liver, gall bladder, and bile ducts. The pancreas is an organ that secretes pancreatic juice into the upper part of the intestine. Pancreatic juice is composed of specialized proteins that help to digest fats, proteins, and carbohydrates. Bile is a substance that helps to digest fats; it is produced by the liver, secreted through the bile ducts, and stored in the gallbladder. Bile is released into the small intestine after a person has eaten a meal containing fat.

A doctor may recommend ERCP if a patient is experiencing abdominal pain of unknown origin, weight loss, or jaundice. These may be symptoms of biliary disease. For instance, gallstones that form in the gallbladder or bile ducts may become stuck there, causing cramping or dull pain in the upper right area of the abdomen, fever, and/or jaundice. Other causes of biliary obstruction include tumors, injury from gallbladder surgery, or inflammation. The bile ducts may also become narrowed (called a biliary stricture) as a result of cancer, blunt trauma to the abdomen, pancreatitis (inflammation of the pancreas), or primary biliary cirrhosis (PBC). PBC may be caused by a condition called primary sclerosing cholangitis, an inflammation of the bile ducts that may cause pain, jaundice, itching, or other symptoms. These symptoms may also be experienced by a patient with cholangitis, or with infection of the bile ducts caused by bacteria or parasites.

ERCP can also be used to diagnose a number of pancreatic disorders. Pancreatitis is an inflammation of the pancreas, caused by chronic alcohol abuse, injury, obstruction of the pancreatic ducts (e.g., by gallstones), or other factors. The condition may be either acute (having a severe but short course) or chronic (persistent). Symptoms of pancreatitis include abdominal pain, weight loss, nausea, and vomiting. ERCP may be used to diagnose cancer of the pancreas; pancreatic pseudocysts (collections of pancreatic fluid); or strictures of the pancreatic ducts. Certain congenital disorders may also be identified by ERCP, such as pancreas divisum, a condition in which parts of the pancreas fail to fuse together during fetal development.

## Demographics

Diseases of the pancreas and biliary tract affect millions of Americans each year. According to the National Health and Nutrition Survey, gallbladder disease affects approximately 6.3 million men and 14.2 million women in the United States between the

## KEY TERMS

**Bile**—A bitter yellowish-brown fluid secreted by the liver that contains bile salts, bile pigments, cholesterol, and other substances. It helps the body to digest and absorb fats.

**Congenital**—Present at birth.

**Endoscope**—An instrument with a light source attached that allows the doctor to examine the inside of the digestive tract or other hollow organ.

**Gastrointestinal tract**—A group of organs and related structures that includes the esophagus, stomach, liver, gallbladder, pancreas, small intestine, large intestine, rectum, and anus.

**Jaundice**—A condition characterized by deposits of bile pigments in the skin, mucous membranes, and the whites of the eyes. It is also known as icterus.

**Magnetic resonance imaging**—A technique that uses a strong magnetic field and pulses of radio waves to produce cross-sectional images of the body.

**Stent**—A thin rod-like or tube-like device made of wire mesh, inserted into a blood vessel or duct to keep it open.

**Stricture**—An abnormal narrowing of a duct or canal.

ages of 24 and 74. Approximately one million new cases of gallstones are diagnosed each year. The incidence of gallstones is higher among women; adults over the age of 40; and people who are overweight. Primary sclerosing cholangitis occurs at a rate of two to seven cases per 100,000 persons. The rate of gallbladder cancer is approximately 2.5 out of 100,000 persons. In addition, approximately 87,000 cases of pancreatitis and 30,000 cases of pancreatic cancer are diagnosed each year in the United States.

## Description

ERCP is performed with the patient given either a sedative or **general anesthesia**. The physician then sprays the back of the patient's throat with a local anesthetic. The endoscope (a thin, hollow tube attached to a viewing screen) is then inserted into the mouth. It is threaded down the esophagus, through the stomach, and into the duodenum (upper part of the small intestine) until it reaches the spot where the bile and pancreatic ducts empty into the duodenum. At this point a small tube called a cannula is inserted through the endoscope and used to inject a contrast

dye into the ducts. The term “retrograde” in the name of the procedure refers to the backward direction of the dye as it is injected through the ducts. A series of x rays are then taken as the dye moves through the ducts.

If the x rays show that a problem exists, ERCP may be used as a therapeutic tool. Special instruments can be inserted into the endoscope to remove gallstones, take samples of tissue for further examination (e.g., in the case of suspected cancer), or place a special tube called a stent into a duct to relieve an obstruction.

### Diagnosis/Preparation

ERCP is generally not performed unless other less invasive diagnostic tests have first been used to determine the cause of a patient’s symptoms. Such tests include:

- complete medical history and physical examination
- blood tests (certain diseases can be diagnosed by abnormal levels of blood components)
- ultrasound imaging (a procedure that uses high-frequency sound waves to visualize structures in the human body)
- computed tomography (CT) scan (an imaging device that uses x rays to produce two-dimensional cross-sections on a viewing screen)

Before undergoing ERCP, the patient will be instructed to refrain from eating or drinking for at least six hours to ensure that the stomach and upper part of the intestine are empty. Arrangements should be made for someone to take the patient home after the procedure, as he or she will not be able to drive. The physician should also be given a complete list of all prescription, over-the-counter, and alternative medications or preparations that the patient is taking. The patient should also notify the doctor if he or she is allergic to iodine because the contrast dye contains it.

### Aftercare

After the procedure, the patient will remain at the hospital or outpatient facility until the effects of the sedative wear off and no signs of any complications have appeared. A longer stay may be warranted if the patient experiences complications or if other procedures were performed.

### Risks

Complications that have been reported with ERCP include pancreatitis; cholangitis (inflammation of the bile ducts); cholecystitis (inflammation of the gallbladder); injury to the duodenum; pain; bleeding;

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

ERCP is usually performed in the x-ray department of a hospital or outpatient facility by a gastroenterologist, a medical doctor who has completed specialized training in the diagnosis and treatment of diseases of the digestive system. An anesthesiologist administers the anesthetic, and a radiologist may be consulted in interpreting the images obtained by the dye injection.

infection; and formation of blood clots. Factors that increase the risk of complications include liver damage, bleeding disorders, a history of post-ERCP complications, and a less experienced endoscopist.

### Normal results

Following ERCP, the patient’s biliary and pancreatic ducts should be free of stones and show no strictures, obstructions, or evidence of infection or inflammation.

### Morbidity and mortality rates

The overall complication rate associated with ERCP is approximately 11%. Pancreatitis may occur in up to 7% of patients. Cholangitis and cholecystitis occur in less than 1% of patients. Infection, injury, bleeding, and blot clot formation also occur in less than 1%. The mortality rate for ERCP is approximately 0.1%.

### Alternatives

Although less invasive techniques exist (such as computed tomography and ultrasonography) to help to diagnose gastrointestinal diseases, these imaging studies are often not precise enough to allow for definite diagnosis of certain conditions. Percutaneous transhepatic cholangiography (PTCA) is an alternative to ERCP that involves the insertion of a long, flexible needle through the skin to the bile ducts; contrast dye is then injected into the ducts so that they may be visualized by x ray. PTCA may be recommended if ERCP fails or cannot be performed. Magnetic resonance cholangiopancreatography (MRCP) is an imaging technology that allows for noninvasive examination of the biliary and pancreatic ducts. Its disadvantage, however, is that unlike ERCP, it cannot be used for therapeutic procedures as well as imaging.



## QUESTIONS TO ASK THE DOCTOR

- Why is ERCP recommended in my case?
- What diagnostic tests will be performed prior to ERCP?
- How long will the procedure take?
- When will I find out the results?
- Will you treat the problem if one is found during the procedure?

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Endoscopic sclerotherapy see **Sclerotherapy for esophageal varices**

## Endoscopic sinus surgery

### Definition

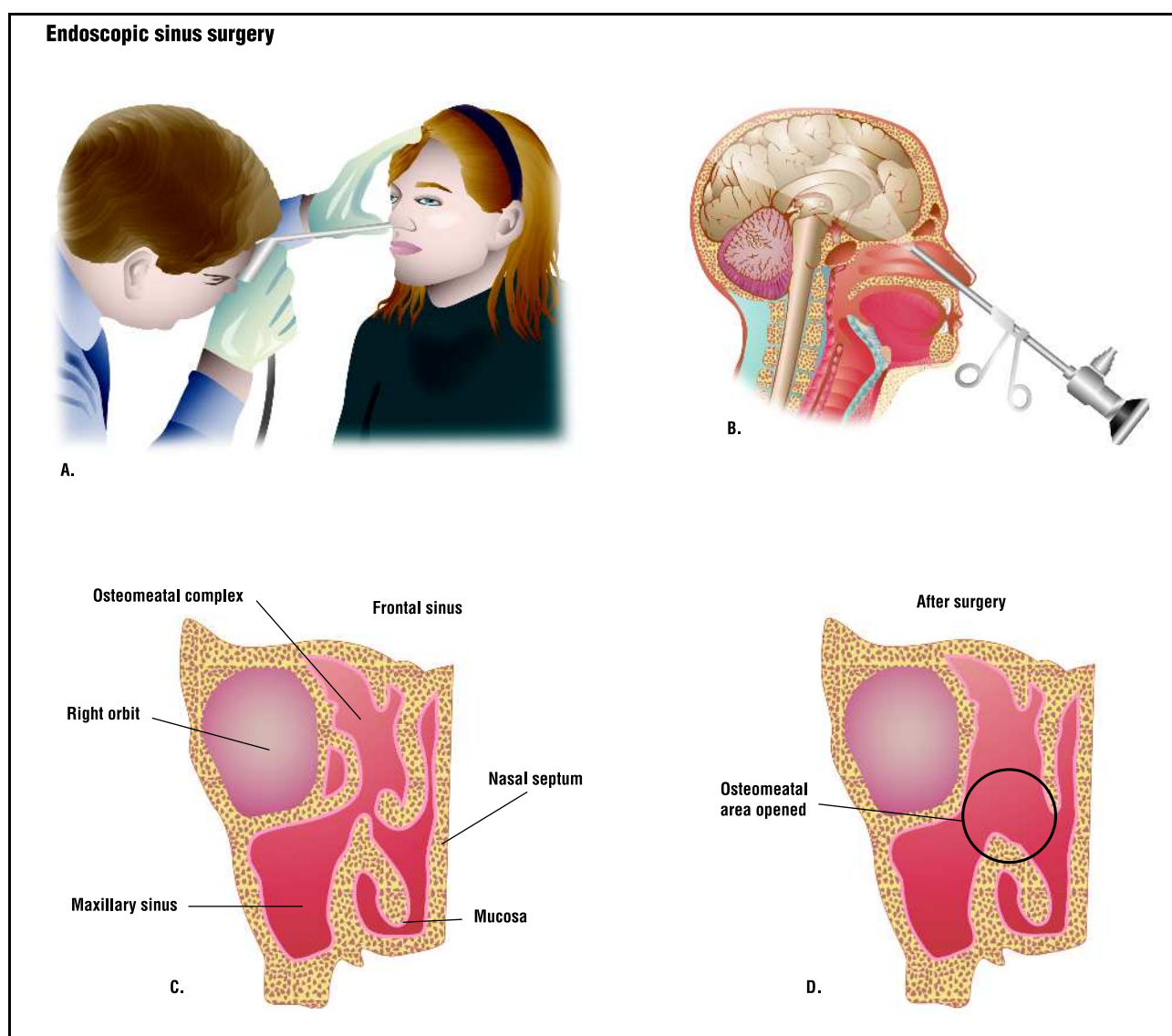
Functional endoscopic sinus surgery (FESS) is a minimally invasive surgical procedure that opens up sinus air cells and sinus ostia (openings) with an endoscope.

The use of FESS as a sinus surgical method has now become widely accepted, and the term "functional" is meant to distinguish this type of endoscopic surgery from nonendoscopic, more conventional sinus surgery procedures.

### Purpose

The purpose of FESS is to restore normal drainage of the sinuses. This function requires ventilation through the ostia (mouth-like opening) and is facilitated by a mucociliary transport process that maintains a constant flow of mucus out of the sinuses. All sinuses need ventilation to prevent infection and inflammation, a condition known as sinusitis. In healthy individuals, sinus ventilation occurs through the ostia into the nose. The sinuses open into the middle meatus (curved passage in each nasal cavity) under the middle turbinate (thin, bony process that is the lower portion of the ethmoid bone in each nasal cavity), which together are known as the osteomeatal complex, the key area of the nose. The hair-like cilia direct the flow of mucus toward the ostia.

Sinusitis develops when there is a problem in the area where the maxillary and frontal sinuses meet near the nose or, occasionally, a dental infection. When sinusitis occurs, the cilia work less efficiently, preventing the flow of mucus. The mucous membranes of the sinuses become engorged, resulting in ostia closure. Poor ventilation and accumulation of mucus then produce the conditions required for bacterial infection.



During endoscopic sinus surgery, a doctor uses an endoscope to view the inner cavities of the nose (A and B). Using special instruments, the sinuses are opened to alleviate problems with sinusitis (C and D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## Demographics

Sinusitis is a very common condition, affecting 31 million Americans each year; 30% of the U.S. population have sinusitis at some point in their lives. The average adult has three to four upper respiratory infections a year; 1% of these infections are complicated by sinusitis, accounting for 16 million visits to the doctor each year.

## Description

After inducing adequate vasoconstriction with cocaine or ephedrine, the surgeon locates the middle

turbinate, the most important landmark for the FESS procedure. On the side of the nose at the level of the middle turbinate lies the uncinate process, which the surgeon removes. The surgeon opens the back ethmoid air cells, to allow better ventilation, but leaves the bone covered with the mucous membrane. Following this step, the ostium located near the jaw is checked for obstruction and, if necessary, opened with a middle meatal antrostomy. This surgical procedure often greatly improves the function of the osteomeatal complex and provides better ventilation of the sinuses.

FESS offers several advantages:

## KEY TERMS

**Antrostomy**—The operation of opening an antrum for drainage.

**Antrum**—The cavity of a sinus.

**Caldwell-Luc procedure**—A surgical procedure in which the surgeon enters the maxillary sinus by making an opening under the upper lip above the teeth.

**Cilia**—Short hairlike processes that are capable of a lashing movement.

**CT scan**—A sectional imaging of the body constructed by computed tomography.

**Endoscope**—An instrument for visualizing the interior of a hollow organ.

**Ethmoid sinuses**—Paired labyrinth of air cells between the nose and eyes.

**Maxillary sinuses**—Sinuses located in the cheek under the eye next to the ethmoid sinus.

**Meatus**—A general term for an opening or passage-way in the body.

**Middle meatus**—A curved passage in each nasal cavity located below the middle nasal concha and extending along the entire superior border of the inferior nasal concha.

**Middle turbinate**—The lower of two thin bony processes on the ethmoid bone on the lateral wall of each nasal fossa that separates the superior and middle meatus of the nose.

**Mucociliary**—Involving cilia of the mucous membranes of the respiratory system.

**Mucous membrane**—A membrane rich in mucous glands that lines body passages and cavities communicating directly or indirectly with the exterior of the body (as for example, the alimentary, respiratory, and genitourinary tracts). Mucous membranes functions in protection, support, nutrient absorption, and secretion of mucus, enzymes, and salts.

**Mucus**—A viscous, slippery secretion that is produced by mucous membranes which it moistens and protects.

**Nasal concha**—Any of three thin bony plates on the lateral wall of the nasal fossa on each side with or without their covering of mucous membrane.

**Ostia**—A mouth-like opening in a bodily part.

**Polyp**—A projecting mass of swollen and hypertrophied or tumorous tissue.

**Sinus**—A cavity in a bone of the skull that usually communicates with the nostrils and contains air.

**Sinusitis**—Inflammation of a sinus.

**Stenosis**—Narrowing of a duct or canal.

**Turbinate**—Relating to a nasal concha.

**Uncinate process**—A downwardly and backwardly directed process of each lateral mass of the ethmoid bone that joins with the inferior nasal conchae.

**Vasoconstriction**—Narrowing of blood vessels, especially as a result of vasomotor action.

- It is a minimally invasive procedure.
- It does not disturb healthy tissue.
- It is performed in less time with better results.
- It minimizes bleeding and scarring.

### Diagnosis/Preparation

As with many diseases, the history of a patient with sinusitis represents a key part of the preoperative evaluation. Before considering FESS, the ear, nose and throat (ENT) specialist will proceed with a thorough diagnostic examination. The development of such diagnostic tools as the fiberoptic endoscope and CT scanning has greatly improved the treatment of sinus disease. The fiberoptic endoscope is used to examine the nose and all its recesses thoroughly. The specific features that the physician must examine and evaluate are the middle turbinate and the middle

meatus, any anatomic obstruction, and the presence of pus and nasal polyps.

CT scanning can also be used to identify the diseased areas, a process that is required for planning the surgery. It shows the extent of the affected sinuses, as well as any abnormalities that may make a patient more susceptible to sinusitis.

FESS is usually performed under **local anesthesia** with intravenous sedation on an outpatient basis with patients going home one to two hours after surgery. It usually does not cause facial swelling or bruising, and does not generally require nasal packing.

### Aftercare

FESS usually does not cause severe postoperative sinus pain. After the procedure, it is important to keep the nose as free from crust build-up as possible. To

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

This procedure is usually performed on an out-patient basis by an ear, nose, and throat (ENT) specialist, such as an otolaryngologist or an ophthalmic surgeon. ENT physicians are graduates of a school of medicine and typically undergo an otolaryngology residency with further specialization in sinus disease and endoscopic sinus surgery.

achieve this, the surgeon may perform a lengthy cleaning two to three times per week, or the patient may perform a simple nasal douching several times a day. Normal function usually reappears after one or two months. In patients with severe sinusitis or polyps, a short course of systemic steroids combined with **antibiotics** may quicken recovery.

### Risks

The most serious risk associated with FESS is blindness resulting from damage to the optic nerve. However, the chances of this complication occurring are extremely low. Cerebrospinal fluid leak represents the most common major complication of FESS, but it occurs in only about 0.2% of cases in the United States. The leak is usually recognized at the time of surgery and can easily be repaired. Other less serious and rare complications include orbital hematoma and nasolacrimal duct stenosis. All of these complications are also associated with conventional sinus surgery and not only with FESS.

### Normal results

The FESS procedure is considered successful if the patient's sinusitis is resolved. Nasal obstruction and facial pain are usually relieved. The outcome has been compared with that of the Caldwell-Luc procedure and, although both methods are considered effective, there is a strong patient preference for FESS. The extent of the disease before surgery dictates the outcome, with the best results obtained in patients with limited nasal sinusitis.

### Morbidity and mortality rates

According to the American Academy of Family Physicians (AAFP), FESS usually has a good outcome, with most studies reporting an 80–90% rate of

## QUESTIONS TO ASK THE DOCTOR

- Why is sinus surgery required?
- What are the risks involved?
- How many endoscopic sinus surgeries do you perform in a year?
- How much time will I need to recover from the procedure?
- Is the procedure painful?
- What are the alternatives?

success. Good results have also been obtained in patients who have had previous sinus surgery.

### Alternatives

- Image-guided endoscopic surgery. This method uses image guidance techniques that feature a three-dimensional mapping system combining CT scanning and real-time data acquisition concerning the location of the surgical instruments during the procedure. It allows surgeons to navigate more precisely in the affected area. The surgeon can monitor the exact location of such vital organs as the brain and eyes as well as positively identifying the affected areas.
- Caldwell-Luc procedure. This procedure improves drainage in the maxillary sinus region located below the eye. The surgeon reaches the region through the upper jaw above one of the second molars. He or she creates a passage to connect the maxillary sinus to the nose in order to improve drainage.

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## Endoscopic ultrasound

### Definition

Endoscopic ultrasound is an imaging test which combines an endoscopic examination with an ultrasound examination. A very thin flexible tube is passed through the mouth, into the throat, and then on through either the bronchi into the lungs or through the esophagus into the stomach. Alternatively, the tube can be passed through the anus and into the lower gastrointestinal tract. A tiny ultrasound transducer is built into this tube, allowing close examination of areas of either the upper or lower gastrointestinal tract, or the respiratory tract. Endoscopic ultrasound can be used to diagnose conditions, to stage cancer, and to access biopsy samples.

### Purpose

Endoscopic ultrasound can be used to evaluate a number of conditions, including:

- Cancer of the esophagus, stomach, pancreas or rectum
- Lung cancer

- Gallstones in the bile duct
- Pancreatitis
- Pancreatic cysts
- Dysfunctional anal sphincter
- Incontinence
- Barrett's esophagus
- Rectal fistulas

### Precautions

Patients who are taking blood thinners, aspirin, or nonsteroidal anti-inflammatory medications may need to discontinue their use in advance of the test, to avoid increasing the risk of bleeding.

### Description

After the patient is adequately sedated, he or she will be placed in the appropriate position, depending on what type of examination is being performed. For upper gastrointestinal or respiratory exams, the throat will be sprayed with a local anesthetic which will prevent the gag reflex from interfering with introduction of the endoscope. Air may be introduced into the gastrointestinal tract, in order to expand the area for more easy visualization of the structures.

The endoscope will be passed either through the mouth into the trachea and then through the bronchial tree into the lungs, or through the mouth into the esophagus and on into the stomach. From the stomach, the endoscope can be passed further into the small intestine, where it can be used to access the pancreas as well. Alternatively, the endoscope can be introduced through the rectum into the large intestine for examination of the bowel.

The progression of the endoscope past the various structures will be visible to the examiner on a television monitor. A separate ultrasound monitor allows the examiner to view ultrasound images during the course of the examination. Fine needle biopsy can be performed through the endoscope in order to obtain biopsy samples.

### Preparations

Patients will need to stop eating and drinking for at least six hours prior to the exam. For examinations involving the gastrointestinal tract, enemas and/or laxatives may be used to empty the GI tract of feces. An intravenous line will be placed in order to provide the patient with fluids and sedation during the exam. Sedation will make the passage of the endoscopy tube less traumatic and uncomfortable. The patient will be attached to a variety of monitors to keep track of

## KEY TERMS

**Barrett's esophagus**—A condition in which the esophageal tissue closest to the stomach contains highly abnormal cells that have a great likelihood of converting to frank cancer.

**Endoscope**—A narrow, flexible tube with a fiber optic light on it, used to pass into the body for a variety of medical examinations.

**Fine needle biopsy**—Use of a very thin type of needle to withdraw cells from an organ, a tumor, or other body tissue, in order to examine those cells for abnormalities (such as malignancy) in a pathology laboratory.

**Fistula**—An abnormal opening occurring between two organs or an abnormal opening leading to the outside of the body.

**Pancreatitis**—Inflammation of the pancreas.

**Transducer**—The instrument that sends sound waves into organs of the body, in order to produce ultrasound images.

blood pressure, heart rate, and blood oxygen level throughout the procedure.

### Aftercare

After the test, patients will rest until the sedative wears off. Once their gag reflex has returned, they can begin drinking fluids. After some hours, they can progress to a light diet. Most people can resume their normal diet and activity level within 24 hours of this type of test.

### Risks

In general, endoscopic ultrasound examinations that are performed without final needle aspiration are relatively low risk. Only about one in 2,000 patients undergoing this procedure develop any kind of complication from it. Possible problems include reaction to the sedatives (such as nausea, vomiting, hives, or skin rash), or swelling or infection of the area where the intravenous line was placed. The most serious complication involves inadvertent perforation (puncture) of the intestinal wall, requiring surgical repair. This is an extremely rare complication.

There is a slightly higher rate of complication when endoscopic ultrasound is performed in conjunction with a fine needle aspiration. Complication rates for this procedure are about 0.5-1.0%. In this case,

there is some chance of bleeding if the needle accidentally passes through the intestinal wall. This may require that the patient be hospitalized for observation, or, even more rarely, for a blood transfusion. Infection can also occur following fine needle aspiration. When the procedure involves the pancreas, there is a risk of pancreatic inflammation or pancreatitis, requiring some days of hospitalization and treatment.

### Normal results

Normal results mean that there are no structural abnormalities visualized during the course of the examination. If biopsies are performed, a normal examination would mean that only normal tissue was identified upon pathological examination.

### Abnormal results

Abnormal results range from the discovery and identification of tumors, cysts, or gallstones, to the demonstration of cancerous tissue upon examination of biopsy material in the pathology laboratory.

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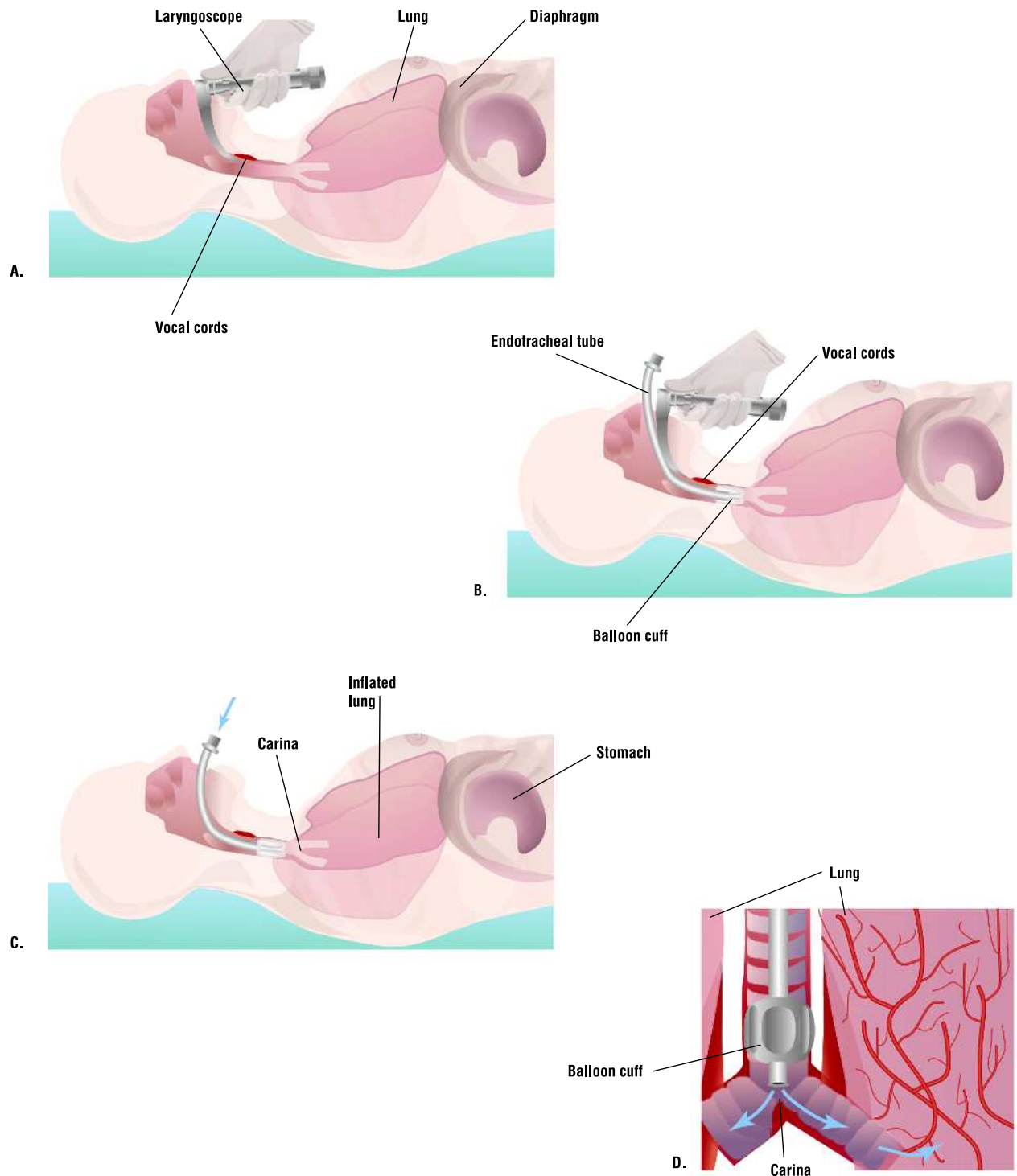
Rosalyn Carson-DeWitt, MD

## Endotracheal intubation

### Definition

Endotracheal intubation is the placement of a tube into the trachea (windpipe) in order to maintain an open airway in patients who are unconscious or unable to breathe on their own. Oxygen, anesthetics, or other gaseous medications can be delivered through the tube.

## Endotracheal intubation



The doctor inserts the laryngoscope into the patient's mouth, advancing to through the trachea to the vocal cords (A). An endotracheal tube is inserted into the airway (B). The balloon cuff is inflated, and the laryngoscope is removed (C). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## Purpose

Specifically, endotracheal intubation is used for the following conditions:

- respiratory arrest
- respiratory failure
- airway obstruction
- need for prolonged ventilatory support
- Class III or IV hemorrhage with poor perfusion
- severe flail chest or pulmonary contusion
- multiple trauma, head injury and abnormal mental status
- inhalation injury with erythema/edema of the vocal cords
- protection from aspiration

## Description

To begin the procedure, an anesthesiologist opens the patient's mouth by separating the lips and pulling on the upper jaw with the index finger. Holding a laryngoscope in the left hand, he or she inserts it into the mouth of the patient with the blade directed to the right tonsil. Once the right tonsil is reached, the laryngoscope is swept to the midline keeping the tongue on the left to bring the epiglottis into view. The laryngoscope blade is then advanced until it reaches the angle between the base of the tongue and the epiglottis. Next, the laryngoscope is lifted upwards towards the chest and away from the nose to bring the vocal cords into view. Often an assistant has to press on the trachea to provide a direct view of the larynx. The anesthesiologist then takes the endotracheal tube, made of flexible plastic, in the right hand and starts inserting it through the mouth opening. The tube is inserted through the cords to the point that the cuff rests just below the cords. Finally, the cuff is inflated to provide a minimal leak when the bag is squeezed. Using a **stethoscope**, the anesthesiologist listens for breathing sounds to ensure correct placement of the tube.

## Preparation

For endotracheal intubation, the patient is placed on the operating table lying on the back with a pillow under the head. The anesthesiologist wears gloves, a gown, and goggles. **General anesthesia** is administered to the patient before starting intubation.

## Risks

The anesthesiologist should evaluate and follow the patient for potential complications that may

## KEY TERMS

**Anesthesia**—The loss of feeling or sensation. Anesthesia is administered during surgery by an anesthesiologist.

**Edema**—The presence of abnormally large amounts of fluid in the intercellular tissue spaces of the body.

**Emphysema**—A pathological accumulation of air in tissues or organs, especially in the lungs.

**Endotracheal**—Located inside the trachea.

**Epiglottis**—A cartilaginous lidlike appendage that closes the glottis while food or drink is passing through the pharynx.

**Glottis**—The vocal part of the larynx, consisting of the vocal cords and the opening between them.

**Laryngoscope**—An instrument used to examine the larynx.

**Larynx**—The voice box.

**Pharynx**—The cavity at the back of the mouth.

**Pneumothorax**—A collapse of the lung due to an abrupt change in the intrapleural pressure within the chest cavity.

**Trachea**—The windpipe; a tough, fibrocartilaginous tube passing from the larynx to the bronchi before the lungs.

**Stethoscope**—A rubber Y-shaped device used to listen to sounds produced by the human body.

include edema, bleeding, tracheal and esophageal perforation, pneumothorax (collapsed lung), and aspiration. The patient should be advised of the potential signs and symptoms associated with life-threatening complications of airway problems. These signs and symptoms include, but are not limited to, sore throat, pain or swelling of the face and neck, chest pain, subcutaneous emphysema, and difficulty swallowing.

## Normal results

The endotracheal tube inserted during the procedure maintains an open passage through the upper airway and allows air to pass freely to and from the lungs in order to ventilate them.

## Alternatives

Alternatives to endotracheal intubation include:

- Esophageal tracheal combitube (ETC). The ETC is a double-lumen tube, combining the function of an



of an inflatable silicone ring attached diagonally to a flexible tube. The ring forms an oval cushion that fills the space around and behind the larynx. It achieves a low pressure seal between the tube and the trachea without insertion into the larynx.

- **Tracheostomy.** A tracheostomy is a surgically created opening in the neck that allows direct access to the trachea. It is kept open with a tracheostomy tube. A tracheostomy is performed when it is not possible to intubate the patient.

## Resources

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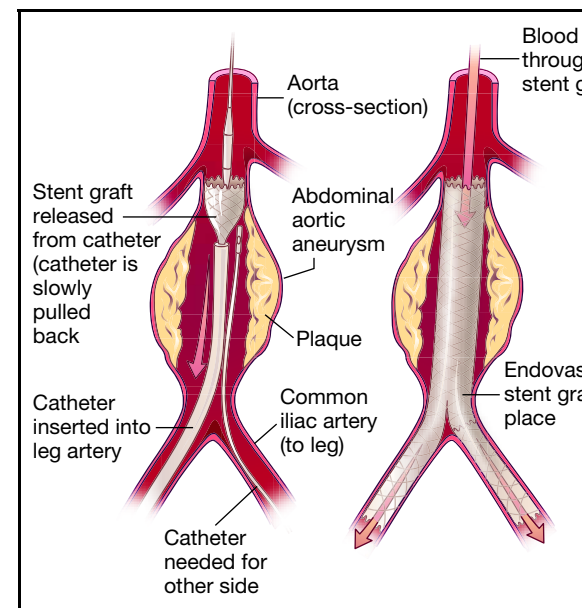
### ORGANIZATIONS

- American Society of Anesthesiologists. 520 N. Northwest Highway, Park Ridge, IL 60068 2573. (847) 825 5586. <http://www.asahq.org/>.

## Endovascular stent surgery

### Definition

Endovascular stent surgery is a minimally invasive surgical procedure that uses advanced technology and instrumentation to treat disorders of the circulatory system such as blockage or damage to blood vessels caused by the buildup of plaque (fatty deposits, calcium deposits, and scar tissue) in the arteries. A condition called atherosclerosis (hardening of the arteries). The surgeon may recommend the placement of an endovascular stent, a small wire-mesh tube that surgeons call a scaffold, in an affected artery. The procedure may be done in conjunction with clearing or repairing the artery. The twofold procedure opens, enlarges, and supports artery walls for a long-lasting improvement in blood flow and a decrease in the



(Illustration by Electronic Illustrators Group.)

of heart attack or stroke. In endovascular stent surgery (*endo*, within, and *vascular*, blood vessel), all of the work done by the surgeon is within the blood vessels themselves. Nearly all of the medium-sized and large blood vessels in the body's vascular system can be accessed from within the vessels. This fact contributes to a rapid increase in the performance of endovascular stent surgery.

### Purpose

The purpose of endovascular stent surgery is to improve or restore the flow of blood and oxygen throughout the body, a process called coronary revascularization. Endovascular stent surgery is used most often to correct the narrowing in medium-sized and large arteries blocked by plaque. Stents have been used in coronary arteries, the carotid arteries in the neck, and renal (kidney) or biliary (gallbladder) arteries. They are rarely used for smaller arteries in the legs, for example, or other smaller vessels in the body.

Endovascular stenting is also the newest treatment for emergency vascular events, such as abdominal or thoracic (related to chest and lung area) aortic aneurysms. Aortic aneurysms are life-threatening bulges in the walls of the aorta, the largest artery in the body, usually the result of progressive atherosclerosis.

### Demographics

Candidates for endovascular stent surgery are patients with atherosclerosis who are at high risk for heart attack and stroke. Heart disease and stroke are the leading causes of **death** and disability in the United States for both men and women. People at greatest risk have high blood pressure and high cholesterol, and sometimes diabetes. Typically these people may also smoke, be overweight, and have close relatives with heart disease or coronary artery disease or who have had a stroke. More than 700,000 people per year have stent surgeries to clear obstructions in the coronary arteries. Abdominal aortic aneurysms are the 13th leading cause of death in the United States, occurring primarily in people over age 67. More than 190,000 aortic aneurysms are diagnosed each year; of these, 45,000 people have surgery. Although the use of stent grafting is increasing, most aneurysms are treated with conventional open surgery procedures.

### Description

The conditions most often treated by endovascular stent surgery are: coronary artery disease; narrowing (stenosis) of the carotid artery in the neck, a risk factor for stroke; and aortic aneurysm.

- Coronary artery disease is a circulatory disorder resulting from plaque blockages in the arteries of the heart. The heart is a muscle that requires a constant flow of blood and oxygen through its blood vessels so that it can perform the critical function of supplying the whole body with blood. When fatty deposits form in the heart's two main arteries, the arteries become narrowed and the flow of blood and oxygen is blocked. Blockages can cause pain in the chest (angina) and eventually, when the blood vessels are occluded (closed up), a heart attack.
- The carotid arteries in the neck carry blood and oxygen to the brain. When these major arteries are blocked by plaque, the narrowing can interrupt the flow of blood to the brain and cause a disabling stroke. A carotid endarterectomy is a surgical procedure performed on people with significant stenosis (50 to 70% narrowing); in this procedure, a surgeon removes the fatty deposits to correct the narrowing and allow blood and oxygen to flow freely to the brain. Although an effective surgical measure, it is a surgery that presents high risks to patients who are already greatly compromised. Endovascular stent surgery is a less invasive procedure, with fewer risks, and is sometimes the surgeon's choice to prevent stroke in certain high-risk patients.
- An aortic aneurysm, which is a life-threatening bulging of the aorta, can occur anywhere along this major artery, either in the abdomen (abdominal aortic aneurysm or AAA) or in the chest area (thoracic aneurysm). When the aorta is blocked by significant amounts of plaque, pressure may cause it to bulge like a balloon directly above or below the blockage, causing a weakening of the vessel wall. The aorta may eventually rupture, causing massive bleeding and death. Sometimes the aneurysm is diagnosed when the victim complains of pain, but there may also be no obvious symptoms. Sometimes the vessel ruptures, causing massive internal bleeding and eventual loss of consciousness, requiring emergency surgery. Endovascular stent surgery is the least invasive method of surgical intervention to repair an aneurysm.

Coronary artery disease and carotid stenosis can be treated in three ways: medically, which is the use of therapeutic drugs in combination with changes in diet and **exercise**; by such open surgery as the highly invasive coronary artery bypass surgery (CABG); or by such minimally invasive procedures as stent implantation, balloon **angioplasty**, and atherectomy or endarterectomy (the cutting of plaque from the inside of vessel walls). Sometimes combinations of these methods are used. The goal of all these procedures is to improve the flow of blood and oxygen throughout the

## KEY TERMS

**Aorta**—The largest artery in the body, which passes through the abdomen and chest, supplying blood to the stomach and legs.

**Aneurysm**—A life-threatening enlargement or bulge in an artery caused by a weakening of the artery wall above or below an area of blockage.

**Balloon angioplasty**—X-ray-guided insertion of a balloon catheter into a blocked blood vessel to remove plaque and open the vessel for better blood flow.

**Endovascular**—Within the walls of a blood vessel.

**Graft**—Replacement of a diseased or damaged part of the body with a compatible substitute that can be artificial (metal or other substance) or taken from the body itself, such as a piece of skin, healthy tissue, or bone.

**Revascularization**—Restoring the body's blood flow after an interruption or blockage has disrupted normal circulation.

**Rupture**—The bursting of a blood vessel or organ that has suffered enlargement, bulging, and weakening from unusual pressure.

**Stent**—A specially designed wire-mesh device that is placed inside a blood vessel to open or support it.

**Thoracic**—Pertaining to the chest cavity, including the lungs and the area around the lungs.

**Vascular**—Pertaining to the blood vessels of the body that make up the circulatory system; veins and arteries.

body, reduce symptoms, and reduce the risk of heart attack or stroke.

Endovascular stent surgery was introduced in the 1980s to treat occlusive (blocking) coronary artery disease, without using open surgery. More recently, endovascular stent grafting, a variation of the procedure, is also being used to repair life-threatening aortic aneurysms, which formerly could be treated only with open surgery. Because the incision for endovascular procedures is just large enough to allow passage of a small tube (catheter) into a blood vessel, the procedure does not disturb the patient's body processes as much as conventional **vascular surgery**. This advance in technique helps reduce the patient's stay in the hospital and makes recovery faster. At the same time, it satisfies a common goal of surgeons to use less

invasive methods that offer patients the best result with the fewest risks.

An endovascular stent is a tiny wire mesh tube that can look like a cage or a coiled spring, depending on the manufacturer's design. The implantation of stents is performed through a tiny incision, using a catheter to deliver it to the site of treatment in a vessel. The stent provides a mechanical way to hold a blood vessel open and improve blood flow over the long term. Stents are sometimes implanted through the same incision after balloon angioplasty has been performed. The balloon angioplasty is another catheter-guided procedure that uses a balloon device to stretch the waxy plaque formation and open the vessel walls. Before stents were used, some patients undergoing angioplasty (in 5–10% of angioplasty procedures) suffered acute closure, which is the complete closing down of the treated artery either during or after the procedure. Stents reduce the likelihood of this medical emergency and the need for immediate cardiac surgery to correct it. Stents are implanted both to treat new blockages and to treat the repeat build-up of plaque after prior surgical treatment, a process called restenosis. Endovascular stent implantation has been shown to reduce the likelihood of restenosis. Some stents can deliver anti-plaque drugs to the area of blockage. These are called drug-eluting stents; they are aimed at preventing restenosis and eliminating the need for further surgery.

Endovascular stent surgery is performed in a **cardiac catheterization** laboratory equipped with a fluoroscope, a special x-ray machine and an x-ray monitor that looks like a regular television screen. The patient will be placed on an x-ray table and covered with a sterile sheet. An area on the inside of the upper leg will be washed and treated with an antibacterial solution to prepare for the insertion of a catheter. The patient is given **local anesthesia** to numb the insertion site and will usually remain awake during the procedure. To implant stents in arteries, the stent is threaded through an incision in the groin up into the affected blood vessel on a catheter with a deflated balloon at its tip and inside the stent. The surgeon views the entire procedure with a fluoroscope. The surgeon guides the balloon catheter to the blocked area and inflates the balloon, causing the stent to expand and press against the vessel walls. The balloon is then deflated and taken out of the vessel. The entire procedure takes from an hour to 90 minutes to complete. The stent remains in the vessel permanently to hold the vessel walls open and allow blood to pass freely as in a normally functioning healthy artery. Cells and tissue will begin to grow over the stent until its inner surface

is covered. It then becomes a permanent part of the functioning artery.

Stent surgery for emergency treatment of aortic aneurysm is called endovascular stent grafting or endovascular repair. Candidates for this treatment have either aortic aneurysms or other abnormal conditions of the aorta, such as an **arteriovenous fistula** (abnormal communication between an artery and a vein), or other kinds of aortic blockage. Formerly these conditions were treated by highly invasive surgical procedures, with incisions that reached from the breastbone to the navel, to access the aorta, open it, and insert and attach a slender fabric-covered tube called a graft. During the less invasive endovascular stent surgery, a collapsed metal stent-graft (also called an endograft) is threaded through an artery beginning from a small incision in the groin and ending in the aorta. Threading is done through a tube-like delivery system lying in the vessel, which allows catheters and stents to move up and down during the procedure. A stent graft is similar to the stents used in coronary artery procedures, but it has a ring of tiny hooks and barbs at each end that allow it to connect to the inner wall of the artery, replacing and repairing (grafting) the weakened area. The surgeon guides the stent graft into the aneurysm by using fluoroscopic x-ray imaging. When the stent graft is in place, its outer sheath is withdrawn and the stent graft is expanded. It will anchor itself to the inside of the artery wall with the hooks and barbs on each end. Some stent-graft systems also use balloons to push the hooks into the vessel wall. Because the procedure is minimally invasive, patients recover quickly and are usually able to eat the same day, walk on the second day, and go home in two to three days after the surgery.

### Diagnosis/Preparation

Often the first test done to diagnose coronary artery disease is an **electrocardiogram**, to show the heart's rhythm. A **stress test**, or exercise electrocardiogram, may be performed as well, though the test can be too strenuous for some patients. Cardiac catheterization is considered the most definitive test. It requires the injection of a special dye into the coronary arteries at the same time a catheter is threaded up into the heart's arteries and x rays are displayed on a monitor to show any narrowing or blockage. To diagnose clogged arteries in other areas of the body, imaging techniques, such as computed tomography (CT) or **magnetic resonance imaging** (MRI) may be used to visualize the presence and extent of narrowing in the blood vessels. Diagnostic procedures for aneurysm may include these same imaging tests; but often,

because of the emergency nature of aneurysm, there is little time to conduct extensive testing beyond immediate confirmation of the presence of the aneurysm.

For up to 12 hours before a stent procedure or combined angioplasty and stent surgery, the patient will have to avoid eating or drinking. An intravenous line will be inserted so that medications (anticoagulants to prevent clot formation and radioactive dye for x rays) can be administered during the surgery. The patient's groin area will be shaved and cleaned with an antiseptic to prepare for the incision. About an hour before the procedure, the patient may be given a mild sedative to ensure that he or she will relax sufficiently for the procedure.

### Aftercare

After stent surgery, the patient will spend several hours in the **recovery room** to be monitored for **vital signs** (temperature, heart rate, and breathing) and heart sounds. Pressure will be applied to the catheter insertion site in the groin to prevent bleeding; a weight may be applied to the leg to restrict movement. For the first 24 hours, the patient will have to lie flat and limit activities. Drinking fluids will be especially important to help flush out the dye that was used for x rays during the procedure. Stent recipients are usually placed on **aspirin** therapy or anti-clotting (anticoagulant) medication immediately after surgery. They will remain on it indefinitely to prevent clots from occurring in the stent. There are no other postoperative precautions, although dietary and lifestyle changes may be recommended to reduce such risk factors as high cholesterol and smoking that could lead to new blockages from ongoing buildup of plaque in the body's blood vessels. Patients are advised not to have magnetic resonance imaging (MRI) procedures after the surgery because of the effect of magnetism on the metal stents. Stents are not affected by metal detectors.

### Risks

The greatest risk with stent implantation is the formation of clots within the stent. Aspirin and oral anti-clotting medications are usually given after stent placement to minimize this risk, which has been reported to occur in about 1–1.5% of patients undergoing endovascular stent surgeries. There has been no evidence of long-term complications from stent implantation, according to the American Heart Association.

A variety of complications can occur with stent grafting for emergency aneurysm repair. Movement of the stent within the vessel can occur in up to 10% of cases, requiring repeat surgery. Clots can occur in the



vessel and migrate to other areas of the body, causing heart attack or stroke. About 2% of patients will require an additional open surgical procedures to correct the aneurysm or complications that occur after emergency endovascular repair.

### Normal results

People undergoing endovascular stent surgeries usually recover within a week or so, compared to months of recovery from conventional open surgery. They can quickly resume normal activities with a reduction of symptoms and little chance of repeat stenosis, depending upon their general health. The American Heart Association reports that 70–90% of procedures for coronary artery disease are endovascular stenting procedures. Stents have been shown to reduce the risk of restenosis after angioplasty or other catheter-based procedures have been performed.

### Morbidity and mortality rates

Deaths have not been reported either during or immediately following endovascular stent surgeries that are linked to the surgical procedure. Stent procedures have been shown to increase survival (by reducing restenosis) among people with coronary artery disease.

The mortality rate for surgically treated abdominal aortic aneurysm is about 5% and increases to 50% for aneurysms that rupture. Thoracic aneurysms also have a mortality rate of about 5%, rising to 67% if ruptured. Stent grafting has been shown overall to have lower rates of morbidity and mortality than conventional open procedures.

### Prevention

Preventive measures are the same as those taken to prevent heart attack and stroke. Any adult can reduce the likelihood of plaque formation by making dietary and lifestyle changes, such as:

- Eating a healthy diet rich in fruits, vegetables, and whole grains, with limited meat and dairy. Especially avoid trans-fatty-acids found in chemical- or heat-extracted oils such as margarine, some vegetable oils, and butter substitutes.
- Keeping blood pressure down by reducing the use of table salt and avoiding salty foods, such as chips, processed meats, pickles and sauerkraut, as well as prepared and packaged foods.
- Losing weight, if necessary, which helps to reduce blood pressure. Excess weight strains the whole circulatory system.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Endovascular stent surgery is performed by a vascular surgeon in a hospital or medical center cardiac catheterization laboratory.

- Engaging in moderate exercise several times a week. Exercise that works up a sweat and increases heart rate is recommended. A brisk walk for 20 minutes, three days a week is thought to be sufficient for people who are less physically active.
- Controlling cholesterol through diet and certain medications.
- Having a heart examination at least once a year with an electrocardiogram. The patient should also consult the doctor about taking aspirin for clot prevention.
- Quitting smoking. Smoking encourages the build-up of plaque. Nicotine raises blood pressure and carbon monoxide in smoke reduces the amount of oxygen circulating in the blood. Strong links have been made between smoking and heart attack or stroke.
- Keeping alcohol use moderate. Moderate alcohol use, one or two drinks a day, has been shown to help increase the levels of “good” cholesterol, improve circulation, and reduce the risk of clots forming in the blood.

### Alternatives

Stent implantation helps to clear blocked arteries. There are no mechanical alternatives; however, there are alternative ways to reduce plaque formation. Nutritional supplements and alternative therapies that have been recommended to help reduce risks and promote good vascular health include:

- Vitamins B<sub>6</sub> and B<sub>12</sub> help to lower homocysteine, an amino acid that is believed to contribute to atherosclerosis. B<sub>6</sub> is also a mild diuretic and helps to balance fluids in the body.
- Folic acid helps lower homocysteine levels and increases the oxygen-carrying capacity of red blood cells.
- Antioxidant vitamins C and E work together to promote healthy blood vessels and improve circulation.
- Angelica, an herb that contains coumadin, a recognized anticoagulant, may help to prevent blood clot formation.

## QUESTIONS TO ASK THE DOCTOR

- Why do I need this procedure?
- What kind of anesthesia will I have?
- Will I be uncomfortable during or after the procedure?
- Will I be able to resume all my normal activities when I go home?
- Will I need any follow-up care or tests after the surgery?
- How often do you perform this procedure?
- Is there any chance I would need this type of surgery again?
- What can I do after surgery to reduce my chances of having this condition again?

- Garlic has been shown in studies to reduce cholesterol and help prevent atherosclerosis.
- Essential fatty acids help reduce blood pressure and cholesterol, and maintain elasticity of blood vessels.
- Chelation therapy can be used to break up plaque and improve circulation.
- Citrin is an herbal extract that inhibits the synthesis of dangerous fats in the body.
- Certain herbs have been shown to improve circulation and help prevent plaque formation, including cayenne, chickweed, ginkgo biloba, and hawthorn berries.
- A vegetarian diet, with plenty of whole grains (brown rice, oats, spelt, whole wheat) showed a reversal of coronary artery disease in a U.S. study called the Lifestyle Heart Trial.

### Resources

#### BOOKS

Heart and Stroke Facts, and Stent Procedure. American Heart Association, 2002.

#### ORGANIZATIONS

American Heart Association. 7320 Greenville Ave. Dallas, TX 75231. (214) 373 6300. <http://www.americanheart.org>.

#### OTHER

"Performing Endovascular Surgery: New Minimally Invasive Approach to Treating Vascular Disease." Patient Care. Department of Surgery, State University of New York, Stony Brook. <http://galactica.informatics.sunysb.edu/surgery/endovasc3.html> [Accessed April 11, 2008].

L. Lee Culvert  
Laura Jean Cataldo, RN, EdD

## Enhanced external counterpulsation

### Definition

Enhanced external counterpulsation (EECP) is a noninvasive procedure in which a set of inflatable cuffs (much like blood pressure cuffs) mechanically compress the blood vessels in the patient's lower limbs to increase blood flow in the coronary arteries of the heart. The blood pressure cuffs (also called stockings) are wrapped around the patient's calves, lower thighs, and upper thighs. Computer technology, **electrocardiography**, and blood pressure monitors enable the pressure cuffs to be inflated and deflated in time with the patient's heartbeat and blood pressure.

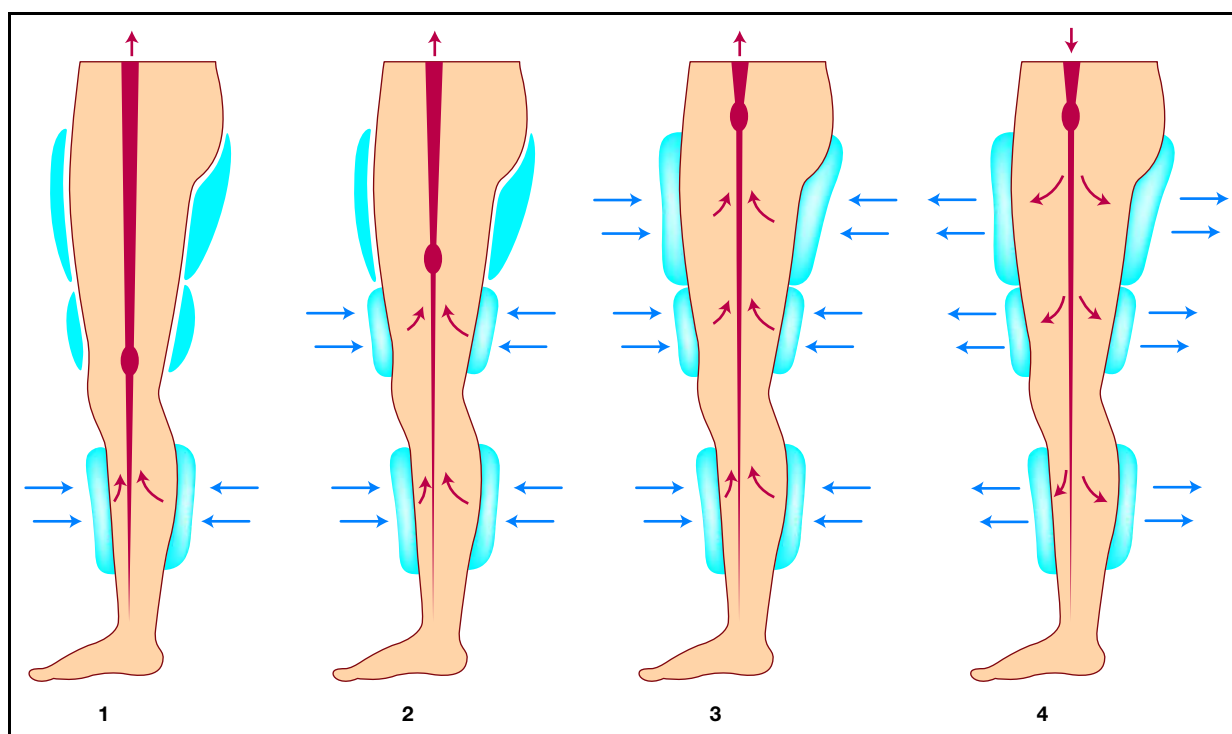
### Purpose

EECP is performed to restore blood flow to the heart and to relieve chest pain (angina pectoris) and ischemia. The goals of the procedure are to relieve the symptoms of coronary artery disease, enable the patient to resume a normal lifestyle, and lower the risk of a heart attack or other heart problems. EECP may encourage blood vessels to open small channels (called collateral blood vessels) to eventually bypass blocked vessels and improve blood flow to the heart.

### Demographics

The concept of counterpulsation is not new; it was first introduced in 1953 at Harvard, and refined in the late 1950s. Early models of EECP, however, used non-sequenced pulsation; that is, compression of the patient's blood vessels was performed simultaneously along the full length of the body. In the 1970s, researchers in China reported on a sequential compression system in which four sets of pressure cuffs were applied to the patient's legs, buttocks, and arms. Favorable reports about the effectiveness of sequential compression encouraged a research team at SUNY Stony Brook to develop the three-cuff EECP model in use in the early 2000s. The computerized technology currently available with EECP makes it a relatively new procedure compared to the systems used in the 1960s and early 1970s. As of 2008, it is available in about 200 centers across the United States.

EECP is used to treat patients with chronic stable angina, coronary artery disease, or high blood pressure. The Food and Drug Administration (FDA) approved EECP for the treatment of congestive heart failure (CHF) in the early 2000s. Researchers at the Ohio Heart and Vascular Center reported in 2006 that



The horizontal arrows indicate pressure (in 1 through 3) and release (4). (Illustration by Electronic Illustrators Group.)

EECP improves **exercise** duration as well as quality of life in patients with CHF. The treatment may be appropriate for patients who are not eligible for such nonsurgical interventional procedures as balloon **angioplasty**, stent placement, rotablation, atherectomy, or brachytherapy. It may also be used for patients who do not qualify for such surgical treatments as **coronary artery bypass graft surgery**.

EECP is not the first-line treatment for angina. Rather, it is reserved for patients who have not achieved good results from medication or interventional management of their symptoms. To be eligible for EECP, a patient must have coronary artery disease that includes at least one heart vessel with at least 70% obstruction. In addition, the patient must have evidence of either an infarction or significant ischemia on a **stress test** with nuclear or echocardiographic imaging.

EECP may benefit patients with such other medical conditions as erectile dysfunction, kidney disease, eye disease, diabetic neuropathy, restless legs syndrome, and other circulatory disorders. More research is needed to evaluate the outcomes of EECP for these patients.

Many insurance providers and **Medicare** have approved EECP treatment for reimbursement. Medicare pays about \$5,500 for the full series of 35 treatments.

### Contraindications

EECP is not recommended for patients who have certain types of valve disease, uncontrolled arrhythmias (irregular heart rhythms), severe hypertension, uncontrolled congestive heart failure, significant blockages or blood clots in the leg arteries, or those who have had a recent **cardiac catheterization**, angioplasty, or bypass surgery. It should also not be given to pregnant women.

### Description

While the patient lies on a bed, the leg cuffs are deflated and inflated with each heartbeat. A computer synchronizes the compression of the cuffs with the heartbeat. The **electrocardiogram** indicates when each heartbeat begins, triggering the cuffs to be mechanically deflated. As each heartbeat ends, the cuffs are mechanically inflated in sequential order, starting with the cuffs on the calves and working upward to the cuffs on the lower and then the upper thighs. The pressure produced by the inflation of the cuffs when the heart is at rest pushes the blood in the legs upward toward the heart. The deflating action that occurs just when the heart begins to beat reduces the work of the heart as it pumps blood to other parts of the body. Inflation is controlled by a pressure monitor that

## KEY TERMS

**Angina**—Also called angina pectoris; chest pain or discomfort that occurs when diseased blood vessels restrict blood flow to the heart.

**Aorta**—The main artery that carries blood from the heart to the rest of the body; the largest artery in the body.

**Artery**—A vessel that carries oxygen-rich blood to the body.

**Atherectomy**—A nonsurgical technique for treating diseased arteries with a rotating device that cuts or shaves away obstructing material inside the artery.

**Atria (singular, atrium)**—The right and left upper chambers of the heart.

**Balloon angioplasty**—A nonsurgical technique for treating diseased arteries by temporarily inflating a tiny balloon inside an artery.

**Beta blocker**—An antihypertensive drug that limits the activity of epinephrine, a hormone that increases blood pressure.

**Brachytherapy**—The use of radiation during angioplasty to prevent the artery from narrowing again (a process called restenosis).

**Calcium channel blocker**—A drug that lowers blood pressure by regulating calcium-related electrical activity in the heart.

**Cardiac catheterization**—An invasive procedure used to create x rays of the coronary arteries, heart chambers and valves.

**Collateral vessel**—A side branch or network of side branches of a large blood vessel.

**Coronary artery disease**—Also called atherosclerosis, it is a buildup of fatty matter and debris in the coronary artery wall that causes narrowing of the artery.

**Echocardiogram**—An imaging procedure used to create a picture of the heart's movement, valves and chambers.

**Electrocardiogram (ECG, EKG)**—A test that records the electrical activity of the heart, using small electrode patches attached to the skin on the chest.

**Infarction**—An area of dead tissue caused by obstruction of the blood supply to that tissue.

**Ischemia**—Decreased blood flow to an organ, usually caused by constriction or obstruction of an artery.

**Rotablation**—A nonsurgical technique for treating diseased arteries in which a special catheter with a diamond-coated tip is guided to the point of narrowing in the artery. The catheter tip spins at high speed and grinds away the blockage or plaque on the artery walls.

**Stent**—A device made of expandable metal mesh that is placed (by using a balloon catheter) at the site of a narrowing artery. The stent remains in place to keep the artery open.

**Stress test**—A test that determines how the heart responds to stress.

**Vein**—A blood vessel that returns oxygen-depleted blood from various parts of the body to the heart.

**Ventricles**—The lower pumping chambers of the heart that propel blood to the lungs and the rest of the body.

inflates the cuffs to about 300 mm Hg. When timed correctly, the procedure increases the cardiac output.

EECP treatments are performed on an outpatient basis and generally last one to two hours. Treatments must be repeated about five times a week for up to seven weeks to achieve improved circulation. This 35-hour regimen is generally followed because it was used in the first multicenter study of EECP in 1999.

## Diagnosis/Preparation

### Preparation

The patient is usually instructed to wear tight-fitting seamless cycling pants or athletic tights to prevent chafing, one of the main adverse side effects.

Before the procedure, the patient's weight, blood pressure, pulse, and breathing rate are measured and recorded. The patient's legs are examined for areas of redness and signs of potential vascular problems.

The patient is asked to record his or her symptoms during the course of treatment to determine whether and how symptoms improve over time. The patient should record the severity and duration of troublesome symptoms, the time the symptoms occurred, and any activities that may have triggered the symptoms. This patient record is reviewed before each treatment session.

**PATIENT EDUCATION.** The healthcare team will ensure that the patient understands the potential benefits and risks of the procedure. Informative and



instructional handouts are usually provided to explain the procedure. Because the procedure requires multiple outpatient visits (generally 35 visits over a seven-week period), the patient must be able to meet the treatment schedule.

**INFORMED CONSENT.** **Informed consent** is an educational process between healthcare providers and patients. Before any procedure is performed, the patient is asked to sign a consent form. Before signing the form, the patient should understand the nature and purpose of the diagnostic procedure or treatment; the risks and benefits of the procedure; and alternatives, including the option of not proceeding with the test or treatment. During the discussion about the procedure, the healthcare providers are available to answer all of the patient's questions.

**SMOKING CESSATION.** Patients who will undergo any procedure to treat cardiovascular disease are encouraged to stop smoking and using any tobacco products before the procedure, and to make a commitment to be a nonsmoker after the procedure. There are several **smoking cessation** programs available in the community. The patient should ask a healthcare provider for more information if he or she needs help quitting smoking.

### Aftercare

#### *Discomfort*

Patients report little or no discomfort during the procedure. Some people may feel tired after the first few treatments, but this loss of energy improves over time.

#### *Lifestyle changes*

To manage heart disease, the patient needs to make several lifestyle changes before and after the procedure, including:

- **Quitting smoking.** Smoking causes damage to blood vessels, increases the patient's blood pressure and heart rate, and decreases the amount of oxygen available in the blood.
- **Managing weight.** Maintaining a healthy weight, by watching portion sizes and exercising, is important. Being overweight increases the work of the heart.
- **Participating in an exercise program.** The cardiac rehabilitation exercise program is usually tailored for the patient, who will be supervised by professionals.
- **Making dietary changes.** Patients should eat a lot of fruits, vegetables, grains, and nonfat or low-fat dairy products, and reduce fats to less than 30% of all calories. Alcoholic beverages should be limited or avoided.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

EECP is performed by healthcare providers trained in the procedure. Interventional cardiologists, registered nurses, and other healthcare professionals may perform the procedure. Currently, EECP credentialing is being investigated by the International EECP Therapists Association (IETA). EECP is generally performed in an outpatient clinic or hospital.

- **Taking medications as prescribed.** Aspirin and other heart medications may be prescribed, and the patient may need to take these medications for life.
- **Following up with healthcare providers.** The patient should visit the physician regularly for follow-up visits to control risk factors.

### Risks

EECP is a relatively safe and effective treatment, and few adverse side effects have been reported. The main adverse side effect is chafing (skin irritation from the compression of the cuffs). To reduce or prevent this side effect, patients are instructed to wear tight-fitting cycling pants or athletic tights. Leg pain is another adverse side effect.

### Normal results

The benefits of EECP are comparable to the results of angioplasty and coronary artery bypass graft surgery: 70–80% of patients experience significant improvement after EECP treatment for as long as five years. The largest research study on EECP indicates that after receiving treatment, patients used less medication, had fewer angina attacks with less severe symptoms, and increased their capacity to exercise without experiencing symptoms. EECP improves the patient's sense of well-being and overall quality of life, and in some cases, prolongs the patient's life. Benefits five years after EECP treatment are comparable to surgical outcomes.

The effects of EECP treatment last from three to five years and sometimes longer.

EECP does not prevent coronary artery disease from recurring; therefore, lifestyle changes are strongly recommended and medications are prescribed to reduce the risk of recurrent disease.

## QUESTIONS TO ASK THE DOCTOR

- Why do you recommend this procedure?
- Who will perform the procedure? How many years of experience does this doctor have? How many other EECP procedures has this doctor performed?
- May I take my medications the day of the procedure?
- May I eat or drink the day of the surgery? If not, how long before the surgery should I stop eating or drinking?
- How long do the treatments last?
- What should I do if I experience chest discomfort or other symptoms similar to those I felt before the procedure?
- What types of symptoms should I report to my doctor?
- Will I be able to perform my normal activities during the course of treatment?
- When will I find out if the procedure was successful?
- Will I have any pain or discomfort after the procedure?
- What lifestyle changes (including diet, weight management, exercise, and activity changes) are recommended to improve my heart health?
- How often do I need to see my doctor for follow-up visits after the procedure?

### Morbidity and mortality rates

Morbidity and mortality have not been reported with this procedure.

### Alternatives

All patients with coronary artery disease can help improve their condition by making lifestyle changes such as quitting smoking, losing weight if they are overweight, eating healthful foods, reducing blood cholesterol, exercising regularly, and controlling diabetes and high blood pressure.

All patients with coronary artery disease should be prescribed medications to treat their condition. Such antiplatelet medications as **aspirin** or clopidogrel (Plavix) are usually recommended. Other medications used to treat angina may include beta blockers, nitrates, and angiotensin-converting enzyme (ACE)

inhibitors. Medications may also be prescribed to lower lipoprotein levels, since elevated lipoprotein levels have been associated with an increased risk of cardiovascular problems.

Treatment with vitamin E is not recommended because it does not lower the rate of cardiovascular events in people with coronary artery disease. Although such antioxidants as vitamin C, beta-carotene, and probucol show promising results, they are not recommended for routine use. Treatment with folic acid and vitamins B<sub>6</sub> and B<sub>12</sub> lowers homocysteine levels (reducing the risk for cardiovascular problems), but more studies are needed to determine if lowered homocysteine levels correlate with a reduced rate of cardiovascular problems in treated patients.

Such nonsurgical interventional procedures as balloon angioplasty, stent placement, rotablation, atherectomy, or brachytherapy can be performed to open a blocked artery.

Coronary artery bypass graft surgery is a surgical procedure in which one or more blocked coronary arteries are bypassed by a blood vessel graft to restore normal blood flow to the heart. These grafts usually come from the patient's own arteries and veins located in the leg, arm, or chest.

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- American Heart Association. 7272 Greenville Ave., Dallas, TX 75231. (800) 242 8721 or (214) 373 6300. <http://www.americanheart.org> (accessed March 19, 2008).
- Cleveland Clinic Heart and Vascular Institute, The Cleveland Clinic Foundation. 9500 Euclid Avenue, F25, Cleveland, Ohio, 44195. (216) 445 9288. <http://www.clevelandclinic.org/heartcenter> (accessed March 19, 2008).
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## Enucleation, eye

### Definition

Enucleation is the surgical removal of the eyeball that leaves the eye muscles and remaining orbital contents intact.

### Purpose

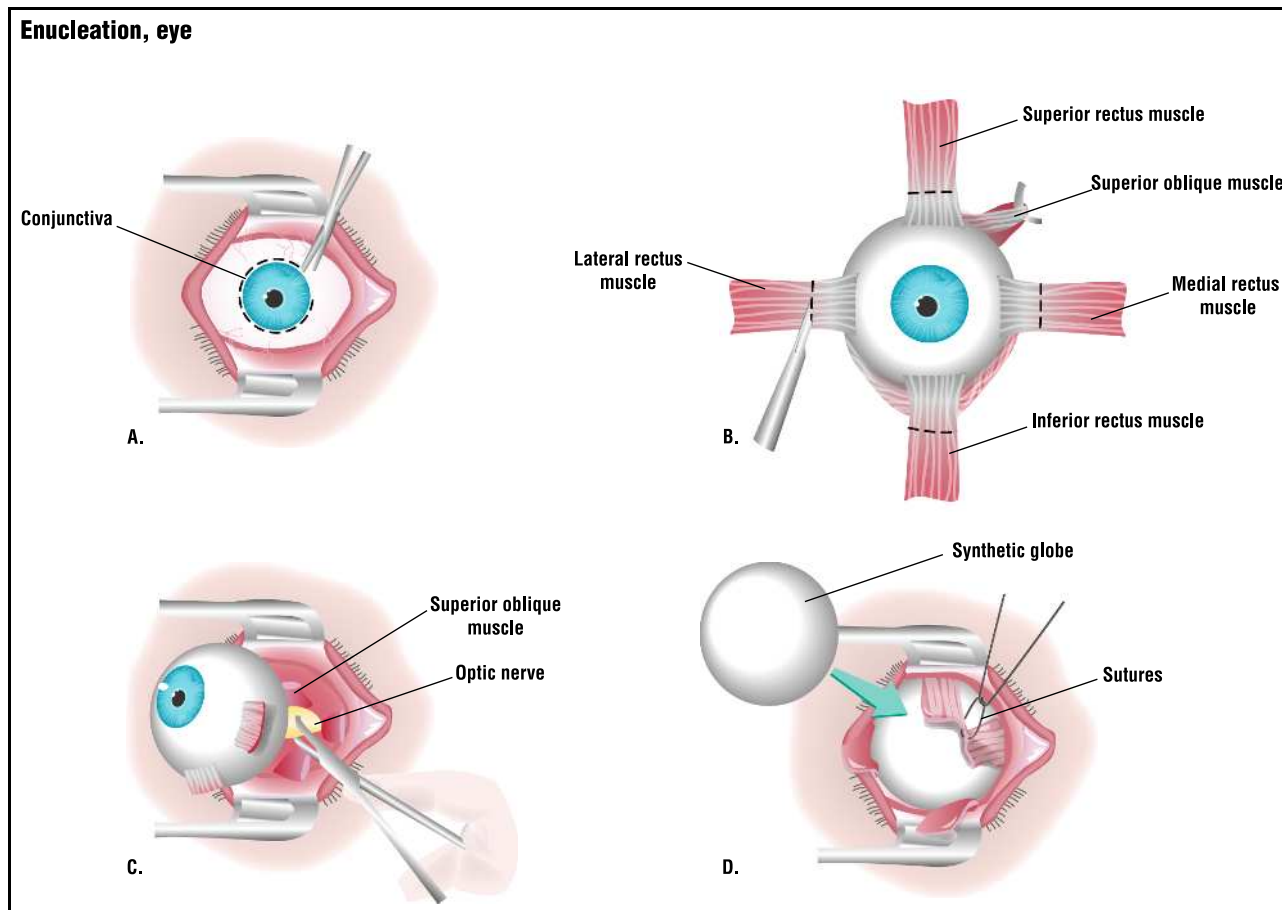
Enucleation is performed to remove large-sized eye tumors or as a result of traumatic injury when the eye cannot be preserved. In the case of tumors, the amount of radiation required to destroy a tumor of the eye may be too intense for the eye to bear. Within months to years, many patients who are treated with radiation for large ocular melanomas lose vision, develop glaucoma, and eventually have to undergo enucleation.

The two types of eye tumors that may require enucleation are:

- **Intraocular eye melanoma.** This is a rare form of cancer in which malignant cells are found in the part of the eye called the uvea, which contains cells called melanocytes that house pigments. When the melanocytes become cancerous, the cancer is called a melanoma. If the tumor reaches the iris and begins to grow, or if there are symptoms, enucleation may be indicated.
- **Retinoblastoma.** Retinoblastoma is a malignant tumor of the retina. The retina is the thin layer of tissue that lines the back of the eye; it senses light and forms images. If the cancer occurs in one eye, treatment may consist of enucleation for large tumors when there is no expectation that useful vision can be preserved. If there is cancer in both eyes, treatment may involve enucleation of the eye with the larger tumor, and radiation therapy to the other eye.

### Demographics

Data from the U.S. National Center for Health Statistics estimate that nearly 2.4 million eye injuries occur in the United States annually. This report calculated that nearly one million Americans have permanent significant visual impairment due to injury, with more than 75% of these individuals being blind in one eye. Eye injury is a leading cause of monocular blindness in the United States, and is second only to cataract as the most common cause of visual impairment. While no segment of the population escapes the risk of eye injury, the victims are more likely to be young. The majority of all eye injuries occur in persons under thirty years of age. Trauma is considered the most



The conjunctiva (outer covering of eye) is removed with blunt scissors (A). The four rectus muscles are removed from their attachments to the eyeball (B). The optic nerve is severed (C), and the eyeball is removed. A synthetic globe replaces the eyeball in the socket, and the rectus muscles are sutured around it (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

common cause of enucleation in children over three years of age.

For the year 2000, Texas demographics for cancer of the eye and orbit were fewer than five per 100,000. According to the National Institutes of Health (NIH), there are about 2,200 cases of eye cancer diagnosed in the United States each year.

### Description

Following anesthesia, the surgeon measures the dimensions of the eye globe, length of the optic nerve, and horizontal dimensions of the cornea. The surgeon then illuminates the globe of the eye before opening it. A dissecting microscope is used to detect major features and possible minute lesions. The eye is opened with a sharp razor blade by holding the globe with the left hand, cornea down against the cutting block, and holding the blade between the thumb and middle finger of the right hand. Enucleation proceeds with a sawing motion from back to front. The plane of

section begins adjacent to the optic nerve and ends at the periphery of the cornea. The plane of section is dependent on whether a lesion has been detected. If not, the globe is cut along a horizontal plane, using as surface landmarks the superior and inferior oblique insertions and the long postciliary vein. If a lesion has been found, the plane of section is modified so that the lesion is included in the slab.

### Diagnosis/Preparation

Enucleation may be performed under general or **local anesthesia**. In either case, the injection is given in the retrobulbar space. An antibiotic and an anti-inflammatory medication such as dexamethasone are also given intravenously.

### Aftercare

Because the eye is surrounded by bones, it is much easier for patients to tolerate enucleation than the loss of a lung or kidney. When surgery is performed under



## KEY TERMS

**Cornea**—The transparent structure forming the anterior part of the fibrous tunic of the eye. It consists of five layers.

**Glaucoma**—A group of eye diseases characterized by an increase in intraocular pressure that causes changes in the optic disk and defects in the field of vision.

**Intraocular melanoma**—A rare form of cancer in which malignant cells are found in the part of the eye called the uvea.

**Iris**—The contractile eye membrane perforated by the pupil, and forming the colored portion of the eye.

**Melanocytes**—Color-containing cells in the uvea.

**Melanoma**—A malignant tumor arising from the melanocytic system of the skin and other organs.

**Optic nerve**—The nerve carrying impulses for the sense of sight.

**Orbit**—The cavity or socket of the skull in which the eye and its appendages are situated.

**Retina**—Thin nerve tissue that lines the back of the eye that senses light and forms images.

**Retinoblastoma**—Malignant (cancerous) tumor of the retina.

**general anesthesia**, patients do not feel or see anything until they regain consciousness. Additional local anesthesia is often given at the end of the surgery so that the patient will have the least pain possible when waking up in the **recovery room**. Most patients have a headache for 24–36 hours after surgery that is relieved with two regular headache medication pills, such as Tylenol, every four hours. A firm pressure dressing is maintained for four to six days; oral **antibiotics** are given for one week; and steroids, such as prednisone, adjusted according to patient status, are given three times daily for four days. The socket is evaluated after removal of the pressure dressing. If the edema has disappeared, the sutures are removed. **Topical antibiotics** are applied four times daily for four weeks.

## Risks

Enucleation surgery is very safe. Only rarely do patients experience major complications, which may include bleeding, infection, scarring, persistent

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Eye enucleation is usually performed by an ophthalmic surgeon or an ophthalmologist in a hospital setting. Young and healthy patients may undergo the surgery on an outpatient basis but most stay in the hospital for at least one night after surgery. Ophthalmic surgeons are members of the American College of Eye Surgeons, and are certified by the American Board of Eye Surgery after submitting to an extensive written application. Before ABES certification, they must be certified by the American Board of Ophthalmology (ABO). This certification indicates successful completion of an approved residency program and acquisition of sufficient knowledge in the areas of medical and surgical ophthalmology.

swelling, pain, wound separation, and the need for additional surgery. Complications may also occur with the orbital implants routinely used with patients who have undergone enucleation. Among these is the risk of infection.

## Normal results

Within two to six weeks of enucleation surgery, patients are sent for a temporary ocular prosthesis (plastic eye). Besides the swelling and the black eye, patient features look normal. After a final prosthetic fitting, 90% of patients are usually quite happy with the way they look; 80% say others cannot even tell that they have only one eye.

## Morbidity and mortality rates

In a study performed by the National Eye Institute on melanoma patients at five-year follow-up, 82% of the patients who underwent enucleation remained alive. At a 10-year follow-up, 31% remained alive. As of 2003, the study was ongoing and would follow all patients for up to 15 years.

## Alternatives

There are no alternatives to enucleation because it is a procedure of last resort performed when other treatments have failed.

## QUESTIONS TO ASK THE DOCTOR

- Why is enucleation required?
- Will there be pain after surgery?
- How many enucleation surgeries do you perform in a year?
- How much time will I need to recover from the operation?
- When can I get a prosthesis?

### Resources

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- American College of Eye Surgeons. 2665 Oak Ridge Court, Suite A, Fort Myers, FL 33901. (239) 275-8881. <http://www.aces-abes.org/>.
- National Cancer Institute. Suite 3036A, 6116 Executive Boulevard, MSC8322, Bethesda, MD 20892-8322. (800) 422-6237. <http://cancer.gov/>.

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Monique Laberge, Ph.D.

Enzyme immunoassay see **Immunoassay tests**

## Epidural therapy

### Definition

An epidural is a local (regional) anesthetic delivered through a catheter (small tube) into a vacant space outside the spinal cord, called the epidural space.

The drugs commonly used in epidural anesthesia are bupivacaine (Marcaine, Sensorcaine), chloroprocaine (Nesacaine), and lidocaine (Xylocaine). The solutions of anesthetic should be preservative free.

### Purpose

The anesthetic agents that are infused through the small catheter block spinal nerve roots in the epidural space and the sympathetic nerve fibers adjacent to them. Epidural anesthesia can block most of the pain of labor and birth for vaginal and surgical deliveries. Epidural analgesia is also used after cesarean sections to help control postoperative pain. More than 50% of women giving birth at hospitals use epidural anesthesia.

### Description

Epidural anesthesia, because it virtually blocks all pain of labor and birth, is particularly helpful to women with underlying medical problems such as pregnancy-induced hypertension, heart disease, and pulmonary disease. Epidural anesthesia for labor is usually initiated at the woman's request, provided that the labor is progressing well, or if the mother feels severe pain during early labor.

### Precautions

The primary problem associated with receiving epidural anesthesia is low blood pressure, otherwise known as hypotension, because of the blocking of sympathetic fibers in the epidural space. The decreased peripheral resistance that results in the circulatory system causes dilation of peripheral blood vessels. Fluid collects in the peripheral vasculature

## KEY TERMS

**Analgesia**—A medication that decreases the awareness of pain.

**Anesthesia**—Loss of sensation through the administration of substances that block the transmission of nerve impulses signaling the feeling of pain and pressure.

**Regional anesthesia**—Blocking of specific nerve pathways through the injection of an anesthetic agent into a specific area of the body.

(vessels), simulating a condition that the body interprets as low fluid volume. A simple measure that prevents most hypotension is the infusion of 500–1000 cc of fluid intravenously into the patient prior to the procedure. Ringer's lactate is preferable to a solution containing dextrose because the elevated maternal glucose that accompanies the rapid infusion of solutions containing dextrose can result in hyperglycemia in the newborn with rebound hypoglycemia.

It is important not to place a woman flat on her back after she has an epidural because the supine position can bring on hypotension. If a woman's blood pressure does drop, then the proper treatment is to turn her on her side, administer oxygen, increase the flow of intravenous fluids, and possibly administer ephedrine if the hypotension is severe. Very rarely, convulsions can result from severe reactions. Seizure activity would be treated with short-acting **barbiturates** or diazepam (Valium).

### Diagnosis/Preparation

To prepare for the administration of epidural anesthesia, the woman should have the procedure explained fully and sign required consent forms. An intravenous line is inserted, if not already in place. She is positioned on her side or in a sitting position and connected to a blood pressure monitoring device. The nurse/assistant has the following equipment available: oxygen, epidural insertion equipment, fetal monitor, and additional intravenous fluid.

The health-care provider cleans the area with an antiseptic solution, injects a local anesthetic to create a small wheal at the L 3–4 area (between the third and fourth lumbar vertebrae), and inserts a needle into the epidural space. Once it is ascertained that the needle is in the correct place, a polyethylene catheter is threaded through the needle. The needle is removed and a test dose of the anesthetic agent is administered. The

catheter is taped in place along the patient's back with the end over her shoulder for easy retrieval when further doses are required.

If the patient responds well to the test dose, a complete dose is administered. Pain relief should come up to the level of the umbilicus. The epidural anesthesia lasts approximately 40 minutes to two hours, or longer as required. If necessary, additional doses of anesthetic, or top-up, are injected through the catheter or by continuous infusion on a special pump.

Epidural anesthesia can be given in labor in a "segmented" manner. In this instance, the laboring woman receives a small dose of anesthesia so that the perineal muscles do not fully relax. The baby's head is more apt to undergo internal rotation when the perineal muscles are not too loose, thus facilitating delivery. At the time of delivery, an additional dose can be administered for perineal relief.

Women who have cesarean deliveries may have additional medication injected into the epidural space to control intra-operative pain. Medications generally used are narcotics such as fentanyl or morphine (Duramorph). Side effects include severe itching, nausea, and vomiting. Treatment of these side effects with the appropriate medication can be helpful. Despite these problems, epidural analgesia is an effective method to relieve pain after cesarean delivery, allowing the woman to move easily and speed recovery.

Local anesthetics are generally safe when administered by the epidural route. There is a low frequency of allergic reaction to the drug. Most often the drug causes a mild skin reaction, but in more severe cases can cause breathing difficulty and an asthma-like reaction. A burning sensation at the site of injection may occur, sometimes with swelling and skin irritation. Other adverse reactions may occur if the epidural anesthetic is not properly administered.

### Aftercare

It is important to carefully monitor **vital signs** after the administration of epidural anesthesia. Hypotension can result in fetal **death** and can also have grave consequences for the mother. The nurse should monitor the patient constantly and use a continuous blood pressure machine to obtain regular blood pressure readings for 20–30 minutes after each administration of anesthesia. The systolic blood pressure should not fall below 100 mm Hg or be 20 mm Hg less than a baseline systolic blood pressure for a hypertensive patient.

It is important to remind the woman to empty her bladder at least every two hours. With epidural anesthesia, there is loss of sensation of the need to void.

Sometimes, an overfull bladder can block the descent of the baby's head. A catheter can be inserted into the bladder to drain the urine. The nurse needs to closely monitor intake and output and assess the bladder for signs of distension.

## Risks

Side effects and complications are rare, but sometimes the patient will experience a "spinal headache" due to leakage of cerebrospinal fluid (CSF).

When a woman receives epidural anesthesia for labor pains, at times the labor can be prolonged because of excessive relaxation of the muscles. Also, the baby's head may not rotate—especially if it is in the occiput-posterior position (the back of the head is facing toward the woman's back). The woman may not have the sensation that results in the desire to push during contractions when she is fully dilated. These complications may result in an increased incidence of births with the use of vacuum extraction, forceps, or even cesarean deliveries. Administering a Pitocin (oxytocin) drip intravenously can counter this problem. Pitocin is a medication that causes the uterus to contract. Allowing the epidural to wear off in the second stage of labor when the woman is pushing may avoid this problem, but the return of the labor pains may be overwhelming to the woman.

Occasionally, slow absorption of the medication from the epidural space into the circulation can result in toxic reactions evident by decreased level of consciousness, slurred speech, loss of coordination, drowsiness, nervousness, and anxiety. The health-care provider should look out for these signs, and also report any elevation in temperature before a top-up dose is administered.

## Nomral results

Epidural anesthesia is a safe and effective method of giving pain relief to women during labor and delivery. It also can be used for cesarean births. It is believed that very little of the anesthetic is absorbed throughout the body (systemically), therefore epidural anesthesia is ideal because it does not pass the medication into the fetal circulation.

## Resources

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American Association of Nurse Anesthetists (AANA). 222 S. Prospect Avenue, Park Ridge, IL 60068. (847) 692 7050. <http://www.aana.com>.

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Epilepsy surgery see **Anterior temporal lobectomy; Corpus callosotomy; Hemispherectomy**

Epinephrine see **Adrenergic drugs**

# Episiotomy

## Definition

An episiotomy is a surgical incision made in the perineum, the area between the vagina and anus. Episiotomies are done during the second stage of labor to expand the opening of the vagina to prevent tearing of the area during the delivery of the baby.

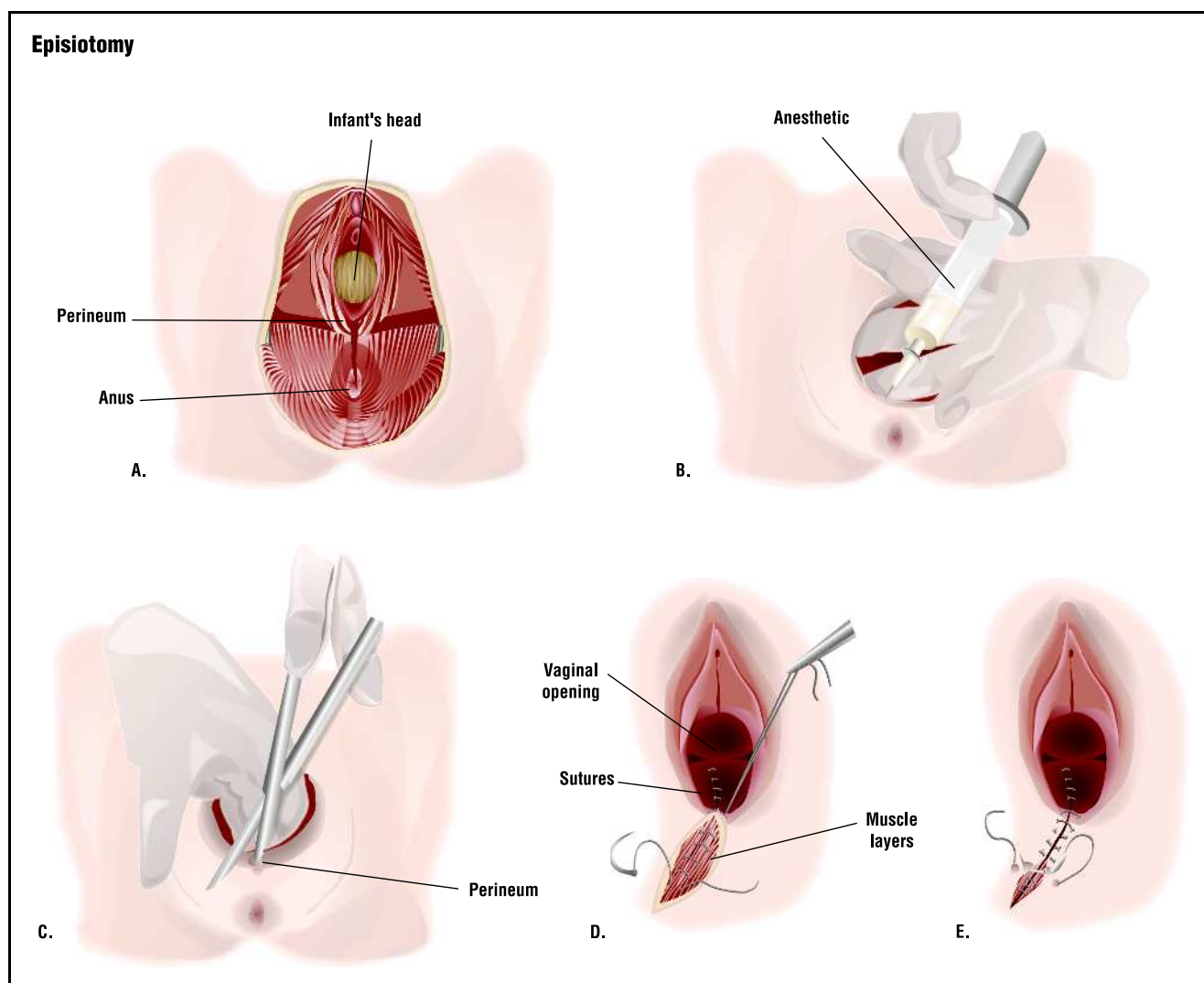
## Purpose

An episiotomy is usually done during the birthing process in order to deliver a baby without tearing the perineum and surrounding tissue. Reasons for an episiotomy might include:

- evidence of maternal or fetal distress (i.e., no time to allow perineum to stretch);
- the baby is premature or in a breech position, and his/her head could be damaged by a tight perineum;
- the baby is too large to be delivered without causing extensive tearing;
- delivery is being assisted by forceps;
- the mother is too tired or unable to push; or
- there is existing trauma to the perineum.

Some experts believe that an episiotomy speeds up the birthing process, making it easier for the baby to be delivered. Speed can be important if there is any sign of distress that may harm the mother or baby.





During childbirth, the area called the perineum is often cut to facilitate delivery (A). First, a local anesthetic may be given (B). The perineum is cut on an angle with scissors (C). After delivery, the layers of muscle and skin are repaired (D and E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

Because tissues in this area may tear during the delivery, another reason for performing an episiotomy is that a clean incision is easier to repair than a jagged tear and may heal faster. Although episiotomies are sometimes described as protecting the pelvic muscles and possibly preventing future problems with urinary incontinence, it is not clear that the procedure actually helps.

### Demographics

About 33% of all American women undergo episiotomy during labor and delivery. While this represents a dramatic drop from the 1983 rate of 69.4%, there are many experts who still believe that this represents too high a number. Episiotomy rates were

higher among white women (32.1%) than African American women (11.2%). Similar differences have been reported in other obstetric procedures (e.g., **cesarean section** and epidural use).

Episiotomy rates differ according to care provider—patients of midwives have lower rates than patients of medical doctors. One study comparing perineal outcomes for women being cared for by midwives or medical doctors found the episiotomy rate among midwives at 25% and 40% among medical doctors. Younger doctors are also less likely to perform an episiotomy than older doctors; one study found the rate of episiotomies performed by residents to be 17%, while the rate among doctors in private practice was 66%.

## KEY TERMS

**Kegel exercises**—A series of contractions and relaxations of the muscles in the perineal area. These exercises are thought to strengthen the pelvic floor and may help prevent urinary incontinence in women.

**Perineum**—The area between the opening of the vagina and the anus in a woman, or the area between the scrotum and the anus in a man.

**Sitz bath**—A shallow tub or bowl, sometimes mounted above a toilet, that allows the perineum and buttocks to be immersed in circulating water.

**Urinary incontinence**—Inability to prevent the leakage or discharge of urine. It becomes more common as people age, and is more common in women who have given birth to more than one child.

## Description

An episiotomy is a surgical incision, usually made with sterile scissors, in the perineum as the baby's head is being delivered. This procedure may be used if the tissue around the vaginal opening begins to tear or does not seem to be stretching enough to allow the baby to be delivered.

In most cases, the physician makes a midline incision along a straight line from the lowest edge of the vaginal opening toward the anus. In other cases, the episiotomy is performed by making a diagonal incision across the midline between the vagina and anus (called a mediolateral incision). This method is used much less often, may be more painful, and may require more healing time than the midline incision. After the baby is delivered through the extended vaginal opening, the incision is closed with **stitches**. A local anesthetic may be applied or injected to numb the area before it is sewn up (sutured).

Episiotomies are classified according to the depth of the incision:

- A first-degree episiotomy cuts through skin only (vaginal/perineal).
- A second-degree episiotomy involves skin and muscle and extends midway between the vagina and the anus.
- A third-degree episiotomy cuts through skin, muscle, and the rectal sphincter.
- A fourth-degree episiotomy extends through the rectum and cuts through skin, muscle, the rectal sphincter, and anal wall.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

An episiotomy is performed by the health care provider attending to a woman's labor and delivery, typically an obstetrician/gynecologist or midwife. An obstetrician/gynecologist is a medical doctor who has completed specialized training in the areas of women's general health, pregnancy, labor and childbirth, prenatal testing, and genetics. A midwife is a person who has been trained to provide care, support, and supervision to women in all stages of pregnancy, labor, delivery, and the postpartum period. The procedure is performed at the site of labor and delivery, most often a hospital or birth center.

## Diagnosis/Preparation

Although there are some reasons for anticipating an episiotomy before labor has begun (e.g., breech presentation of the baby), the decision to perform an episiotomy is generally not made until the second stage of labor, when delivery of the baby is imminent.

## Aftercare

The area of the episiotomy may be uncomfortable or even painful for several days. Several practices can relieve some of the pain. Cold packs can be applied to the perineal area to reduce swelling and discomfort. Use of a sitz bath can ease the discomfort. This unit circulates warm water over the area. A squirt bottle with water can be used to clean the area after urination or defecation rather than wiping with tissue. Also, the area should be patted dry rather than wiped. Cleansing pads soaked in witch hazel (such as the brand Tucks) are very effective for soothing and cleaning the perineum.

## Risks

Several side effects of episiotomy have been reported, including infection (in 0.3% of cases), increased pain, increased bleeding, prolonged healing time, and increased discomfort once sexual intercourse is resumed. There is also the risk that the incision will be deeper or longer than is necessary to permit the birth of the infant. An incision that is too long or deep may extend into the rectum, causing more bleeding and an increased risk of infection. Additional tearing or tissue damage may occur beyond the episiotomy itself.

## QUESTIONS TO ASK THE DOCTOR

- What is your episiotomy rate?
- For what reasons would you perform an episiotomy?
- What are my alternatives to having an episiotomy?
- How should I care for my episiotomy when I return home?

### Normal results

In a normal and well-managed delivery, an episiotomy may be avoided altogether. If an episiotomy is considered necessary, a simple midline incision will be made to extend the vaginal opening without additional tearing or extensive trauma to the perineal area. Although there may be some pain associated with the healing of the incision, relief can usually be provided with mild pain relievers and supportive measures, such as the application of cold packs.

### Morbidity and mortality rates

Studies have found that the rates of urinary/fecal incontinence, postpartum perineal pain, and sexual dysfunction are generally the same between women who have had an episiotomy and those who had a spontaneous tear of the perineum. There does appear to be a higher risk of more extensive perineal trauma when an episiotomy is performed (20.9% experienced third- or fourth-degree lacerations) than when it is not (3.1% experienced major perineal damage).

### Alternatives

It may be possible to avoid the need for an episiotomy. Pregnant women may want to talk with their care providers about the use of episiotomy during the delivery. Kegel exercises are often recommended during the pregnancy to help strengthen the pelvic floor muscles. Prenatal perineal massage may help to stretch and relax the tissue around the vaginal opening. During the delivery process, warm compresses can be applied to the area along with the use of perineal massage. Coaching and support are also important during the delivery process. Slowed, spontaneous pushing during the second stage of labor (when the mother gets the urge to push) may allow the tissues to stretch rather than tear. Also, an upright birthing position (rather than one where the mother is lying down) may decrease the need for an episiotomy.

## Resources

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### ORGANIZATIONS

- American College of Nurse-Midwives, 8403 Colesville Road, Suite 1550, Silver Spring, MD, 20910, (240) 485-1800, <http://www.midwife.org>.
- American College of Obstetricians and Gynecologists, 409 12th St., SW, P.O. Box 96920, Washington, DC, 20090-6920, (202) 638-5577, <http://www.acog.org>.
- Midwives Alliance of North America, 611 Pennsylvania Avenue, SE, #1700, Washington, DC, 20003-4303, (888) 923-MANA, <http://www.mana.org>.

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EPS see **Electrophysiology study of the heart**

ERCP see **Endoscopic retrograde cholangiopancreatography**

## Erythromycins

### Definition

Erythromycins are a group of medicines that kill bacteria or prevent their growth.

## Purpose

Erythromycins are **antibiotics**, a type of medicine used to treat infections caused by microorganisms. Physicians prescribe these drugs for many types of infections caused by bacteria, including strep throat, sinus infections, pneumonia, ear infections, tonsillitis, bronchitis, gonorrhea, pelvic inflammatory disease (PID), and urinary tract infections. Some medicines in this group are also used to treat Legionnaires' disease and ulcers caused by bacteria. These drugs will not work for colds, flu, and other infections caused by viruses.

Drugs in the erythromycin group may be used to eliminate areas of infection, such as abscesses, prior to surgery. For this purpose, they have been used in dentistry, eye surgery, and intestinal surgery. In some cases, erythromycin has been used to treat brain abscesses.

## Description

The drugs described here include erythromycins (Erythrocin, Ery-C, E-Mycin, and other brands) and medicines that are chemically related to erythromycins such as azithromycin (Zithromax) and clarithromycin (Biaxin). They are available only with a physician's prescription and are sold in capsule, tablet (regular and chewable), liquid, and injectable forms.

## Recommended dosage

The recommended dosage depends on the type of erythromycin, the strength of the medicine, and the medical problem for which it is being taken. The person should check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

The patient must always take erythromycins exactly as directed. The patient should never take larger, smaller, more frequent, or less frequent doses. To make sure the infection clears up completely, it is very important to take the medicine for as long as it has been prescribed. Patients must not stop taking the drug just because symptoms begin to improve. This is important with all types of infections, but it is especially important in streptococcal infections, which can lead to serious heart problems if they are not cleared up completely.

Erythromycins work best when they are at constant levels in the blood. To help keep levels constant, the medicine should be taken in doses spaced evenly through the day and night. The patient must not miss any doses. Some of these medicines are most effective when taken with a full glass of water on an empty

## KEY TERMS

**Abscess**—A collection of pus, appearing in a localized infection, and associated with tissue destruction and frequently with swelling.

**Bronchitis**—Inflammation of the air passages of the lungs.

**Gonorrhea**—A sexually transmitted disease (STD) that causes infection in the genital organs and may cause disease in other parts of the body.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

**Legionnaires' disease**—A lung disease caused by a bacterium.

**Microorganism**—An organism that is too small to be seen with the naked eye.

**Pelvic inflammatory disease (PID)**—Inflammation of the female reproductive tract, caused by any of several microorganisms. Symptoms include severe abdominal pain, high fever, and vaginal discharge. Severe cases can result in sterility.

**Pneumonia**—A disease in which the lungs become inflamed. It may be caused by bacteria, viruses, or other organisms, or by physical or chemical irritants.

**Sinus**—Any of several air-filled cavities in the bones of the skull.

**Strep throat**—A sore throat caused by infection with *Streptococcus* bacteria. Symptoms include sore throat, chills, fever, and swollen lymph nodes in the neck.

**Tonsillitis**—Inflammation of a tonsil, a small mass of tissue in the throat.

**Urinary tract**—The passage through which urine flows from the kidneys out of the body.

stomach, but they may be taken with food if stomach upset is a problem. Others work equally well when taken with or without food. Patients should check package directions or ask the physician or pharmacist for instructions on how to take the medicine.

## Precautions

There are warnings and cautions that apply to erythromycin and its related drugs when they are taken by mouth over a period of several days. These warnings may not apply when erythromycin is given intravenously (by vein), or as a single dose prior to or immediately after surgery.



Symptoms should begin to improve within a few days of beginning to take this medicine. If they do not, or if they get worse, the patient should check with the physician who prescribed the medicine.

Erythromycins may cause mild diarrhea, which usually goes away during treatment; however, severe diarrhea could be a sign of a very serious side effect. Anyone who develops severe diarrhea while taking erythromycin or related drugs should stop taking the medicine and call a physician immediately.

### *Special conditions*

Taking erythromycins may cause problems for people with certain medical conditions or people who are taking certain other medicines. Before taking these drugs, the patient should tell the physician about any of these conditions.

**ALLERGIES.** Anyone who has had unusual reactions to erythromycins, azithromycin, or clarithromycin in the past should let the physician know before taking the drugs again. The physician should also be told about any allergies to foods, dyes, preservatives, or other substances.

**PREGNANCY.** Some medicines in this group may cause problems in pregnant women and have the potential to cause birth defects. Women who are pregnant or who may become pregnant should check with their physicians before taking these drugs.

**BREAST-FEEDING.** Erythromycins pass into breast milk. Mothers who are breast-feeding and who need to take this medicine should check with their physicians.

**OTHER MEDICAL CONDITIONS.** Before using erythromycins, people with any of these medical problems should make sure their physicians are aware of their condition:

- heart disease;
- liver disease; or
- hearing loss.

**USE OF CERTAIN MEDICINES.** Taking erythromycins with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

### **Side effects**

The most common side effects are mild diarrhea, nausea, vomiting, and stomach or abdominal cramps. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as sore mouth or tongue and vaginal itching and discharge, also may occur. They do not need medical attention unless they persist or are bothersome.

More serious side effects are not common, but may occur. If any of the following side effects occur, the patient is advised to check with a physician immediately:

- severe stomach pain, nausea, vomiting, or diarrhea;
- fever;
- skin rash, redness, or itching; or
- unusual tiredness or weakness.

Although rare, very serious reactions to azithromycin (Zithromax) are possible, including extreme swelling of the lips, face, and neck; and anaphylaxis (a violent allergic reaction). Anyone who develops these symptoms after taking azithromycin should stop taking the medicine and get immediate medical help.

Other rare side effects may occur with erythromycins and related drugs. Anyone who has unusual symptoms after taking these medicines should get in touch with the physician.

### **Interactions**

Erythromycins may interact with many other medicines. When an interaction occurs, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes erythromycins should let the physician know all other medicines he or she is taking. Drugs that may interact with erythromycins include:

- acetaminophen (Tylenol);
- medicine for overactive thyroid;
- male hormones (androgens);
- female hormones (estrogens);
- other antibiotics;
- blood thinners;
- disulfiram (Antabuse), used to treat alcohol abuse
- anti-seizure medicines such as valproic acid (Depakote, Depakene);
- caffeine;
- the antihistamine astemizole (Hismanal); and
- antiviral drugs such as zidovudine (Retrovir).

The list above does not include every drug that may interact with erythromycins. A physician or pharmacist should be consulted before combining erythromycins with any other prescription or nonprescription (over-the-counter) medicine.

### **Resources**

#### **BOOKS**

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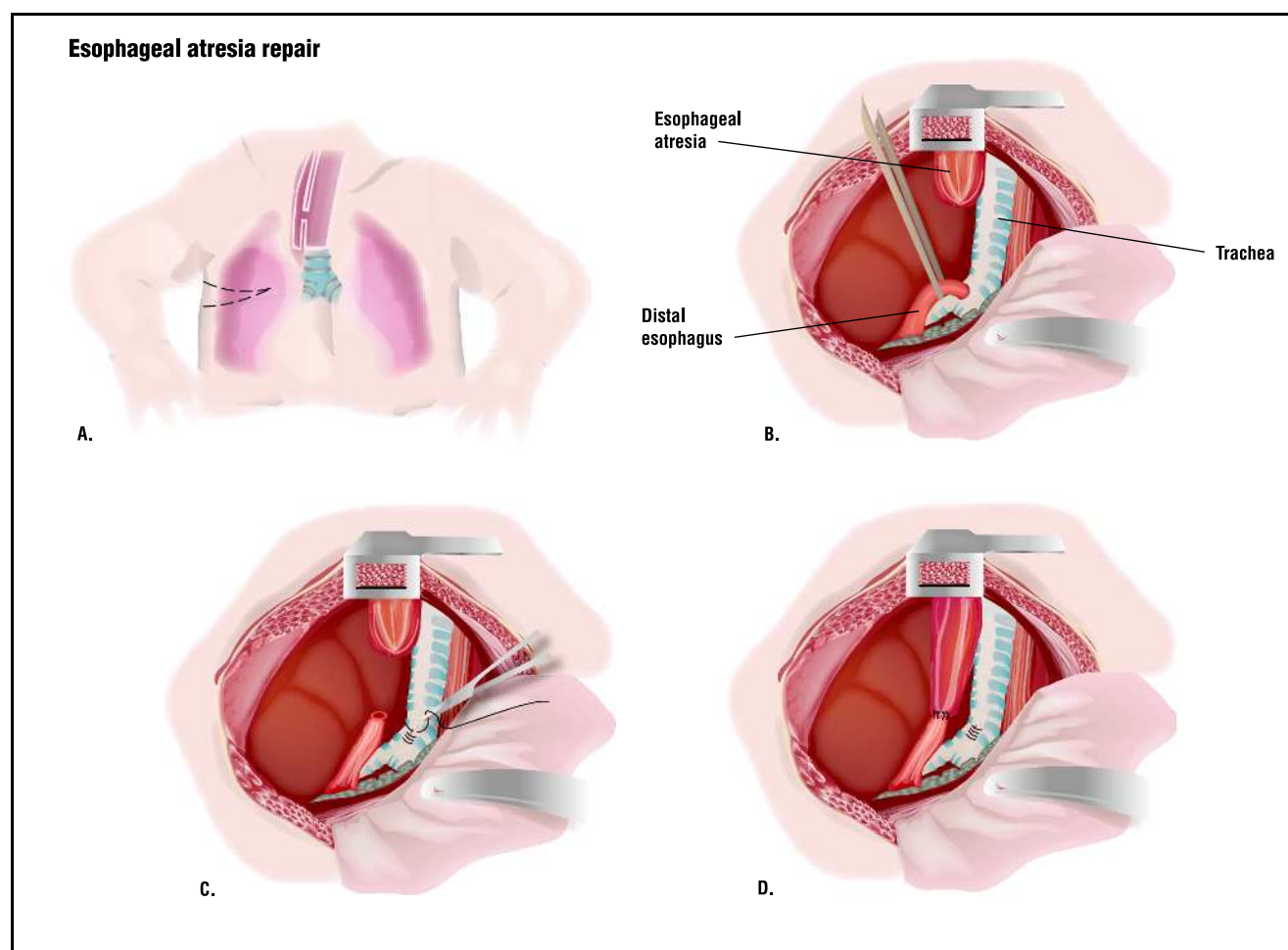
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## Esophageal atresia repair

### Definition

Esophageal atresia repair, also known as tracheo-oesophageal fistula or TEF repair, is a surgical procedure performed to correct congenital defects of the



To repair esophageal atresia, an opening is cut into the chest (A). The two parts of the existing esophagus are identified (B). The lower esophagus is detached from the trachea (C) and connected to the upper part of the esophagus (D). The wound in the trachea is closed, and the chest incision is repaired. (Illustration by GGS Information Services. Cengage Learning, Gale.)

esophagus (the muscular tube that connects the mouth to the stomach) and the trachea (the windpipe that carries air into the lungs). Esophageal atresia (EA) and tracheoesophageal fistula (TEF) are commonly found together (EA/TEF), but may also occur separately. As of 2003, there is no known cause for these congenital defects.

### Purpose

In children born with EA, the esophagus has not developed as a continuous passage into the stomach but ends in a blind pouch. In the majority of cases (86%) it is also abnormally connected to the trachea by a small channel called a fistula. EA/TEF repair is performed to correct these defects, ensuring the survival of affected infants and their proper breathing and digestion.

### Demographics

EA/TEF is reported to occur in about one in 4,500 births. It occurs equally among male and female infants and has been associated with prematurity. There are no other notable associations.

### Description

The human esophagus and trachea are normally formed as two separate but parallel passageways early in fetal development. The esophagus leads from the throat to the stomach and digestive tract, and the trachea leads from the larynx to the lungs and respiratory system. Esophageal atresia occurs when the esophagus is incompletely formed; most typically, its upper portion ends in a pouch, failing to connect with the lower portion that leads to the stomach. Esophageal atresia with tracheoesophageal fistula, commonly known as EA/TEF, occurs when the membrane that divides the trachea from the esophagus (tracheoesophageal septum) is incompletely formed, leaving a fistula between the two normally separate organs. The combined defect is found in 86% of children who need esophageal atresia repair. Isolated esophageal atresia, or esophageal atresia without TEF, is a much less common congenital defect thought to occur later in fetal development and requiring a more complicated operation. The presence of TEF without EA occurs also, but with fewer noticeable symptoms in the infant, making it more difficult to diagnose. It may not be diagnosed until months or even years later when digestive disturbances occur. Surgery is required to correct all of these congenital defects.

## KEY TERMS

**Anastomosis**—The connection of separate parts of a body organ or an organ system.

**Anomaly (anomalies)**—Abnormal development of a body organ or a defect in part of an organ system.

**Aspiration**—To take into the lungs by breathing.

**Atresia**—Absence of a normal opening.

**Congenital**—Present at birth.

**Dysmotility**—A lack of normal muscle movement (motility), especially in the esophagus, stomach, or intestines.

**Dysplasia**—The abnormal form or abnormal development of a body organ or organ system.

**Esophagus**—The upper portion of the digestive system, a tube leading from the mouth to the stomach.

**Fistula**—An abnormal tube-like passage between body organs or from a body organ to the body surface.

**Trachea**—The medical term for the windpipe.

A classification system is commonly used to describe five types of esophageal atresia, with and without TEF:

- **Type A:** Esophageal atresia (7.7% of cases). EA alone is a condition in which both segments of the esophagus, upper and lower, end in blind pouches with neither segment attached to the trachea.
- **Type B:** Esophageal atresia with upper tracheoesophageal fistula (0.8%). This is a rare type of EA/TEF, in which the upper segment of the esophagus forms a channel to the trachea (TEF) and the lower segment of the esophagus ends in a blind pouch (EA).
- **Type C:** Esophageal atresia with lower tracheoesophageal fistula (86.5%). This is the most common type of EA/TEF, in which the upper portion of the esophagus ends in a blind pouch and the lower segment of the esophagus is attached to the trachea by a fistula.
- **Type D:** Esophageal atresia with tracheoesophageal fistula (0.7%). Type D is the rarest form of EA/TEF, in which both segments of the esophagus are attached to the trachea.
- **Type E:** Tracheoesophageal fistula (4.2%). TEF alone is a condition in which a fistula is present between the esophagus and the trachea, while the esophagus has a normal connection to the stomach.

The incomplete esophagus in EA/TEF will not allow swallowed saliva, food, or liquids to pass into the stomach for normal digestion and nutrition. Because of the defect, normal eating or drinking can be dangerous because food and fluids have a direct route through the fistula into the lungs. Swallowed material in the dead-end esophagus as well as stomach fluids may be aspirated into the lungs through the fistula, compromising the child's breathing and potentially causing pneumonia or infection. The impossibility of normal eating, breathing, and digestion creates a life-threatening condition that requires immediate surgery.

The first signs of EA/TEF in a newborn infant may be tiny white frothy bubbles of mucus in the infant's mouth and sometimes in the nose as well. These bubbles reappear when they are suctioned away. Although the infant can swallow normally, the parents can often hear a rattling sound in the chest along with coughing and choking, especially when the baby is trying to nurse. Depending on the severity of the defect, some infants may develop a bluish complexion (cyanosis), caused by a lack of sufficient oxygen in the circulatory system. The infant's abdomen may be distended (swollen and firm) because the abnormally formed trachea will allow air to build up in the stomach and fill the space surrounding the abdominal organs. Saliva and stomach fluids may be aspirated into the lungs through the abnormal opening in the infant's trachea. Aspiration can lead to infection or even asphyxiation (impaired breathing or loss of consciousness due to lack of oxygen).

Other congenital defects are found in at least 50% of infants with EA/TEF. Typically more than one type of malformation will be found. These may include:

- heart defects (about 25% of affected infants)
- gastrointestinal (digestive) anomalies, including malformed anus (rectum) or twisting of the small intestine (about 16%)
- urinary tract and kidney defects (10%)
- musculoskeletal (muscle and bone) defects, especially of the ribs and limbs

The multiple anomalies that can occur with EA/TEF have been described by an acronym, VATER or VACTERL. This acronym stands for vertebral defect, anorectal malformation, cardiac defect, tracheoesophageal fistula, renal anomaly, radial dysplasia, and limb defects. About 10% of children with EA have what is called the VATER syndrome. More infants with Type A esophageal atresia have multiple anomalies than those with Type B, the combined EA/TEF.

Healthy infants who have no complications, such as heart or lung problems or other types of intestinal malformations, can usually have esophageal surgery

within the first 24 hours of life. The operation will be delayed for low birth weight infants or those with complicated malformations, usually until their nutritional status can be improved and other problems resolved sufficiently to reduce the risks of surgery. H-type TEF, which has fewer symptoms and is typically diagnosed when the child is at least four months old, is also easier to repair when the child's size and weight have increased. The esophagus can be dilated periodically during the growth period and a stomach tube used to decompress the stomach until the surgical repair is performed. All infants with some type of esophageal atresia will require surgery; many will have the repair performed in separate stages over a period of years. The procedures used to treat the five types of EA/TEF defects are similar.

Surgery is conducted while the infant is under **general anesthesia**, unconscious and free of pain. The surgeon makes an incision in the right chest wall between the ribs. If the gap between the two portions of the esophagus is short, the surgeon may join both ends of the esophagus together. This is called an anastomosis. If the upper portion of the esophagus is short and a long gap exists between the upper and lower portions, **reconstructive surgery** cannot be performed and the infant will have to be fed in another way to allow several months of growth. In this case, a **gastrostomy** (stomach tube) may be surgically placed directly into the stomach for feeding. In the most typical EA/TEF repair, the fistula will first be closed off, creating a separate airway. Then the blind esophageal pouch will be opened and connected to the other portion of the esophagus, creating a normal pathway directly into the stomach.

## Diagnosis/Preparation

### Diagnosis

A tentative diagnosis of EA/TEF may be made before the child is born. One of the first signs of esophageal atresia may be seen during the mother's prenatal **ultrasound** examination. Polyhydramnios, which is an excessive amount of amniotic fluid surrounding the fetus, is not always diagnostic but offers a warning sign. Fluid is normally exchanged between the fetus and the amniotic fluid through swallowing, urination, and discharges from the nose and mouth. In EA/TEF, the fetus may drool excessively because of a collection of fluid in the abnormal esophageal pouch, thus increasing the amount of amniotic fluid.

A newborn infant suspected of EA/TEF will be given an x-ray examination. The imaging study may reveal a dilated esophageal pouch that is larger than



expected because it has collected a pool of amniotic fluid. During fetal development, the enlarged esophagus may also have pressed on and narrowed the trachea, a condition that may contribute to fistula development. Air in the stomach may confirm the presence of a fistula while gas in the large intestine will rule out duodenal atresia. The physician will also perform a comprehensive **physical examination**, looking for other congenital anomalies that are known to accompany EA/TEF. Chest x-rays may be taken to look for skeletal and cardiac abnormalities. Abdominal X-rays may be taken as well to look for intestinal obstruction and abnormalities. An echocardiogram (ECG) may be performed to evaluate heart function and an ultrasound of the kidneys performed to evaluate kidney function. A nasogastric (NG) tube may be placed in the infant; it may help to confirm a diagnosis of EA/TEF if it stops short of the usual distance (17 cm or about 6.7 in) to the stomach.

### Preparation

When an infant is suspected of having EA/TEF, he or she will be transferred from the regular nursery to the neonatal (newborn) or pediatric intensive care department of the medical facility. Corrective surgery must be scheduled immediately to help ensure survival and promote proper swallowing, digestion, nutrition, and breathing. In patients with pneumonia or other lung problems, the doctor may clean out the baby's stomach and esophageal pouch with a suction tube to prevent the baby's stomach contents from being drawn through the fistula and into the trachea. A tube will be placed through the baby's mouth to continuously suction the esophageal pouch during surgery. The baby will be given fluids intravenously during surgery. **Oxygen therapy** will be administered if needed. An airway will be placed in the trachea if the baby has lung problems. **Antibiotics** may be given to treat or to prevent infection in the lungs, especially if the stomach contents have been drawn into the lungs. Preoperative blood and urine tests will also be performed.

### Aftercare

Immediately after surgery, the patient will be cared for in the neonatal ICU with monitoring of breathing, **body temperature**, and heart and kidney function. Oxygen may be administered, and a mechanical respirator may also be necessary. Pain medication will be given if needed. Blood and urine tests may be performed to evaluate the infant's overall condition. Scans may be performed to evaluate esophageal functioning. The infant will be fed intravenously or will have a gastrostomy tube placed directly into the

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

EA/TEF repair is performed in a hospital operating room by a pediatric or general surgeon.

stomach until oral feedings can be swallowed and digested. Secretions may be suctioned from the throat and a nasogastric tube may be placed in the infant's nose to clear the stomach as needed. Hospitalization may be required for two weeks or longer, depending on the presence of complications or other underlying conditions. An x-ray procedure known as esophagography is usually performed at two months, six months, and one year of age to monitor the digestive function as the child grows. Long-term follow-up of patients who have had EA/TEF repair is essential.

### Risks

There is some risk of postoperative breathing difficulties or respiratory complications, particularly infection or pneumonia due to aspiration of stomach contents. Pretreatment with antibiotics helps to prevent infection to some degree. Other risks of esophageal atresia repair include those that may occur with any surgery: reactions to anesthesia or medications; bleeding or clot formation; narrowing of the repaired organs; nerve injury; fluid imbalances; and collapsed lung (pneumothorax).

Complications that can occur in infants who have had EA/TEF repair include the following:

- Esophageal dysmotility. Dysmotility refers to weakness of the muscular walls of the esophagus. Some degree of dysmotility is expected to occur in all infants undergoing esophageal repair. This complication requires special precautions when the child is eating or drinking.
- About 50% of patients will develop gastroesophageal reflux disease (GERD) later in childhood or adult life. GERD is a condition in which the acid contents of the stomach flow back into the esophagus. The condition requires medical or surgical treatment.
- Recurrence of TEF. Recurrence is treated with repeat surgery.
- Swallowing difficulties (dysphagia). Dysphagia can cause food or pills to become stuck in the esophagus at the site of the surgical repair. Medications should be taken with water to prevent ulcers from developing.

## QUESTIONS TO ASK THE DOCTOR

- Is surgery the only solution? When will surgery be performed and what will be the likely results?
- How many children have you treated with this procedure? What were the results?
- Will my child be able to breast feed or drink milk from a bottle? How soon after surgery?
- How soon can I take my child home?
- What symptoms should I watch for and what kind of problems may occur when we get home?
- How will my child's early years be affected by this condition and the repair surgery? Will my child enjoy normal eating, growth, and social activities?
- What are the chances of my child needing another operation?

- Breathing difficulties and choking. These complications are related to the slow passage of food, food stuck in the esophagus, or aspiration of food into the trachea.
- Chronic cough. The cough is characteristic of TEF repair; it is caused by weakness in the trachea and does not indicate a cold or illness.
- Increased susceptibility to colds, respiratory infections, and pneumonia. Precautions should be taken to avoid contact with other sick children. Parents and caregivers can seek advice about strengthening the child's immune system through appropriate nutrition and supplements.

### Normal results

EA/TEF can usually be corrected with surgery, allowing the child to eat, breathe, and digest food in a normal fashion. Although almost 100% of children who have corrective surgery for EA/TEF survive the procedure, they may continue to have complications, some of which can be chronic. Ongoing medical care and additional surgery may be necessary.

### Morbidity and mortality rates

The postoperative mortality rate in healthy infants is essentially zero. Prior to the development of a more advanced EA/TEF repair technique in 1939, the condition was often fatal. Pre- and postoperative neonatal care has also significantly improved the surgical outcome. Infants with multiple anomalies

or cardiac or pulmonary problems are more subject to complications than otherwise healthy infants.

### Alternatives

Esophageal atresia and tracheoesophageal fistula are congenital defects for which there are no recommended alternatives. These defects are commonly corrected surgically. There are no known measures to prevent these congenital defects.

### Resources

#### BOOKS

Allan, W., MD, et al. *Pediatric Gastrointestinal Disease: Pathophysiology, Diagnosis, Management*, 3rd ed. Boston, MA: B.C. Decker, 2000.

#### ORGANIZATIONS

American Academy of Family Physicians. PO Box 11210, Shawnee Mission, KS 66207. (800) 274 2237. [www.aafp.org](http://www.aafp.org).

EA/TEF Child and Family Support Connection. 111 West Jackson Blvd., Suite 1145, Chicago, IL 60604. (312) 987 9085. [www.eatef.org](http://www.eatef.org).

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L. Lee Culvert

## Esophageal function tests

### Definition

The esophagus is the muscular tube through which food passes on its way from the mouth to the stomach. The main function of the esophagus is to propel food into the stomach. To ensure that food does not move backward—a condition known as reflux—sphincters (constricting ring-shaped muscles) at either end of the esophagus close when the food is not passing through them in a forward direction. Esophageal function tests are used to determine whether the sphincters are working properly.

### Purpose

The esophagus has two sets of sphincters at its upper and lower ends. Each of these muscular rings

must contract in an exact sequence for swallowing to proceed normally. The upper esophageal sphincter normally stops the contents of the stomach from moving backward into the pharynx and larynx (voice box). The lower esophageal sphincter guards against stomach acid moving upward into the esophagus. The lower sphincter should be tightly closed except to allow food and fluids to enter the stomach.

The three major symptoms occurring with abnormal esophageal function are difficulty with swallowing (dysphagia); heartburn; and chest pain. Doctors perform a variety of tests to evaluate these symptoms. Endoscopy, which is not a test of esophageal function, is often used to determine if the lining of the esophagus has any ulcers, tumors, or areas of narrowing (strictures); however, many times endoscopy only shows the doctor if there is an injury to the esophageal lining; it does not always provide information about the cause of the problem. Tests that measure the functioning of the esophagus are sometimes needed in addition to endoscopy. There are three basic types of tests used to assess esophageal function:

- **Manometry.** Manometry is used to study the way the muscles of the esophagus contract, and is most useful for investigating dysphagia.
- **Esophageal pH monitoring.** This test measures changes in the acidity of the esophagus, and is valuable for evaluating patients with heartburn or gastroesophageal reflux disease (GERD).
- **X-ray studies.** This type of imaging study is used to investigate dysphagia, either by using a fluoroscope to follow the progress of a barium mixture during the process of swallowing, or by using radioactive scanning techniques.

## Description

### *Manometry*

This study is designed to measure the pressure changes produced by contraction of the muscular portions of the esophagus. An abnormality in the function of any one of the segments of the esophagus can cause difficulty in swallowing (dysphagia). A manometric examination is most useful in evaluating patients when an endoscopy yields normal results.

During manometry, the patient swallows a thin tube carrying a device that senses changes in pressures in the esophagus. Readings are taken at rest and during the process of swallowing. Medications are sometimes given during the study to aid in the diagnosis. The results are then transmitted to recording equipment. Manometry is most useful in

## KEY TERMS

**Achalasia**—Failure to relax. The term is often applied to sphincter muscles.

**Barium**—A metallic element used in its sulfate form as a contrast medium for X-ray studies of the digestive tract.

**Bolus**—A mass of food ready to be swallowed, or a preparation of medicine to be given by mouth or IV all at once rather than gradually.

**Cathartic**—A medication or other agent that causes the bowels to empty.

**Craniopharyngeal achalasia**—A swallowing disorder of the throat.

**Diffuse esophageal spasm (DES)**—An uncommon condition characterized by abnormal simultaneous contractions of the esophagus.

**Dysphagia**—Difficulty or discomfort in swallowing.

**Esophagus**—The muscular passageway between the throat and the stomach.

**Heartburn**—A sensation of warmth or burning behind the breastbone, rising upward toward the neck. It is often caused by stomach acid flowing upward from the stomach into the esophagus.

**Hiatal hernia**—A condition in which part of the stomach pushes up through the same opening in the diaphragm that the esophagus passes through.

**Motility**—Ability to move freely or spontaneously. Esophageal motility refers to the ability of the muscle fibers in the tissue of the esophagus to contract in order to push food or other material toward the stomach.

**Peristalsis**—The wavelike contraction of the muscle fibers in the esophagus and other parts of the digestive tract that pushes food through the system.

**Sphincter**—A circular band of muscle fibers that constricts or closes a passageway in the body. The esophagus has sphincters at its upper and lower ends.

identifying diseases that produce disturbances of motility or contractions of the esophagus. In 2003, a solution containing five drops of peppermint oil in 10 mL (milliliters) of water was found to improve the manometric features of diffuse esophageal spasm (DES). The peppermint oil solution eliminated simultaneous esophageal contractions in all patients in the study.

### *Esophageal pH monitoring*

This procedure measures the esophagus' exposure to acid reflux from the stomach. The test is ideal for evaluating recurrent heartburn or gastroesophageal reflux disease (GERD). Excessive acid reflux may produce ulcers, or strictures resulting from healed ulcers, in addition to the symptom of heartburn.

Normally, acid from the stomach washes backward into the esophagus in small amounts for short periods of time. The lower esophageal sphincter usually prevents excessive reflux in patients without disease. Spontaneous contractions that increase esophageal emptying and production of saliva also act to prevent damage to the esophagus.

Researchers have shown that in the esophagus, the presence of acid is damaging only if it lasts over long periods of time. Therefore, esophageal **pH monitoring** has been designed to monitor the level of acidity over a 24-hour period, usually in the patient's home. In this way, patients are able to maintain their daily routine, document their symptoms, and correlate symptoms with specific activities. During this period, a thin tube with a pH monitor remains in the esophagus to record changes in acidity. After the study, a computer is used to compare the changes with symptoms reported by the patient.

In addition to esophageal pH monitoring, the doctor may perform a Bernstein test (also known as the acid perfusion test) and an acid clearing test. In the Bernstein test, a small quantity of hydrochloric acid (HCl) is directed into the patient's esophagus. If the patient feels pain from the acid, the test is positive for reflux esophagitis. If there is no discomfort, another explanation must be sought for the patient's symptoms. In the acid clearing test, HCl is also directed into the esophagus. This test measures the patient's ability to quickly swallow the acid. If the patient has to swallow more than 10 times to move the acid down the esophagus, he or she has a problem with esophageal motility.

Monitoring of pH levels is usually performed before surgery to confirm the diagnosis and to judge the effects of drug therapy. In 2003, studies showed that integrated esophageal and gastric acidity provided better quantitative measures of esophageal dysfunction in GERD than conventional measurements of pH. This finding may suggest better ways to evaluate the effectiveness of different treatments for GERD.

### *X-ray tests*

X-ray tests of esophageal function fall into two categories: (1) tests performed with barium and a fluoroscope; and (2) those performed with radioactive

materials. Studies performed with fluoroscopy are especially useful in identifying structural abnormalities of the esophagus. Sometimes the patient is given a sandwich or marshmallow coated with barium in order to identify the site of an obstruction. Fluoroscopy can diagnose or provide important information about a number of disorders involving esophageal function, including cricopharyngeal achalasia (a swallowing disorder of the throat); decreased or reverse peristalsis; and **hiatal hernia**.

During fluoroscopy, the radiologist can observe the passage of material through the esophagus in real time, and also make video recordings. These observations are particularly useful when the swallowing symptoms appear to occur mostly in the upper region of the esophagus. The most common cause of difficulty swallowing is a previous stroke, although other diseases of the neuromuscular system (like myasthenia gravis) can produce similar symptoms.

Scans using low-dose radioactive materials are useful because they may demonstrate that food passes more slowly than usual through the esophagus. They can also measure the speed of the bolus' passage. These studies involve swallowing food coated with radioactive material, followed by a nuclear medicine scan. Scans are often used when other methods have failed to make a diagnosis, or if it is necessary to determine the degree of the abnormality.

### **Preparation**

Patients should not eat or drink anything after midnight before an esophageal function test. Many medications affect the esophagus; doses may need to be adjusted or even discontinued prior to testing. Patients must inform their physician of any and all medications they take, including over-the-counter medications and herbal preparations. They must also tell the doctor about any known allergies.

### **Aftercare**

No special care is needed after most esophageal function tests. Patients can usually return to their normal daily activities following almost all of these tests.

### **Risks**

Exposure to x rays, especially in the first three months of a woman's pregnancy, can be harmful to the fetus. Barium swallows may also cause impaction (hardening) of fecal matter. Additionally, although the tubes passed through the esophagus during some of the esophageal function tests are small, and most patients adjust to them quite well, some patients may



gag and aspirate (breathe into the lungs rather than passing through the esophagus) some gastric juices.

### Normal results

Normal findings include:

- lower esophageal sphincter pressure, 10–20 mm Hg (millimeters of mercury);
- normal peristaltic waves;
- normal size, shape, position, patency, and filling of the esophagus;
- negative acid reflux;
- acid clearing in fewer than 10 swallows; and
- negative Bernstein test.

Manometry is used to diagnose abnormalities related to contraction or relaxation of the various muscular regions of the esophagus. These studies cannot distinguish whether injury to either the muscle or nerves of the esophagus is producing the abnormal results—only the final effect on esophageal muscle is identified. The results of this test should be interpreted in light of the patient's entire medical history. For example, there are many diseases that affect the relaxation of the lower esophageal sphincter; one such condition is called achalasia, and is a frequent finding in individuals with Down's syndrome. Achalasia is a type of esophageal motility disorder characterized by the lack of muscular contractions in the lower portion of the esophagus. In addition, there is failure of the valve at the bottom of the esophagus to open and let food into the stomach. This condition results in difficulty eating solid foods and in drinking fluids and may become more advanced over time, causing regurgitation and spasm of the chest wall muscles.

Abnormal results of pH tests can confirm symptoms of heartburn or indicate a cause of chest pain (or rarely, swallowing difficulties). The patient's doctor may want to prescribe or change medications based on these results, or even repeat the test using different doses of medication. As noted above, these studies should be done before surgical treatment of GERD.

X-ray tests can serve to document an abnormality in the esophagus. If the results are negative, other studies may be needed.

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- American Society for Gastrointestinal Endoscopy, 1520 Kensington Road, Suite 202, Oak Brook, IL, 60523, (630) 573 0600, <http://www.asge.org>.
- Society for Gastroenterology Nurses and Associates, 401 North Michigan Avenue, Chicago, IL, 60611 4267, (800) 245 7462, <http://www.sgna.org>.

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Esophageal radiography see **Upper GI exam**

## Esophageal resection

### Definition

An esophageal resection is the surgical removal of the esophagus, nearby lymph nodes, and sometimes a portion of the stomach. The esophagus is a hollow muscular tube that passes through the chest from the mouth to the stomach—a "foodpipe" that carries food and liquids to the stomach for digestion and nutrition. Removal of the esophagus requires reconnecting the remaining part of the esophagus to the stomach to allow swallowing and the continuing passage of food. Part of the stomach or intestine may be used to

## KEY TERMS

**Achalasia**—Failure to relax. The term is often applied to sphincter muscles.

**Adenocarcinoma**—A type of cancer that develops in the esophagus near the opening into the stomach.

**Anastomosis**—A surgically created joining or opening between two organs or body spaces that are normally separate.

**Barrett's esophagus**—A potentially precancerous change in the type of cells that line the esophagus, caused by acid reflux disease.

**Carcinoma**—The common medical term for cancer.

**Dysphagia**—Difficulty and pain in swallowing.

**Dysplasia**—The presence of precancerous cells in body tissue.

**Endoscopic ultrasound**—An imaging procedure that uses high-frequency sound waves to visualize the esophagus via a lighted telescopic instrument (endoscope) and a monitor.

**Esophagus**—The upper portion of the digestive system, a tube that carries food and liquids from the mouth to the stomach.

**Gastroesophageal reflux disease (GERD)**—A condition of excess stomach acidity in which stomach acid and partially digested food flow back into the esophagus during or after eating.

**Malignancy**—The presence of tumor-causing cancer cells in organ tissue.

**Metastasis (plural, metastases)**—The spread of cancer cells from a cancerous growth or tumor into other organs of the body.

**Resection**—The surgical cutting and removing of a body organ, portion of an organ, or other body part.

**Sphincter**—A circular band of muscle fibers that constricts or closes a passageway in the body. The esophagus has sphincters at its upper and lower ends.

**Squamous cell carcinoma**—A type of cancer that develops in the cells in the top layer of tissue.

**Thoracotomy**—An open surgical procedure performed through an incision in the chest.

**Thorascopy**—Examination of the chest through a tiny incision using a thin, lighted tube-like instrument (thoroscope).

make this connection. Several surgical techniques and approaches (ways to enter the body) are used, depending on how much or which part of the esophagus needs to be removed; whether or not part of the stomach will be removed; the patient's overall condition; and the surgeon's preference.

There are two basic esophageal resection surgeries. Esophagectomy is the surgical removal of the esophagus or a cancerous (malignant) portion of the esophagus and nearby lymph nodes. **Esophagogastrectomy** is the surgical removal of the lower esophagus and the upper part of the stomach that connects to the esophagus, performed when cancer has been found in both organs. Lymph nodes in the surrounding area are also removed.

An esophageal resection may be performed in combination with pre- and postoperative radiation and chemotherapy (chemoradiation).

### Purpose

An esophagectomy is most often performed to treat early-stage cancer of the esophagus before the cancer has spread (metastasized) to the stomach or other organs. Esophagectomy is also a treatment for

esophageal dysplasia (Barrett's esophagus), which is a precancerous condition of the cells in the lining of the esophagus. Lymph nodes are removed to be tested for the presence of cancer cells, which helps to determine if the cancer is spreading. Esophagectomy is also recommended when irreversible damage has occurred as a result of traumatic injury to the esophagus; swallowing of caustic (cell-damaging) agents; chronic inflammation; and complex motility (muscle movement) disorders that interfere with the passage of food to the stomach.

An esophagogastrectomy is performed when cancer of the esophagus has been shown to be spreading to nearby lymph nodes and to the stomach, creating new tumors. When cancer invades other tissues in this way, it is said to be metastatic. The goal of esophagogastrectomy is to relieve difficult or painful swallowing (dysphagia) in patients with advanced esophageal cancer, and to prevent or slow the spread of metastases to more distant organs such as the liver or the brain.

### Demographics

The candidates for esophageal resection parallel those at high risk for esophageal cancer. Esophageal

cancer is found among middle-aged and older adults, with the average age at diagnosis between 55 and 60. Esophageal cancer and esophageal dysplasia occur far more often in men than in women. One type of esophageal cancer (squamous cell carcinoma) occurs more frequently in African Americans; another type (adenocarcinoma) is more common in Caucasian males. Caucasian and Hispanic men with a history of gastroesophageal reflux disease (GERD) are also at increased risk, because GERD has been shown to cause changes in the cells of the esophagus that may lead to cancer. Higher risks are also associated with smoking (45%), alcohol abuse (20%), and lung disorders (23%).

## Description

Esophageal cancer is diagnosed in about 13,000 people annually in the United States; it is responsible for approximately 1.5–5% of cancer deaths each year. Although it is not as prevalent as breast and colon cancer, its rate of occurrence is increasing. This rise is thought to be related to an increase in gastroesophageal reflux disease, or GERD.

The esophagus has a muscular opening, or sphincter, at the entrance to the stomach, which usually keeps acid from passing upward. In people with GERD, the esophageal sphincter allows partially digested food and excess stomach acid to flow back into the esophagus. This occurrence is known as regurgitation. Regurgitation continually exposes the lining of the esophagus to large amounts of acid, causing repetitive damage to the cells of the esophageal lining. The result is Barrett's esophagus, a condition in which the normal cells (squamous cells) of the esophageal lining are replaced by the glandular type of cells that normally line the stomach. Glandular cells are more resistant to acid damage but at the same time, they can more readily develop into cancer cells. Studies at New York's Memorial Sloan-Kettering Hospital have shown that only 30% of people diagnosed with Barrett's esophagus will later be diagnosed with cancer; the other 70% will not develop dysplasia, the precancerous condition. Effective medical treatment of acid reflux is thought to be a factor in the low incidence of cancer in people with Barrett's esophagus. Other types of cancer can also occur in the esophagus, including melanoma, sarcoma, and lymphoma.

The risk factors for esophageal cancer include:

- Use of tobacco. The highest risk for esophageal cancer is the combination of smoking and heavy alcohol use.
- Abuse of alcohol.

- Barrett's esophagus as a result of long-term acid reflux disease.
- A low-fiber diet; that is, a diet that is low in fruits and vegetables, and whole grains that retain their outer bran layer. Other dietary risk factors include vitamin and mineral deficiencies, such as low levels of zinc and riboflavin.
- Accidental swallowing of cleaning liquids or other caustic substances in childhood.
- Achalasia. Achalasia is an impaired functioning of the sphincter muscle between the esophagus and the stomach.
- Esophageal webs. These are bands of abnormal tissue in the esophagus that make it difficult to swallow.
- A rare inherited disease called tylosis, in which excess layers of skin grow on the hands and the soles of the feet. People with this condition are almost certain to develop esophageal cancer.

Cancer of the esophagus begins in the inner layers of the tissue that lines the passageway and grows outward. Cancer of the top layer of the esophageal lining is called squamous cell carcinoma; it can occur anywhere along the esophagus, but appears most often in the middle and upper portions. It can spread extensively within the esophagus, requiring the surgical removal of large parts of the esophagus. Adenocarcinoma is the type of cancer that develops in the lower end of the esophagus near the stomach. Both types of cancer may develop in people with Barrett's esophagus. Prior to 1985, squamous cell carcinoma was the most common type of esophageal cancer, but adenocarcinoma of the esophagus and the upper part of the stomach is increasing more rapidly than any other type of cancer in the United States. Up to 83% of patients undergoing esophagectomy have been shown to have adenocarcinoma. This development may be related to such changes in risk factors as decreased smoking and alcohol use as well as increased reflux disease. People at high risk for esophageal cancer should be examined and tested regularly for changes in cell types.

Esophageal cancer is classified in six stages determined by laboratory examination of tissue cells from the esophagus, nearby lymph nodes, and stomach. The six stages are:

- Stage 0. This is the earliest stage of esophageal cancer, in which cancer cells are present only in the innermost lining of the esophagus.
- Stage I. The cancer has spread to deeper layers of cells but has not spread into nearby lymph nodes or organs.

- Stage IIA. The cancer has invaded the muscular layer of the esophageal walls, sometimes as far as the outer wall.
- Stage IIB. The cancer has invaded the lymph nodes near the esophagus and has probably spread into deeper layers of tissue.
- Stage III. Cancer is present in the tissues or lymph nodes near the esophagus, especially in the trachea (windpipe) or stomach.
- Stage IV. The cancer has spread to more distant organs, such as the liver or brain.

Unfortunately, the symptoms of esophageal cancer usually don't appear until the disease has progressed beyond the early stages and is already metastatic. Without early diagnostic screening, patients may wait to consult a doctor only when there is little opportunity for cure. The symptoms of esophageal cancer may include difficulty swallowing or painful swallowing; unexplained weight loss; hiccups; pressure or burning in the chest; hoarseness; lung disorders; or pneumonia.

The decision to perform an esophageal resection will be made when staging tests have confirmed the presence of cancer and its stage. Two-thirds of people who undergo endoscopy, a close examination of the inside lining of the esophagus, and biopsies (testing esophageal tissue cells) will already have cancer, which can progress rapidly. Some will be treated with surgery and others with medical therapy, depending on the stage of the cancer, the patient's general health status, and the degree of risk. Removing the esophagus or the affected portion is the most common treatment for esophageal cancer; it can cure the disease if the cancer is in the early stages and the patient is healthy enough to undergo the stressful surgery. Esophagectomy will be recommended if early-stage cancer or a precancerous condition has been confirmed through extensive diagnostic testing and staging. Esophagectomy is not an option if the cancer has already spread to the stomach. In this case an esophagogastrectomy will usually be performed to remove the cancerous part of the esophagus and the upper part of the stomach.

### *Esophagectomy*

An esophagectomy takes about six hours to perform. The patient will be given **general anesthesia**, keeping him or her unconscious and free of pain during surgery. One of several approaches or incisional strategies will be used, chosen by the surgeon to gain adequate access to the upper abdomen and remove the esophagus or the tumor and the nearby lymph nodes. The four common incisional approaches are:

transthoracic, which involves a chest incision; Ivor-Lewis, a side entry through the fifth rib; three-hole esophagectomy, which uses small incisions in the chest and abdomen to accommodate the use of instruments; and transhiatal, which involves a mid-abdominal incision. The approach chosen depends on the extent of the cancer, the location of the tumor or obstruction, and the overall condition of the patient.

In a minimum-access laparoscopic and thorascopic procedure, the surgeon makes several small incisions on the chest and abdomen through which he or she can insert thin telescopic instruments with light sources. The abdomen will be inflated with gas to enlarge the abdominal cavity and give the surgeon a better view of the procedure. First, the camera-tipped laparoscope will be inserted through one small incision, allowing images of the organs in the abdominal area to be displayed on a video monitor in the **operating room**. If the surgeon is going to use a portion of the stomach to replace the resected esophagus, he or she will first locate the fundus, or upper portion of the stomach. The fundus will be manipulated, stapled off, and removed laparoscopically, to be sutured in place (gastroplasty) as a replacement esophagus.

Next, the surgeon will pass thorascopic instruments into the chest through another incision. The esophagus or cancerous portion of the esophagus will be visualized, manipulated, cut and removed. Lymph nodes in the area will also be removed. Then the surgeon will either pull up a portion of the stomach and connect it to the remaining portion of the esophagus (anastomosis), or use a piece of the stomach or intestine, usually the colon, to reconstruct the esophagus. Either procedure will allow the patient to swallow and pass food and liquid to the stomach after recovery. As discussed above, other approaches may be used to gain access to the affected portion of the esophagus.

There are several variations of an esophagectomy, including:

- Standard open esophagectomy. This technique requires larger incisions to be made in the chest (thoracotomy) and in the abdomen so that the surgeon can dissect the esophagus or cancerous portion and remove it along with the nearby lymph nodes. The esophagus can then be reconnected to the stomach using a portion of either the stomach or the colon.
- Laparoscopic esophagectomy. This is a less invasive technique performed through several small incisions on the chest and abdomen with the camera-tipped laparoscope and a video monitor to guide removal of the esophagus or tumor along with nearby lymph glands.



- Vagal-sparing esophagectomy. This procedure preserves the branches of the vagus nerve that supply the stomach, with only minimal alteration of the size of the stomach and the nerves that control acid production and digestive functions.

### *Esophagogastrectomy*

An esophagogastrectomy is also major surgery performed with the patient under general anesthesia. The surgeon will choose the incisional approach that allows the best possible access for resecting the lower portion of the esophagus and the upper portion of the stomach. The surgeon's decision will depend on the extent of the cancer, the amount of the esophagus that must be removed, and the patient's overall health status. An esophagogastrectomy can be performed as an open procedure through large incisions, or as a laparoscopic procedure through small incisions.

In a minimum-access laparoscopic procedure, several small incisions are made in the patient's abdomen. A laparoscope will be inserted through one small incision, allowing images of the abdominal organs to be displayed on a video monitor. As in an esophagectomy, gas may be used to inflate the abdominal cavity for better viewing and space for the surgeon to maneuver. The cancerous upper portion of the stomach will first be stapled off and resected. The cancerous portion of the esophagus will then be cut and removed along with nearby lymph nodes. Finally, a portion of the stomach will be pulled upward and connected to the remaining portion of the esophagus (anastomosis); or, if most of the esophagus has been removed, a piece of the colon will be used to construct a new esophagus. Sometimes the surgeon must make an incision in the neck in order to gain access to and resect the upper portion of the esophagus, followed by making an anastomosis between the esophagus and a portion of the stomach.

## **Diagnosis/Preparation**

### *Diagnosis*

The diagnosis of esophageal cancer begins with a careful history and a review of symptoms, and involves a number of different diagnostic examinations. An esophagoscopy may be performed in the doctor's office, allowing the doctor to examine the inside of the esophagus with a lighted telescopic tube (esophagoscope). A barium swallow is another common screening test, performed in the radiology (x-ray) department of the hospital or in a private radiology office. In a barium swallow, the patient drinks a small amount of radio-paque (visible on x ray) barium that will highlight any

raised areas on the wall of the esophagus when chest x rays are taken. The x-ray studies will reveal irregular patches that may be early cancer or larger irregular areas that may narrow the esophagus and could represent a more advanced stage of cancer. If either of these conditions is present, the doctors will want to confirm the diagnosis of esophageal cancer; determine how far it has invaded the walls of the esophagus; and whether it has spread to nearby lymph nodes or organs. This staging process is essential in order to determine the best treatment for the patient.

One staging technique is a diagnostic procedure called **endoscopic ultrasound**. The doctor will thread an endoscope, which is a tiny lighted tube with a small **ultrasound** probe at its tip, into the patient's mouth and down into the esophagus. This procedure allows the inside of the esophagus to be viewed on a monitor to show how far a tumor has invaded the walls of the esophagus. At the same time, the doctor can perform biopsies of esophageal tissue by cutting and removing small pieces for microscopic examination of the cells for cancer staging. Staging tests may also include computed tomography (**CT scans**); thorascopic and laparoscopic examinations of the chest and abdomen; and **positron emission tomography (PET)**.

### *Preparation*

The patient will be admitted to the hospital on the day of the operation or the day before, and will be taken to a preoperative nursing unit. The surgeon and anesthesiologist will visit the patient to describe the resection procedure and answer any questions that the patient may have. The standard preoperative blood and urine tests will be performed. Intravenous lines (IV) will be inserted in the patient's vein for the administration of fluids and pain medications during and after the surgery. Sedatives may be given before the patient is taken to the operating room.

### **Aftercare**

Immediately after surgery the patient will be taken to a recovery area where the pulse, **body temperature**, and heart, lung, and kidney function will be monitored. Several hours later, the patient will be transferred to a concentrated care area. Surgical wound **dressings** will be kept clean and dry. Pain medication will be given as needed. A chest tube inserted during surgery will be checked for drainage and removed when the drainage stops. A nasogastric (nose to stomach) tube, also placed during surgery, will be used to drain stomach secretions. Nurses will check it regularly and rinse it out. It will eventually be removed by the surgeon. Until the patient is able to swallow soft

foods, he or she will be fed intravenously or through a feeding tube that was placed in the small intestine during surgery. Patients will be encouraged to cough and to breathe deeply after surgery to fully expand the lungs and help prevent infection and collapse of the lungs. Walking and movement will also be encouraged to promote a quicker recovery.

About 10–14 days after the surgery, the patient will be given another barium swallow so that the doctor can examine the esophagus for any areas of leaking fluid. If none are seen, the nasogastric tube can be removed. The patient can then begin to sip clear liquids, followed gradually by small amounts of soft foods. Patients being treated for esophageal cancer may begin chemotherapy (cytotoxic or cell-killing medications), radiation therapy, or both, before or soon after **discharge from the hospital**. Patients typically remain in the hospital as long as two weeks after surgery if no complications have occurred.

When the patient goes home, any remaining **bandages** must be kept clean and dry. Frequent walking and gentle **exercise** are encouraged. Because laparoscopic and thorascopic surgery is less invasive and uses only small incisions, there is less trauma to the body and activity can be resumed more quickly than with open procedures that require larger incisions. The patient should report any fever or chills, persistent pain, or incision drainage to the surgeon. The patient's diet will typically be restricted for a while to soft foods and small portions; a normal diet can be resumed in about a month, but with smaller quantities. Patients are advised not to drive if they are still taking prescribed narcotic pain medications. Daily care and assistance at home is recommended during the recuperation period. Regular medical care and periodic diagnostic testing, such as endoscopic ultrasound, is essential to monitor the condition of the esophagus and to detect recurrence of the cancer or the development of new tumors.

## Risks

One of the primary risks associated with esophageal resection surgeries is leakage at the site of the anastomosis, where a new feeding tube was sutured (stitched) to the remaining esophagus. As many as 9% of all patients have been reported to develop leaks, most occurring when a portion of the stomach rather than the colon was used to construct the new section of the esophagus.

Other risks include:

- formation of blood clots that can travel to the heart, lungs, or brain
- nerve injury, which can cause defective emptying of the stomach

## WHO PERFORMS THE SURGERY AND WHERE IS IT PERFORMED?

Esophageal resection surgeries are performed in a hospital or medical center operating room by a general surgeon or a thoracic surgeon.

- infection
- breathing difficulties and pneumonia
- adverse reactions to anesthesia
- narrowing of the remaining esophagus (strictures), which may cause swallowing problems
- increased acid reflux and heartburn as a result of injury to or removal of the esophageal sphincter

## Normal results

Esophageal resection, especially esophagectomy, can be curative if cancer has not spread beyond the esophagus. About 75% of patients undergoing esophagectomy will be found to have metastatic disease that has already spread to other organs. Esophagectomy will reduce symptoms in most patients, especially swallowing difficulties, which will improve the patient's nutritional status as well. Patients whose esophagectomy is preceded and followed by a combination of chemotherapy and radiation treatments have longer periods of survival.

The typical result of an esophagogastrectomy is palliation, which is the relief of symptoms without a cure. Because esophagogastrectomy is always performed when metastases have already been found elsewhere in the body, the procedure may relieve pain and difficulty in swallowing, and may delay the spread of the cancer to the liver and brain. Cure of the disease, however, is not an expectation.

Patients having less invasive laparoscopic and thorascopic resection procedures will experience less pain and fewer complications than patients undergoing open procedures.

## Morbidity and mortality rates

Because 75% of all esophagectomy patients and 100% of all esophagogastrectomy patients will have metastatic disease, morbidity and mortality rates for these procedures are high. Thirty-day mortality for esophagectomy ranges from 6–12%; it is 10% or higher for esophagogastrectomy. Survival of early-stage cancer patients after esophagectomy ranges from 17 to 34 months if surgery alone is the treatment.

## QUESTIONS TO ASK THE DOCTOR

- Why do I need this surgery?
- How will the surgery be performed? How long will it take?
- How many times have you performed this procedure? How often is it performed in this hospital?
- How much discomfort can I expect in the short term? Over the long term?
- Will this surgery cure my cancer? Will it allow me to live longer?
- What are the chances that the cancer will come back?
- What are my options if I don't have the surgery?
- What are the risks involved in having this surgery?
- What kind of care will I need at home afterward?
- How quickly will I recover?

The mortality rate for early-stage cancer patients having esophagectomy alone is higher than when surgery is combined with pre- and postoperative chemoradiation. The three-year survival rate for early-stage cancer patients who received pre- and post-esophagectomy chemoradiation is about 63%. Better staging techniques, more careful selection of patients, and improved surgical techniques are also believed to be responsible for the increase in postoperative survival rates. Recurrence of cancer in esophagectomy patients has been shown to be about 43%. A higher percentage of patients undergoing esophageal resections survive beyond the 30-day postoperative period in hospitals where the surgeons perform these procedures on a regular basis.

### Alternatives

People with Barrett's esophagus can be treated with medicine and dietary changes to reduce acid reflux disease. These nonsurgical approaches are effective in relieving heartburn, calming inflamed tissues, and preventing further cell changes.

Fundoplication, or anti-reflux surgery, can strengthen the barrier to acid regurgitation when the lower esophageal sphincter does not work properly, curing GERD and reducing the exposure of the esophagus to excessive amounts of acid.

Photodynamic therapy (PDT) is the injection of a cytotoxic (cell killing) drug in conjunction with laser

treatments, delivering benefits comparable to more established treatments. Endoscopic laser treatments that deliver short, powerful laser beams to the tumor through an endoscope can improve swallowing difficulties; however, multiple treatments are required and the benefits are neither long-lasting nor shown to prevent cancer.

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## Esophagogastrectomy

### Definition

Esophagogastrectomy is a surgical procedure in which a section of diseased esophagus is removed, along with part of the stomach and neighboring lymph nodes. The remaining piece of the esophagus is then reattached to the remaining stomach.

### Purpose

Esophagogastrectomy is performed to treat cancer of the esophagus. There are two types of esophageal cancer: squamous cell and adenocarcinoma. Squamous cell cancer of the esophagus used to be the most common type, but now is only responsible for fewer than 50% of cases of esophageal cancer. Squamous cell cancer occurs when the cells of the

esophageal lining convert into malignant cells. This type of esophageal cancer is more common in white patients. Adenocarcinoma of the esophagus often follows a condition called Barrett's esophagus, in which the lower cells of the esophagus convert into cells resembling the glandular cells of the stomach. Over time, these abnormal Barrett's cells have the potential of converting into truly malignant cells. Adenocarcinoma of the esophagus is the more common type of esophageal cancer in African-American patients.

Men are three to four times more likely to develop esophageal cancer than are women, and African-Americans are about 50% more likely to develop the condition. According to the American Cancer Society, about 16,470 new cases of esophageal cancer will be diagnosed in the United States in 2008, and the disease will be responsible for about 14,280 deaths. The disease is much more common in other countries, such as Iran, northern China, India, and southern Africa, where rates are between ten and 100 times as high as they are in the United States. Still, esophageal cancer rates among white men in Western countries are increasing steadily, at a rate of about 2% per year; the rate has held steady among white women. Among patients diagnosed at all stages of esophageal cancer, five-year survival rates are about 18% in white patients and 11% in African-American patients.

### Precautions

Patients who are taking blood thinners, aspirin, or nonsteroidal anti-inflammatory medications may need to discontinue their use in advance of the test, to avoid increasing the risk of bleeding.

### Description

Patients undergoing esophagogastrectomy require general anesthesia. This will be administered in the form of intravenous medications as well as anesthetic gasses that are inhaled. The patient will be intubated for the duration of the surgery, and a ventilator will breathe for them.

Esophagogastrectomy can be achieved through a traditional upper abdominal incision, or through multiple very small laparoscopic incision. Traditional open abdominal esophagogastrectomy exposes the entire upper abdomen in order to allow careful visual inspection of all the structures and lymph nodes surrounding the stomach and esophagus. Laparoscopic esophagogastrectomy involves the introduction of a scope through one of the keyhole incisions, and the use of other tiny incisions for introducing the miniature

## KEY TERMS

**Adenocarcinoma**—A cancer originating in glandular cells.

**Barrett's esophagus**—A condition in which the esophageal tissue closest to the stomach contains highly abnormal cells that have a great likelihood of converting to frank cancer.

**Squamous cells**—A type of flat cell that usually is involved in the lining of organs.

**Stricture**—A narrowing, often due to scar tissue formation.

surgical instruments necessary for the operation. The exact technique utilized in the surgery will depend on where in the esophagus the cancerous segment is located, and how much of the stomach is involved. Surgical preference is to be able to preserve part of the esophagus, in order to allow it to be reconnected to the remaining stomach. In some cases, however, so much esophagus must be removed that there is not enough left to reattach to the stomach. When this occurs, a piece of intestine can be removed and used to connect the throat to the stomach. Requiring this step considerably increases the complexity and risks of the operation.

### Preparations

Patients will need to stop eating and drinking for about 12-16 hours prior to their operation. The evening before the operation, a series of enemas and/or laxatives are used to empty the GI tract of feces. An intravenous line will be placed in order to provide the patient with fluids, general anesthesia agents, sedatives, and pain medicines during the operation. A urinary catheter will be placed in the patient's bladder. The patient will be attached to a variety of monitors to keep track of blood pressure, heart rate, and blood oxygen level throughout the procedure.

### Aftercare

Esophagogastrectomy is major surgery, and often requires that the patient remain hospitalized for recuperation for as much as two weeks after the operation. Over this time, the patient's diet will slowly be reinstated, progressing gradually from liquids to soft foods to solids. Because esophageal cancer often causes symptoms of dysphagia (difficulty swallowing),



a therapist specializing in re-teaching swallowing may be needed to help design a rehabilitative program.

### Risks

Esophagogastrrectomy carries a number of significant risks, including the general risks accompanying major surgery, such as blood clots, bleeding, heart attack, and infection. Specific complications that can occur with esophagogastrrectomy include:

- Leakage of the new esophageal-stomach connection
- Slow stomach emptying due to surgical effects on the nerves controlling this function, sometimes resulting in chronic nausea and vomiting
- Severe heartburn if the lower part of the esophagus and upper part of the stomach are weakened by the surgery, allowing stomach contents to reflux back up into the esophagus
- Strictures or narrowing of the esophagus due to scarring from the surgery

The risk of fatal complications from esophagogastrrectomy may range from about three to about seventeen percent. In general, studies have shown that hospital and surgeon experience with esophagogastrrectomy reduces the risk of morbidity and mortality for patients.

### Normal results

Normal results occur when the cancerous tissue is completely removed, and a patent, functional connection is created between the remaining esophageal and stomach tissue.

### Abnormal results

Abnormal results range from remaining malignant tissue, to those complications detailed above, such as a leaky esophageal-stomach connection, chronic nausea secondary to nerve damage and slow stomach emptying, dysphagia due to strictures, etc.

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## Esophagogastrroduodenoscopy

### Definition

An esophagogastrroduodenoscopy (EGD), which is also known as an upper endoscopy or upper gastrointestinal endoscopy, is a diagnostic procedure that is performed to view the esophagus, stomach, and duodenum (part of the small intestine). In an EGD, the doctor uses an endoscope, a flexible, tube-like, telescopic instrument with a tiny camera mounted at its tip, to examine images of the upper digestive tract displayed on a monitor in the examination room. Small instruments may also be passed through the tube to treat certain disorders or to perform biopsies (remove small samples of tissue).

### Purpose

An EGD is performed to evaluate, and sometimes to treat, such symptoms relating to the upper gastrointestinal tract as:

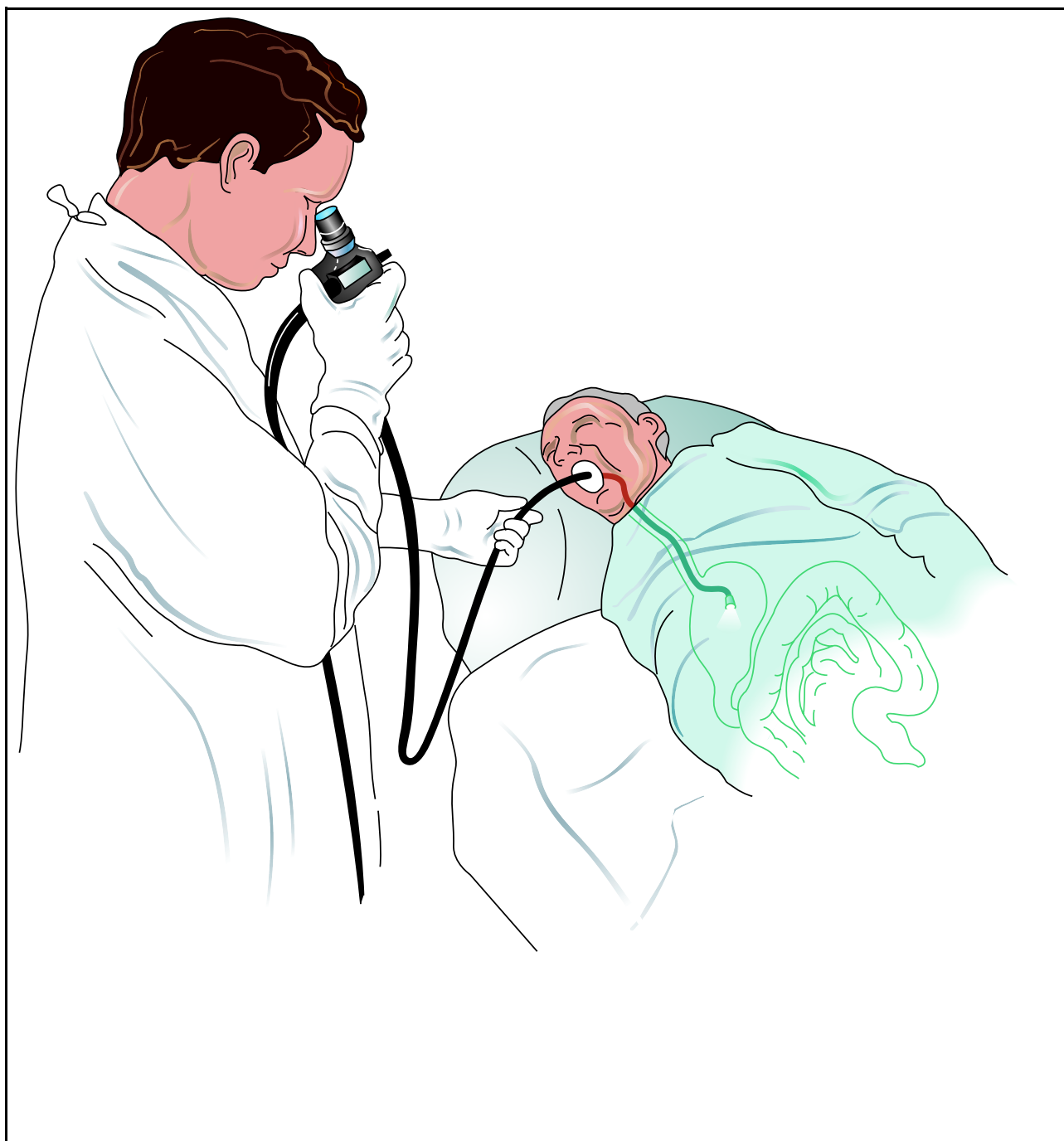
- pain in the chest or upper abdomen
- nausea or vomiting
- gastroesophageal reflux disease (GERD)
- difficulty swallowing (dysphagia)
- bleeding from the upper intestinal tract and related anemias

In addition, an EGD may be performed to confirm abnormalities indicated by such other diagnostic procedures as an upper gastrointestinal (upper GI) x-ray series or a CT scan. It may be used to treat certain conditions, such as an area of narrowing (stricture) or bleeding in the upper gastrointestinal tract.

### Description

Upper endoscopy is considered to be more accurate than x-ray studies for detecting inflammation, ulcers, or tumors. It is used to diagnose early-stage cancer and can frequently help determine whether a growth is benign or malignant. The doctor can obtain biopsies of inflamed or suspicious tissue for examination in the laboratory by a pathologist or cytologist. Cell scrapings can also be taken by introducing a small brush through the endoscope; this technique is especially helpful in diagnosing cancer or an infection.

Besides its function as an examining tool, an endoscope has channels that permit the passage of instruments. This feature gives the physician an opportunity to treat on the spot many conditions that may be seen in the esophagus, stomach, or duodenum. These treatments may include:



**Esophagogastroduodenoscopy (EGD) is performed to evaluate or treat symptoms relating to the upper gastrointestinal tract. By inserting an endoscope into the mouth and guiding it through the gastrointestinal tract, the esophagus, stomach and duodenum can be examined and abnormalities treated.** (Illustration by Electronic Illustrators Group. Cengage Learning, Gale.)

- removal of polyps and other noncancerous (benign) tissue growths
- stretching narrowed areas (strictures) in the esophagus
- stopping bleeding from ulcers or blood vessels
- removing foreign objects that have been swallowed, such as coins, pins, buttons, small nails, and similar items

## KEY TERMS

**Cytologist (cytology)**—A medical technologist who specializes in preparing and examining biopsy specimens and cell specimens for changes that may indicate precancerous conditions or a specific stage of cancer.

**Diverticulum (plural, diverticula)**—A blind tubular sac or pouch created when the mucous tissue lining the esophagus or colon herniates through its muscular wall.

**Duodenum**—The first portion of the small intestine below the stomach.

**Endoscope**—A tube-like telescopic tool used to view areas of the body that cannot be directly observed, such as the esophagus, stomach, or colon, and to allow treatment of these areas.

**Endoscopist**—A physician or other medical professional highly trained in the use of the endoscope and related diagnostic and therapeutic procedures.

**Esophagus**—The hollow muscular tube that passes from the mouth to the stomach, carrying food and liquids to the stomach to be digested and absorbed.

**Gastroenterologist**—A physician who specializes in digestive disorders and diseases of the organs of the digestive tract, including the esophagus, stomach, and intestines.

**Gastroesophageal reflux disease (GERD)**—A condition of excess stomach acidity in which stomach acid and partially digested food flow back into the esophagus during or after meals.

**Pathologist (pathology)**—A doctor who specializes in the anatomic (structural) and pathologic (disease-causing) chemical changes in the body and the related results of diagnostic testing.

**Stricture**—An abnormal narrowing of the esophagus or other duct or canal in the body.

Some of the diseases and conditions that are investigated, identified, or treated using EGD include:

- abdominal pain
- achalasia, a defect in the muscular opening between the esophagus and the stomach
- Barrett's esophagus, a precancerous condition of the cells lining the esophagus
- Crohn's disease and inflammatory disease of the small intestine
- esophageal cancer

- gastroesophageal reflux disease (GERD), a condition caused by excess stomach acid
- hiatal hernia
- irritable bowel syndrome
- rectal bleeding
- stomach cancer
- stomach ulcers
- swallowing problems

An EGD procedure is usually performed by a gastroenterologist, who is a physician specializing in the diagnosis and treatment of disorders of the digestive tract. GI (gastrointestinal) assistants, **operating room** nurses, or technicians may be involved in the collection of samples and care of the patient. Patients will be asked to either gargle using a local anesthetic or will have an anesthetic sprayed into their mouths onto the back of the throat to numb the gag reflex. Then the endoscopist will guide the endoscope through the mouth into the upper gastrointestinal tract while the patient is lying on his or her left side. The lens or camera at the end of the instrument allows the endoscopist to examine each portion of the upper gastrointestinal tract by observing images on a monitor. Photographs are usually taken for reference. During the procedure, air is pumped in through the instrument to expand the structure that is being studied and allow better viewing. Biopsies and other procedures will be performed as needed. The patient's breathing will not be disturbed and there will be little if any discomfort. Many patients fall asleep during all or part of the procedure.

Some patients should not have an EGD. This examination is contraindicated in patients who have:

- severe upper gastrointestinal (UGI) bleeding
- history of such bleeding disorders as platelet dysfunction or hemophilia
- esophageal diverticula, which are small pouches in the esophagus that can trap food or pills and become infected
- suspected perforation (puncture or rupture) of the esophagus or stomach
- recent surgery of the upper gastrointestinal tract (throat, esophagus, stomach, pyloric valve, duodenum)

An EGD is also contraindicated for those patients who are unable to cooperate fully with the procedure or whose overall condition includes a severe underlying illness that increases the risk of complications.

## Diagnosis/Preparation

Certain medications (such as **aspirin** and the anti-inflammatory drugs called NSAIDs) should be discontinued at least seven days before an EGD to reduce the risk of bleeding. Patients will be asked not to eat or drink anything for at least six to 12 hours before the procedure to ensure that the upper intestinal tract will be empty. Before the procedure, patients may be given a sedative and/or pain medication, usually by intravenous injection.

## Aftercare

After the procedure, the patient will be observed in the endoscopy suite or in a separate recovery area for an hour, or until the sedative or pain medication has worn off. Someone should be available to take the patient home and stay with them for a while. Eating and drinking should be avoided until the local anesthetic has worn off in the throat and the gag reflex has returned, which may take two to four hours. To test if the gag reflex has returned, a spoon can be placed on the back of the tongue for a few seconds with light pressure to see if the patient gags. Hoarseness and a mild sore throat are normal after the procedure; the patient can drink cool fluids or gargle to relieve the soreness.

The patient may experience some bloating, belching, and flatulence after an EGD because air is introduced into the digestive tract during the procedure. To prevent any injury to the esophagus from taking medications by mouth, patients should drink at least 4 or more ounces of liquid with any pill, and remain sitting upright for 30 minutes after taking pills that are likely to cause injury. The doctor should be notified if the patient develops a fever; difficult or painful swallowing (dysphagia); breathing difficulties; or pain in the throat, chest, or abdomen.

## Risks

Endoscopy is considered a safe procedure when performed by a gastroenterologist or other medical professional with special training and experience in endoscopy. The overall complication rate of EGD performance is less than 2%; many of these complications are minor, such as inflammation of the vein through which medication is given. Serious complications can and do occur, however, with almost half being related to the heart or lungs. Bleeding or perforations are also reported, especially when tumors or strictures have been treated or biopsied. Infections have been reported, though rarely; careful attention to cleaning the instrument should prevent this

complication. Perforation, which is the puncture of an organ, is very rare and can be surgically repaired if it occurs during an EGD.

## Normal results

The results of the procedure or probable findings are often available to the patient prior to discharge from the endoscopy suite or the recovery area. The results of tissue biopsies or cell tests (cytology) will take from 72–96 hours. Normal results will show that the esophagus, stomach and duodenum are free of strictures, ulcers or erosions, diverticula, tumors, or bleeding. Abnormal results include the presence of any of these problems, as well as esophageal infections, fissures, or tears. An increasingly common finding is medication-induced esophageal injury, caused by tablets and capsules that have lodged in the esophagus. These injuries are thought to be associated with damage to the esophageal tissue from gastrointestinal reflux disease (GERD) and the related exposure of the esophagus to large amounts of stomach acid.

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Society for Gastroenterology Nurses and Associates (SGNA). 401 North Michigan Avenue, Chicago, IL 60611 4267. (800) 245 7462. [www.sgna.org](http://www.sgna.org).

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## Essential surgery

### Definition

Essential surgery is an operative procedure that is considered to be vitally necessary for treating a disease or injury. Postponing or deciding against an essential procedure may result in a patient's **death** or permanent impairment.



## Description

Essential surgery may be performed on either an elective or emergency basis. **Elective surgery** is defined as surgery that can be scheduled in advance and is not considered an emergency. Some elective surgeries, however, may be considered essential. For example, an aortic aneurysm is a weak spot in the wall of the aorta, a major blood vessel. If an aortic aneurysm is found during a **physical examination** or imaging procedure, an aneurysmectomy (surgical repair of an aneurysm) may be scheduled as an elective procedure. In most cases, complications can be avoided if the aneurysm is repaired in a timely manner. If no repair is performed, however, the aneurysm may grow larger and eventually burst; this serious medical emergency is most often fatal.

In other cases, essential surgery arises out of a medical emergency, giving the patient and physician less time to prepare for surgery or seek alternatives. An example of such an emergency is appendicitis, or an infection of the appendix (a pouch-shaped organ in the abdomen). If left untreated, appendicitis may result in a ruptured appendix, which is a life-threatening condition. An **appendectomy** (surgical removal of the appendix) is usually considered essential in treating appendicitis and avoiding rupture. Another example is trauma surgery, or surgery to repair serious injuries to the body.

A surgical procedure may be optional under some circumstances, and essential under others. An example is surgery for Crohn's disease, or chronic inflammation of the intestines. This condition is associated with such symptoms as abdominal pain, fatigue, fever, loss of appetite, and weight loss. Patients who are not able to manage their symptoms with medication may choose surgical treatment (such as the removal of a segment of bowel) as a means of improving their quality of life. Without surgery, a patient's condition would not necessarily deteriorate. In contrast, the presence of severe bleeding, a bowel obstruction, or a hole in the intestinal wall—all potential complications of Crohn's disease—would be considered a medical emergency. Surgery subsequently becomes necessary to prevent permanent damage or to save the patient's life.

Whether a surgical procedure is essential is important in determining whether it will be covered by health insurance. If a procedure is not considered "medically necessary" (i.e., is considered elective), most insurance companies will not pay for the procedure, or will

## KEY TERMS

**Aorta**—The largest artery in the body; carries oxygenated blood from the heart to the extremities and major organs.

**Appendix**—A pouch-shaped organ that is attached to the upper part of the large intestine.

**Cosmetic surgery**—Surgery that is intended to improve a patient's appearance or correct disfigurement. It is also called aesthetic surgery.

**Elective surgery**—Surgery that would be beneficial to the patient but is not urgent, and is therefore a matter of choice.

provide only minimal coverage. A common example of an elective procedure that is not usually covered by insurance is **cosmetic surgery**. In some cases, however, an elective procedure is covered by health insurance because it is considered essential in improving the patient's quality of life. An example is **breast reconstruction** following **mastectomy** (surgical removal of the breast). While breast reconstruction is an elective procedure according to most definitions (i.e., it is not medically necessary nor considered an emergency), it is considered essential in restoring a woman's self-image following the removal of a breast for the treatment of cancer. A 1998 federal law (the Women's Health and Cancer Rights Act) states that insurance companies are required to cover breast reconstruction in patients who are covered for mastectomy.

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Excessive sweating surgery see

**Sympathectomy**

Excimer laser photorefractive keratectomy

see **Photorefractive keratectomy (PRK)**

## Exenteration

### Definition

Exenteration is a major operation during which all the contents of a body cavity are removed. Pelvic exenteration refers to the removal of the pelvic organs and adjacent structures; orbital exenteration refers to the removal of the entire eyeball, orbital soft tissues, and some or all of the eyelids.

### Purpose

The pelvis is the basin-shaped cavity that contains the bladder, rectum, and reproductive organs. The internal reproductive organs include the ovaries, fallopian tubes, uterus, and cervix for women, and the prostate and various ducts and glands for men. Pelvic exenteration is performed to surgically remove cancer that involves these organs and that has not responded well to other types of treatment. Pelvic exenteration is also indicated when cancer returns after an earlier treatment. In women, the operation is performed mostly for advanced and invasive cases of endometrial, ovarian, vaginal, and cervical cancer; for aggressive prostate cancer in men; and rectal cancer in either sex.

Orbital exenteration is performed to remove the eye and surrounding tissues when cancer of the orbital contents cannot be controlled by simple removal or irradiation. It is often the only course of treatment for advanced cancers of the eyelid, eyeball, optic nerve, or retina.

Exenteration is a major operation for both patient and surgeon; it is technically very challenging because it involves elaborate **reconstructive surgery**. Although it is a radical surgical procedure, exenteration often

provides the only opportunity available for patients to eliminate the cancer and to prevent it from recurring.

### Demographics

No data are available regarding the demographic nature of patients undergoing exenteration, given the numerous conditions that may warrant it. Cancer affects individuals of any age, sex, race, or ethnicity, although incidence may differ among these groups by cancer type.

### Description

Both pelvic and orbital exenterations are considered to be major surgery and are performed under **general anesthesia**. The exact surgical procedure performed depends on the type of exenteration.

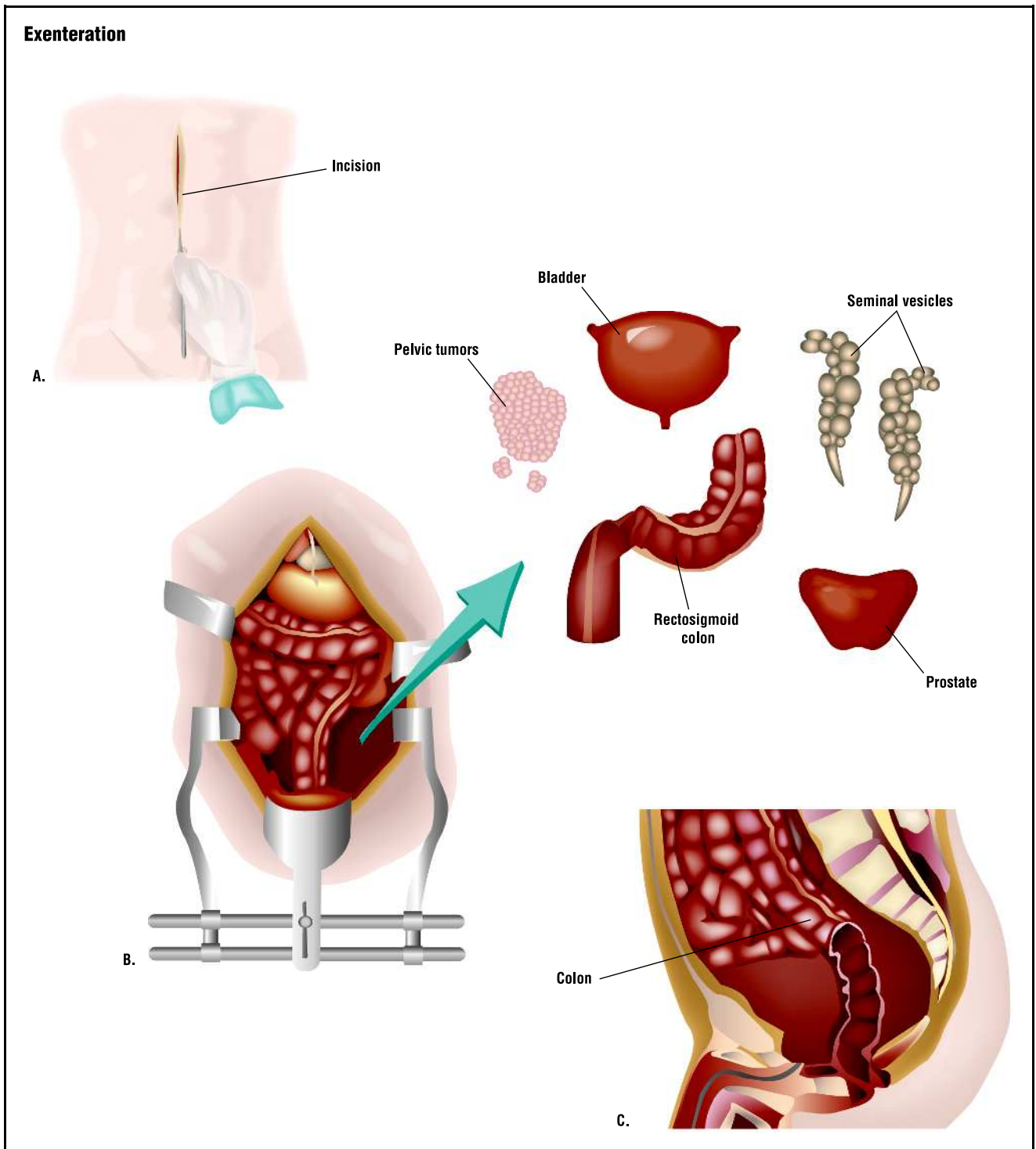
#### *Pelvic exenteration*

Pelvic exenterations start with an incision in the lower abdomen. Blood vessels are clamped and the organs specified by the procedure are removed. The site of incision is then stitched up. There are three types of pelvic exenteration: anterior, posterior, and total.

**ANTERIOR EXENTERATION.** This operation is called anterior exenteration because it removes organs toward the front of the pelvic cavity. It usually involves the removal of the female reproductive organs, bladder, and urethra. (In males, an operation that removes the bladder and prostate is called a cystoprostatectomy.) Patients selected for this operation have cancers in areas that allow the rectum to be spared.

A new method for excreting urine must be created. One common approach, called an ileal conduit, diverts the ureters to a pouch made of small intestine, which is then connected to the abdominal wall. Urine exits the body through a small opening called a stoma, and collects in a small bag attached to the body. Vaginal reconstruction may also be performed during the exenteration, or in a later procedure.

**POSTERIOR EXENTERATION.** Posterior exenteration removes organs that are located in the back part of the pelvic cavity. These include the reproductive organs, plus the lower part of the bowel; the bladder and urethra are kept intact. A patient who has undergone posterior exenteration will require a **colostomy**, a procedure that connects the colon to the abdominal wall; waste exits the body through a stoma and is collected in a small bag.



**A large abdominal incision exposes abdominal and pelvic contents for pelvic exenteration (A). Contents of the lower abdominal cavity, including the rectosigmoid colon, prostate and seminal vesicles (if male), bladder, and any pelvic tumors are removed (B).** (Illustration by GGS Information Services. Cengage Learning, Gale.)

**TOTAL PELVIC EXENTERATION.** This operation removes the bladder, urethra, rectum, anus, and supporting muscles and ligaments, together with the

reproductive organs. Total pelvic exenteration is performed when there is no opportunity to perform a less extensive operation, because of the location and

## KEY TERMS

**Anus**—The terminal orifice of the gastrointestinal (GI) or digestive tract that includes all organs responsible for getting food in and out of the body.

**Catheter**—Long thin tubes that carry urine from the kidneys to the bladder.

**Conjunctiva**—A clear membrane that covers the inside of the eyelids and the outer surface of the eye.

**General anesthesia**—Method used to stop pain from being felt during an operation. General anesthesia is generally used only for major operations such as brain, neck, chest, abdomen, and pelvis surgery.

**Ocular orbit**—Bony cavity containing the eyeball.

**Rectum**—The last part of the large intestine (colon) that connects to the anus.

**Resection**—The complete or partial removal of an organ or tissue.

size of the cancer. A urinary stoma and a colostomy stoma will be created to collect waste.

### *Orbital exenteration*

This operation removes the eyeball and surrounding tissues of the orbit. (Since the eye is surrounded by bone, orbital exenteration is often easier to tolerate than pelvic exenteration.) Orbital exenteration with partial preservation of eyelids and conjunctiva can sometimes be achieved. After the surgical site has healed, patients can be fitted with a temporary ocular prosthesis (plastic eye), although many patients prefer to wear an eye patch. Later, facial prostheses can be attached to the facial skeleton.

### Diagnosis/Preparation

The evaluation of patients before pelvic exenteration includes a thorough physical exam with rectal and pelvic examination. Endorectal **ultrasound** and imaging studies such as computed tomography scans (**CT scans**) and **magnetic resonance imaging** (MRI) are routinely used to obtain pictures of the abdominal and pelvic areas and evaluate the spread of the cancer.

Ocular ultrasound examination, CT scan, and **angiography** evaluation (used to image blood vessels) are usually performed to prepare for orbital exenteration.

Some patients begin treatment with chemotherapy and/or radiation before the procedure. Surgery is typically performed approximately six weeks later.

In the case of pelvic exenteration, the patient will be given a bowel prep to cleanse the colon and prepare it for surgery. This procedure is required to lower the level of intestinal bacteria, thus helping to prevent **post-surgical infections**. **Antibiotics** are also typically given to help decrease bacteria levels in the bowel.

### Aftercare

#### *Pelvic exenteration*

After a pelvic exenteration, a drainage tube is inserted at the site of the incision. There usually is some bleeding, discharge, and considerable tenderness and pain for a few days. At least a three- to five-day hospital stay is usually required. Side effects depend on the type of pelvic exenteration performed, but often include urination difficulty, especially if adjustment to a catheter is required; and a very painful lower abdomen.

**Stitches** are usually removed from the skin on the third day, or before the patient is sent home. A prescription for pain medication is usually given as well as instructions for follow-up care.

#### *Ocular exenteration*

After ocular exenteration, most patients have a headache for several days, which goes away with over-the-counter pain medications. An eye ointment is also prescribed that contains antibiotics and steroids to help the healing process.

### Risks

As with any operation, there is a risk of complications due to anesthesia, wound infection, or injury to adjacent organs or structures.

In the case of pelvic exenteration, the following complications are also possible:

- hemorrhage that may require a blood transfusion
- injury to the bowel
- urinary tract infection
- urinary retention requiring permanent use of a catheter
- bowel obstruction

After removal of the reproductive organs, women will no longer have monthly periods nor will they be able to become pregnant. For men, surgery involving the prostate and the nerves around the rectum may also result in the inability to produce sperm or to have an erection.



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

As exenteration is considered to be major surgery, the procedure is performed under the strict conditions that a hospital operating room affords. A team of physicians, nurses, and other health care workers are involved in the procedure. Pelvic exenteration may be performed by a gynecologist, gynecologic oncologist, urologist, and/or plastic surgeon. Orbital exenteration may be performed by an ophthalmologist and/or oculoplastic surgeon.

In the case of orbital exenteration, the following complications have been known to occur:

- growth of an orbital cyst (rare)
- chronic throbbing orbital pain
- sinusitis (nasal stuffiness)
- ear problems
- reoccurrence of malignancy

### Normal results

During and after recovery from exenteration, it is normal for a patient to undergo a period of psychological adjustment to the major change in lifestyle (e.g., learning to care for a urostomy or colostomy) or appearance (e.g., following orbital exenteration). It is important that all aspects of the procedure be discussed with the patient before undergoing surgery, and that any psychosocial distress that the patient experiences after exenteration be addressed.

### Morbidity and mortality rates

There is a 30–44% chance of complications during pelvic exenteration, and the operative mortality rate ranges from 3–5%. About one-third of patients will experience postoperative complications such as bowel obstruction, fistula formation, inflammation or failure of the kidneys, narrowing of the ureters, or pulmonary embolism (a blood clot that travels to the lungs). The five-year survival rate after pelvic exenteration ranges from 23% to 61%. For patients who undergo pelvic or orbital exenteration, short- and long-term morbidity and mortality rates depend on the particular condition that required the procedure.

### Alternatives

Exenteration is generally pursued only if no other less invasive options are available to the patient.

## QUESTIONS TO ASK THE DOCTOR

- Why is exenteration recommended in my case?
- What organs or other structures will be removed?
- In the case of pelvic exenteration, what methods of urinary/fecal diversion will be performed?
- In the case of orbital exenteration, what are my options in terms of cosmetic prostheses?
- What non-surgical options are available to me?
- How long after surgery may I resume normal activity?

Alternatives, however, include chemotherapy, radiation therapy, and more conservative surgery.

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## Exercise

### Definition

The Surgeon General of the United States defines exercise as physical activity that involves planned, structured, and repetitive bodily movements in order to improve or maintain physical fitness. As an element of health, exercise involves both strength training of the muscles and cardiovascular fitness, with stretching activities for flexibility. Most research on physical activity for fitness stresses the intensity and regularity of exercise as key elements. Typical exercise activities include fast walking, running, cycling, swimming, or aerobics classes. The latest Centers for Disease Control and Prevention (CDC) report, in conjunction with the American Council on Sports Medicine, recommends that all adults perform 30 or more minutes a day of moderate-intensity activity for five to seven days per week. The National Institutes of Health Consensus Development Conference Statement on Physical Activity and Cardiovascular Health identifies inactivity as a major public health problem in the United States. They have recommended exercise regimens five to seven days a week for people who are already active, and such leisure activities as gardening, walking, using stairs instead of an elevator, cleaning house, and recreational pursuits, etc., for people who are largely sedentary.

### Purpose

One important purpose of exercise is speeding recovery from surgery. Nowhere is being fit as important as when a person is facing surgery or recovering from surgery. Regular exercise leads to important health advantages, including weight loss; greater cardiovascular efficiency; lower cholesterol levels; increased musculoskeletal strength and flexibility; increased bone density; and better functioning of the metabolic, endocrine, and immune systems. These effects diminish with lack of exercise within two weeks if physical activity is substantially reduced; the fitness effects disappear altogether within two to eight months if physical activity is not resumed.

With regard to **preparing for surgery**, the effects of regular exercise on all body systems create optimal responses both to the surgical procedures itself and during the postoperative recovery period.

### Demographics

Most adults in North America would benefit from increasing their level of physical activity. The majority

of adults in the United States (65%) are overweight, and two-thirds of those with weight problems are likely also to have diabetes, heart disease, high blood pressure, or other obesity-related conditions. A sedentary lifestyle and unhealthy eating patterns are responsible for at least 300,000 deaths each year from chronic diseases. It is estimated that two-thirds of people over 65 have at least one chronic condition, with 36 million Americans suffering from some form of arthritis. More than 300,000 total joint replacement procedures are performed each year due to osteoarthritis. Lack of physical activity contributes substantially to conditions like osteoarthritis, low back pain, and osteoporosis.

Obesity reached epidemic proportions among adults in the United States in the years between 1987 and 2008. Over 45 million adults are obese; in addition, the percentage of young people who are overweight has more than doubled in the last 20 years. Despite the benefits of physical activity, more than 60% of American adults do not get enough physical activity to provide health benefits. More than 25% are not active in their leisure time. Insufficient activity increases with age; it is also more common in women than men and among those with lower levels of economic stability and educational achievement. On the other hand, the CDC reported in 2007 that more adult Americans are getting more regular exercise than was the case in the recent past; the rate of women exercising at least 30 minutes per day increased by 8.6% from 2001 to 2005, and the rate for men increased by 3.5%.

The direct consequences of obesity include:

- Heart disease and stroke, the leading causes of death and disability in the United States.
- Type 2 diabetes (also known as NIDDM, or non-insulin-dependent diabetes mellitus).
- Cancer. Obesity increases the risk of cancer of the uterus, gallbladder, cervix, ovary, breast, and colon in women; it increases the risk of cancer of the colon, rectum, and prostate in men.
- Osteoarthritis. Obesity adds to daily “wear and tear” on joints, primarily the knees, as well as the hips and lower back.
- Gallbladder disease. The risk of gallbladder disease and gallstones increases as a person’s weight increases.
- Stress incontinence in women, especially those over 65 years old.
- Gastroesophageal reflux disease (GERD).

## KEY TERMS

**Aerobic exercise**—Any type of exercise that is intended to increase the body's oxygen consumption and improve the functioning of the cardiovascular and respiratory systems.

**Body mass index (BMI)**—A measurement that has replaced weight as the preferred determinant of obesity. The BMI can be calculated (in English units) as 703.1 times a person's weight in pounds divided by the square of the person's height in inches.

**Obesity**—Excessive weight gain due to accumulation of fat in the body, sometimes defined as a BMI of 30 or higher, or body weight greater than 30% above one's desirable weight on standard height-weight tables.

**Physical activity**—Any activity that involves moving the body and results in the burning of calories.

**Physical fitness**—The combination of muscle strength and cardiovascular health usually attributed to regular exercise and good nutrition.

**Sedentary**—Characterized by inactivity and lack of exercise. A sedentary lifestyle is a major risk factor for becoming overweight or obese.

## Diagnosis/Preparation

More than 30 million Americans undergo surgery each year. Each patient's **surgical risk**, complications, and outcomes will depend on how fit they are; how well their cardiovascular and pulmonary systems withstand the stress of anesthesia; how quickly their bones and muscles recover after surgical procedures; and how well their metabolic and immune systems respond to surgery and the risk of infection. The general physical status of the patient is the most important factor in preparing for surgery. This status is determined by the physician, including his or her evaluation of the specific procedures to be performed. On the other hand, however, the patient's lifestyle may affect management of the surgery both before and after the actual procedures. A healthful diet, regular exercise, and quitting smoking are highly recommended before surgery. Each of these factors has an important role to play in optimal functioning of the circulatory and pulmonary systems. Smoking should cease two weeks before surgery to be beneficial.

## Aftercare

After surgery, it is important to return to daily activities when the physician gives permission to do so.

Most doctors encourage their patients to be as active as possible as soon as possible. While aftercare is individualized, and physicians may place certain limitations on physical activity for specific patients, walking as soon as the patient is able to walk is generally recommended. The patient should be as active as possible within the limits set by the physician for post-operative recovery, with the goal of returning to his or her normal daily activities and exercise routines. The patient should ask the physician for explicit guidelines about returning to an established exercise program or other physical or recreational activities.

## Risks

The benefits of exercise before and after surgery, and continuing as a daily life activity cannot be overemphasized. There are risks, however, for people who begin an exercise program without having had one in the past. Patients should always have a **physical examination** before taking up an exercise program for the first time or after a long period of inactivity. It is also a good idea to look for a form of exercise that one finds personally appealing or interesting; studies have found that people are more likely to stick with an exercise program when they enjoy the sport or activity, whether it is an individual form of exercise (walking, running, cycling, yoga, tai chi, swimming) or one that involves a team or an exercise partner (dancing, martial arts, fencing, golf, tennis, volleyball, softball, etc.). One reason that walking is often recommended as a form of exercise is that it can be combined with a number of activities that many people enjoy, such as nature walks, bird watching, visiting an art or science museum, socializing with a friend, or exercising a pet dog. For some people, participation in a team sport is also a good way to make friends, as well as to commit to an exercise program.

Too much exercise can be as harmful to the body as too little; overuse of certain muscles and joints can lead to such health problems as tennis elbow and shin splints. Many exercise programs now recommend days of rest as well as regularly scheduled periods of exercise, as inadequate rest increases the risk of stroke and circulatory disorders. In particular, pregnant women should not exercise two days in a row.

Such high-intensity exercise regimens as high-impact aerobics and jogging are not recommended as often as they once were for helping patients attain a specific fitness level as measured by resting heart rate and muscle mass. Running in particular is hard on the knees and ankle joints; in addition, runners are frequently injured by falls. Walking, swimming, and gardening can all contribute to aerobic fitness. Strength

training with resistance exercises for the arms and legs using weights or bands is now an important aspect of physical fitness. These exercises can be done at a moderate rate, with the number of repetitions increased over time. Stretching is very important to both kinds of exercise activities; yoga is often recommended for stretching, bending, and improving overall flexibility.

People who have specific health problems can still find ways to exercise that will not make their injuries or disorders worse. The American Council on Exercise (ACE) offers articles on exercising for the elderly and for adults with such problems as bad knees, shoulder injuries, asthma, chronic pain, arthritis, and flat feet.

### Morbidity and mortality rates

Without exercise and a healthful diet, people burn fewer calories than they take in, resulting in increasing weight gain. While the formula is familiar, the outcomes are surprising. According to studies based on a newer index for obesity—the body mass index (BMI)—people who are overweight or obese have dramatically shorter life spans. This correlation was confirmed by a study published in the *Journal of the American Medical Association* in 2007. In fact, some studies are showing that individuals who are fat in middle age are as likely to lose years of life as those who smoke. Researchers have found obesity and overweight combined are the second leading cause of preventable **death** in the United States, behind tobacco use. Correlating the BMI—calculated from a person's weight in kilograms divided by height in meters squared—and the mortality of different cohorts of subjects in large longitudinal studies, researchers have found that the lowest mortality rates from all causes were found among those having a BMI between 23.5 and 24.9 for men and 22.0–23.4 for women. The strongest association between obesity and death from all causes are found among individuals with the highest BMI—people with a BMI of 40+. Clinical obesity is defined as a BMI of 30 or above. Morbid obesity is defined as a BMI of 40 or above.

With respect to health care, people who are obese have higher rates of complications in the hospital. Researchers in New York studied a group of patients who were in the **intensive care unit** (ICU) for a variety of causes, and found that those who were morbidly obese were far more likely to die of their illness than those who were closer to their desirable weight (23.3% vs. 6.1%). Patients who were morbidly obese had higher rates of transfers to **nursing homes** from the ICU, rather than being discharged to their homes—over 16% for the obese patients compared to 3% for patients who were less overweight.

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Exercise electrocardiogram see **Stress test**

Exercise stress test see **Stress test**

Exploratory laparotomy see **Laparotomy, exploratory**

## Extracapsular cataract extraction

### Definition

Extracapsular cataract extraction (ECCE) is a category of eye surgery in which the lens of the eye is removed while the elastic capsule that covers the lens is left partially intact to allow implantation of an intraocular lens (IOL). This approach is contrasted with intracapsular cataract extraction (ICCE), an older procedure in which the surgeon removed the complete lens within its capsule and left the eye aphakic (without a lens). The patient's vision was corrected after intracapsular extraction by extremely thick eyeglasses or by contact lenses.

There are two major types of ECCE: manual expression, in which the lens is removed through an incision made in the cornea or the sclera of the eye; and phacoemulsification, in which the lens is broken into fragments inside the capsule by **ultrasound** energy and removed by aspiration.

### Purpose

#### Historical background

The purpose of ECCE is to restore clear vision by removing a clouded or discolored lens and replacing it with an IOL. Cataract operations are among the oldest recorded surgical procedures; there are references to cataract surgery in the *Code of Hammurabi* in 1750 B.C., and in the treatises written around 600 B.C. by Susruta, a famous surgeon from India. In the ancient world, lenses damaged by cataracts were dislocated rather than removed in the strict sense; the surgeon used a lance to push the clouded lens backward into the vitreous body of the eye. This operation, known as couching, was standard practice until the mid-eighteenth century. Couching is still performed by some traditional healers in Africa and parts of Asia.

The first extracapsular extraction of a cataract was performed by a French surgeon named Jacques Daviel in 1753. Daviel removed the lens through a fairly long incision in the cornea of the eye. In 1865, the German ophthalmologist Albrecht von Graefe refined the operation by removing the lens through a much smaller linear incision in the sclera of the eye. After von Graefe, however, intracapsular extraction gradually became the favored method of cataract removal even though it left the patient without a lens inside the eye. The two inventions that made extracapsular extraction preferable again were the operating microscope and the intraocular lens. The first eye surgery performed with an operating microscope was done in Portland, Oregon, in 1948; in the same year, a British ophthalmologist named Harold Ridley implanted the first IOL in the eye of a cataract patient. Between 1948 and the 1980s, manual expression was the standard form of ECCE. Although phacoemulsification was first introduced in 1967, it was not widely accepted at first because it requires special techniques that take time for the surgeon to learn, as well as expensive specialized equipment. As of 2007, phacoemulsification is now performed more often in the United States and Europe than "standard" ECCE. The manual expression technique, however, is still widely used in developing countries with large numbers of patients with eye disorders and limited hospital budgets.

#### Lens and cataract formation

The lens, which is sometimes called the crystalline lens because it is transparent, is located immediately behind the iris. In humans, the lens is about 0.35 in (9 mm) long and 0.15 in (4 mm) wide. It consists of protein fibers and water, with the fibers arranged in a

## KEY TERMS

**Acuity**—Sharpness or clarity of vision.

**Aphakic**—Without a lens. An older form of cataract surgery known as intracapsular extraction left patients' eyes aphakic.

**Aspiration**—Removal by suction.

**Brunescent**—Developing a brownish or amber color over time; nuclear cataracts are sometimes called brunescent.

**Capsulorrhexis**—The creation of a continuous circular tear in the front portion of the lens capsule during cataract surgery to allow for removal of the lens nucleus.

**Capsulotomy**—A procedure that is sometimes needed after ECCE to open a lens capsule that has become cloudy.

**Cataract**—A cloudy or opaque area on or in the lens of the eye.

**Cornea**—The transparent front portion of the exterior cover of the eye.

**Couching**—The oldest form of cataract surgery, in which the lens is dislocated and pushed backward into the vitreous body with a lance.

**Endophthalmitis**—An infection on the inside of the eye that may result in vision loss.

**Hyphema**—Bleeding inside the anterior chamber of the eye.

**Keratometer**—A device that measures the curvature of the cornea. It is used to determine the correct power for an IOL prior to cataract surgery.

**Lens capsule**—A clear elastic membrane-like structure that covers the lens of the eye.

**Macula**—A small yellowish depression on the retina of the eye slightly below the optic disk that is the central point of sharpest vision. Its primary function is the absorption of shorter wavelengths of light.

**Ophthalmology**—The branch of medicine that deals with the diagnosis and treatment of eye disorders.

**Phacoemulsification**—A method of extracapsular cataract extraction in which the lens is broken apart by ultrasound energy and the fragments removed by suction.

**Sclera**—The tough white fibrous membrane that forms the outermost covering of the eyeball.

**Uvea**—The middle of the three coats of tissue surrounding the eye, comprising the choroid, iris, and ciliary body. The uvea is pigmented and well supplied with blood vessels.

**Uveitis**—Inflammation of any part of the uvea.

**Vitreous body**—The transparent gel that fills the inner portion of the eyeball between the lens and the retina. It is also called the vitreous humor or crystalline humor.

pattern that allows light to pass through the lens. There are three layers of cells in the lens: a central nucleus, which becomes denser and harder as a person ages; a cortex surrounding the nucleus, which contains cells that are metabolically active and continue to grow and divide; and a layer of cells between the cortex and the lens capsule known as the subcapsular epithelium.

Although a few people are born with cataracts or develop them in childhood, most cataracts are the result of the aging process. Between 5 and 10 million people around the world each year develop cataracts severe enough to impair their vision. As people grow older, the protein fibers in the lens become denser, start to clump together, and form cloudy or opaque areas in the lens. Cataracts vary considerably in their speed of progression; they may develop in a few months or over a period of many years. Some people have cataracts that stop growing at an early stage of

development and do not interfere with their vision. Although most people develop cataracts in both eyes, they do not usually progress at the same rate, so that the person has much better vision in one eye than in the other.

Ophthalmologists classify cataracts according to their location in the lens. It is possible for a person to have more than one type of cataract, including:

- **Nuclear cataracts.** Nuclear cataracts grow slowly over many years but can become very large and hard, which complicates their removal. They are sometimes called brunescent cataracts because they are characterized by deposits of brown pigment that give the lens an amber color. Nuclear cataracts are most commonly associated with age and with smoking as risk factors.
- **Cortical cataracts.** Cataracts in the cortex of the lens develop more rapidly than nuclear cataracts but remain softer and are easier to remove. They are

thought to be caused by an increase in the water content of the lens. Risk factors for cortical cataracts include female sex and African or Caribbean heritage.

- Posterior subcapsular (PSC) cataracts. This type of cataract, which develops between the back of the lens and the lens capsule, is the softest and most rapidly growing type. PSC cataracts tend to scatter light at night and thus interfere with nighttime driving. Risk factors for PSC cataracts include diabetes, high blood pressure, and a history of treatment with steroid medications.

## Demographics

Cataract extraction is one of the most frequently performed surgical procedures in industrialized countries. It is estimated that 300,000–400,000 cases of visually disabling cataracts occur each year in the United States alone, and that between 1 and 1.5 million cataract extractions are performed annually in the United States. This frequency reflects the importance of cataracts as a major public health problem. The World Health Organization (WHO) estimated in 1997 that cataracts were responsible for 50% of cases of blindness around the world, or 19 million people. By the year 2020, that figure is expected to rise to 50 million. More recent publications estimate that 1.2% of the general population of Africa is blind, with cataracts responsible for 36% of these cases of blindness.

About one person in every 50 in the general American population will eventually have to have a cataract removed. However, it is difficult to compare the rates of cataract formation among various subgroups because present published studies use a number of different grading systems for defining and detecting cataracts. In addition, the elderly are often underrepresented in general population studies even though age is the greatest single risk factor for cataract development. Three recent research projects carried out in the United States, Australia, and England, respectively, reported that 50% of people over the age of 60 have some degree of cataract formation, with the figure rising to 100% for those over 80. As of 2007, little conclusive information is available regarding the incidence of cataracts in different racial and ethnic groups in the United States.

A variety of risk factors in addition to age have been associated with cataracts, but their precise significance is debated among researchers, including:

- Genetic factors. Twin studies show that the identical twin of a patient with a nuclear cataract has a 48% chance of developing one.

- Sex. Women are slightly more likely than men to develop cataracts. One American study found that 53.3% of women over 60 had nuclear cataracts compared to 49.7% of the men; 25.9% of the women had cortical cataracts versus 21.1% of the men.
- Exposure to ultraviolet radiation. Cortical cataracts are more likely to develop in people with frequent exposure to sunlight; however, nuclear cataracts are not related to sun exposure.
- Exposure to infrared light waves. Occupations as different as military surveillance, weather forecasting, spectroscopy, thermal efficiency analysis, and astronomy expose workers to infrared radiation.
- Smoking. People who smoke more than 25 cigarettes per day are three times as likely as nonsmokers to develop nuclear or PSC cataracts. Smoking does not appear to be related to cortical cataracts.
- Alcohol consumption. Heavy drinking has been reported to increase the risk of developing all three types of cataracts.
- Diabetes. Patients with diabetes are at increased risk of developing all three types of cataracts.
- Use of steroid medications. PSC cataracts are known to be induced by steroids, even though they represent less than 10% of all cataracts.
- Socioeconomic status (SES). People with college or professional-school education have lower rates of cataract formation than people who did not finish high school, even attempting to correct for environmental and nutritional factors. There is, however, no obvious biochemical or medical explanation for this correlation, and some researchers treat it with caution.
- Chronic dehydration, diarrhea, and malnutrition. Studies carried out in India indicate that severe malnutrition or repeated episodes of diarrhea in childhood carry a three- to fourfold increase in risk of developing cataracts in later life. It is not yet known, however, whether this statistic would hold true for people in other countries.

## Description

### *Conventional extracapsular cataract extraction*

Although phacoemulsification has become the preferred method of extracapsular extraction for most cataracts in the United States since the 1990s, conventional or standard ECCE is considered less risky for patients with very hard cataracts or weak epithelial tissue in the cornea. The ultrasound vibrations that are used in phacoemulsification tend to stress the cornea.

A conventional extracapsular cataract extraction takes less than an hour to perform. After the area around the eye has been cleansed with antiseptic, sterile drapes are used to cover most of the patient's face. The patient is given either a local anesthetic to numb the tissues around the eye or a topical anesthetic to numb the eye itself. An eyelid holder is used to hold the eye open during the procedure. If the patient is very nervous, the doctor may administer a sedative intravenously.

The surgeon makes an incision in the cornea at the point where the sclera and cornea meet. Although the typical length of a standard ECCE incision was 0.39–0.47 in (10–12 mm) in the 1970s, the development of foldable acrylic IOLs has allowed many surgeons to work with incisions that are only 0.19–0.23 in (5–6 mm) long. This variation is sometimes referred to as small-incision ECCE. After the incision is made, the surgeon makes a circular tear in the front of the lens capsule; this technique is known as capsulorrhexis. The surgeon then carefully opens the lens capsule and removes the hard nucleus of the lens by applying pressure with special instruments. After the nucleus has been expressed, the surgeon uses suction to remove the softer cortex of the lens. A special viscoelastic material is injected into the empty lens capsule to help it keep its shape while the surgeon inserts the IOL. After the intraocular lens has been placed in the correct position, the viscoelastic substance is removed and the incision is closed with two or three **stitches** using a very fine monofilament suture. A newer technique uses a laser rather than stitches to close the incision, and appears to give equally good results.

### *Phacoemulsification*

In phacoemulsification, the surgeon uses an ultrasound probe inserted through the incision to break up the nucleus of the lens into smaller pieces. The newer technique offers the advantages of a smaller incision than standard ECCE, fewer or no stitches to close the incision, and a shorter recovery time for the patient. Its disadvantages are the need for specialized equipment and a steep learning curve for the surgeon. One study found that surgeons needed to perform about 150 cataract extractions using phacoemulsification before their complication rates fell to a baseline level. As of 2007, there is a need for more residency programs in eye surgery that give residents sufficient practice in this technique of cataract extraction.

## **Diagnosis/Preparation**

### *Diagnosis*

The diagnosis of cataract is usually made when the patient begins to notice changes in his or her vision

and consults an eye specialist. In contrast to certain types of glaucoma, there is no pain associated with the development of cataracts. The specific changes in the patient's vision depend on the type and location of the cataract. Nuclear cataracts typically produce symptoms known as myopic shift (in nearsighted patients) and second sight (in farsighted patients). What these terms mean is that the nearsighted person becomes more nearsighted while the farsighted person's near vision improves to the point that there is less need for reading glasses. Cortical and posterior subcapsular cataracts typically reduce visual acuity; in addition, the patient may also complain of increased glare in bright daylight or glare from the headlights of oncoming cars at night.

Because visual disturbances may indicate glaucoma as well as cataracts, particularly in older adults, the examiner will first check the intraocular pressure (IOP) and the anterior chamber of the patient's eye. The examiner will also look closely at the patient's medical history and general present physical condition for indications of diabetes or other systemic disorders that affect cataract development. The next step in the diagnostic examination is a test of the patient's visual acuity for both near and far distances, commonly known as the Snellen test. If the patient has mentioned glare, the Snellen test will be conducted in a brightly lit room.

The examiner will then check the patient's eyes with a slit lamp in order to evaluate the location and size of the cataract. After the patient's eyes have been dilated with eye drops, the slit lamp can also be used to check the other structures of the eye for any indications of metabolic disorders or previous eye injury. Lastly, the examiner will use an ophthalmoscope to evaluate the condition of the optic nerve and retina at the back of the eye. The ophthalmoscope can also be used to detect the presence of very small cataracts.

Imaging studies of the eye (ultrasound, MRI, or **CT scan**) may be ordered if the doctor cannot see the back of the eye because of the size and density of the cataract.

### *Preparation*

ECCE is almost always elective surgery—emergency removal of a cataract is performed only when the cataract is causing glaucoma or the eye is severely injured or infected. After the surgery has been scheduled, the patient will need to have special testing known as keratometry if an IOL is to be implanted.



The testing, which is painless, is done to determine the strength of the IOL needed. The ophthalmologist measures the length of the patient's eyeball with ultrasound and the curvature of the cornea with a device called a keratometer. The measurements obtained by the keratometer are entered into a computer that calculates the correct power for the IOL.

The IOL is a substitute for the lens in the patient's eye, not for corrective lenses. If the patient was wearing eyeglasses or contact lenses before the cataract developed, he or she will continue to need them after the IOL is implanted. The lens prescription should be checked after surgery, however, as it is likely to need adjustment.

### Aftercare

Patients can use their eyes after ECCE, although they should have a friend or relative drive them home after the procedure. The ophthalmologist will place some medications—usually steroids and antibiotics—in the operated eye before the patient leaves the office. Patients can go to work the next day, although the operated eye will take between three weeks and three months to heal completely. At the end of this period, they should have their regular eyeglasses checked to see if their lens prescription should be changed. Patients can carry out their normal activities within one to two days after surgery, with the exception of heavy lifting, severe chronic coughing, or extreme bending. Most ophthalmologists recommend that patients wear their eyeglasses during the day and tape an eye shield over the operated eye at night. They should wear sunglasses on bright days and avoid rubbing or bumping the operated eye. In addition, the ophthalmologist will prescribe eye drops for one to two weeks to prevent infection, manage pain, and reduce swelling. It is important for patients to use these eye drops exactly as directed.

Patients recovering from cataract surgery will be scheduled for frequent checkups in the first few weeks following ECCE. In most cases, the ophthalmologist will check the patient's eye the day after surgery and about once a week for the next several weeks.

About 25% of patients who have had a cataract removed by either extracapsular method will eventually develop clouding in the lens capsule that was left in place to hold the new IOL. This clouding, which is known as posterior capsular opacification (PCO), is not a new cataract but may still interfere with vision. It is thought to be caused by the growth of epithelial cells

left behind after the lens was removed. PCO is treated by capsulotomy, which is a procedure in which the surgeon uses a laser to cut through the clouded part of the capsule.

### Risks

The risks of extracapsular cataract extraction include:

- Edema (swelling) of the cornea.
- A rise in intraocular pressure (IOP).
- Uveitis, which refers to inflammation of the layer of eye tissue that includes the iris.
- Infection of the external eye may develop into endophthalmitis, or infection of the interior of the eye.
- Hyphema, which refers to the presence of blood inside the anterior chamber of the eye and is most common within the first two to three days after cataract surgery.
- Leaking or rupture of the incision.
- Retinal detachment (RD) or tear. The risk of RD appears to be increased in patients for as long as 20 years after extracapsular cataract extraction.
- Malpositioning of the IOL. This complication can be corrected by surgery.
- Cystoid macular edema (CME). The macula is a small yellowish depression on the retina that may be affected after cataract surgery by fluid collecting within the tissue layers. The typical symptoms are blurring or distortion of central vision. CME rarely causes loss of sight, but may take between two and 15 months to resolve completely.

### Normal results

Extracapsular cataract extraction is one of the safest and most successful procedures in contemporary eye surgery; about 95% of patients report that their vision is substantially improved after the operation.

### Morbidity and mortality rates

Mortality as a direct result of cataract surgery is very rare. On the other hand, several studies have indicated that patients over the age of 50 who undergo cataract extraction have higher rates of mortality in the year following surgery than other patients in the same age group who have other types of **elective surgery**. Some researchers have interpreted these data to imply that cataracts related to the aging process reflect some kind of systemic weakness rather than a disorder limited to the eye.

About 23% of patients who have undergone cataract extraction have a postoperative complication. The majority of these, however, are not vision-threatening. The most common complication is swelling of the cornea (9.5%), followed by raised IOP (7.9%); uveitis (5.6%); leaking from the incision (1.2%); hyphema (1.1%); external eye infection (0.06%); endophthalmitis (0.03%); retinal detachment (0.03%); retinal tear (0.02%), and CME (0.017%). Of these complications, only endophthalmitis and retinal detachment or tear are considered potentially vision-threatening.

Standard ECCE and phacoemulsification have similar success rates and complication rates when performed by surgeons of comparable skill and length of experience, although a meta-analysis of 17 trials of these two methods reported in 2006 that phacoemulsification gives a better long-term outcome than standard ECCE with sutures.

## Alternatives

### *Medical treatment*

As of 2007, there are no medications that can prevent or cure cataracts. Many ophthalmologists, however, recommend a well-balanced diet as beneficial to the eyes as well as the rest of the body, on the grounds that some studies suggest that poor nutritional status is a risk factor for cataract. While vitamin supplements do not prevent cataracts, there is some evidence that an adequate intake of vitamins A, C, and E helps to slow the rate of cataract progression. Elderly people who may be at risk of inadequate vitamin intake due to loss of appetite and other reasons may benefit from supplemental doses of these vitamins.

### *Watchful waiting*

Not all cataracts need to be removed. A patient whose cataracts are not interfering with his or her normal activities and are progressing slowly may choose to postpone surgery indefinitely. It is important, however, to have periodic checkups to make sure that the cataract is not growing in size or density. In the recent past, surgeons often advised patients to put off surgical treatment until the cataract had “ripened,” which meant that the patient had to wait until the cataract had caused significant vision loss and was interfering with reading, driving, and most daily activities. At present, ophthalmologists prefer to remove cataracts before they get to this stage because they are harder and consequently more difficult to remove. In addition, a rapidly growing cataract that is not treated surgically may lead to swelling of the lens, secondary

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Cataract surgery is performed by ophthalmologists, who are physicians that have completed four to five years of specialized training following medical school in the medical and surgical treatment of eye disorders. Ophthalmology is one of 24 specialties recognized by the American Board of Medical Specialties.

If cataract surgery is being considered, it is a good idea to find out how many extracapsular extractions the surgeon performs each year. The greatest single factor in the success rate of ECCE procedures is not whether the surgeon performs a standard extraction or phacoemulsification, but the volume of operations that he or she performs. Surgeons who perform between 200 and 400 extracapsular extractions per year have higher rates of successful outcomes than those who perform fewer than 200.

Extracapsular cataract extractions are done as outpatient procedures, either in the ophthalmologist's office or in an ambulatory surgery center.

glaucoma, and eventual blindness. In most cases, however, it is up to the patient to decide when the cataract is troublesome enough to schedule surgery.

### *Surgical alternatives*

The major surgical alternative to ECCE is intracapsular cataract extraction, or ICCE. It is rarely performed at present in Europe and North America, but is still done in countries where operating microscopes and high-technology equipment are not always available. In ICCE, the surgeon makes an incision about 150 degrees of arc, or about half the circumference of the cornea, in order to extract the lens and its capsule in one piece. The surgeon then inserts a cryoprobe, which is an instrument for applying extreme cold to eye tissue. The cryoprobe is placed on the lens capsule, where it freezes into place. It is then used to slowly pull the capsule and lens together through the long incision around the cornea. Because of the length of the incision needed to perform ICCE and the pressure placed on the vitreous body, the procedure has a relatively high rate of complications. In addition, the recovery period is much longer than for standard ECCE or phacoemulsification.

## QUESTIONS TO ASK THE DOCTOR

- What type of cataract do I have and how fast is it developing?
- Would you recommend watchful waiting to see if surgery is necessary?
- How many cataract extractions do you perform each year, and what technique do you use?
- What is your success rate with cataract extractions?

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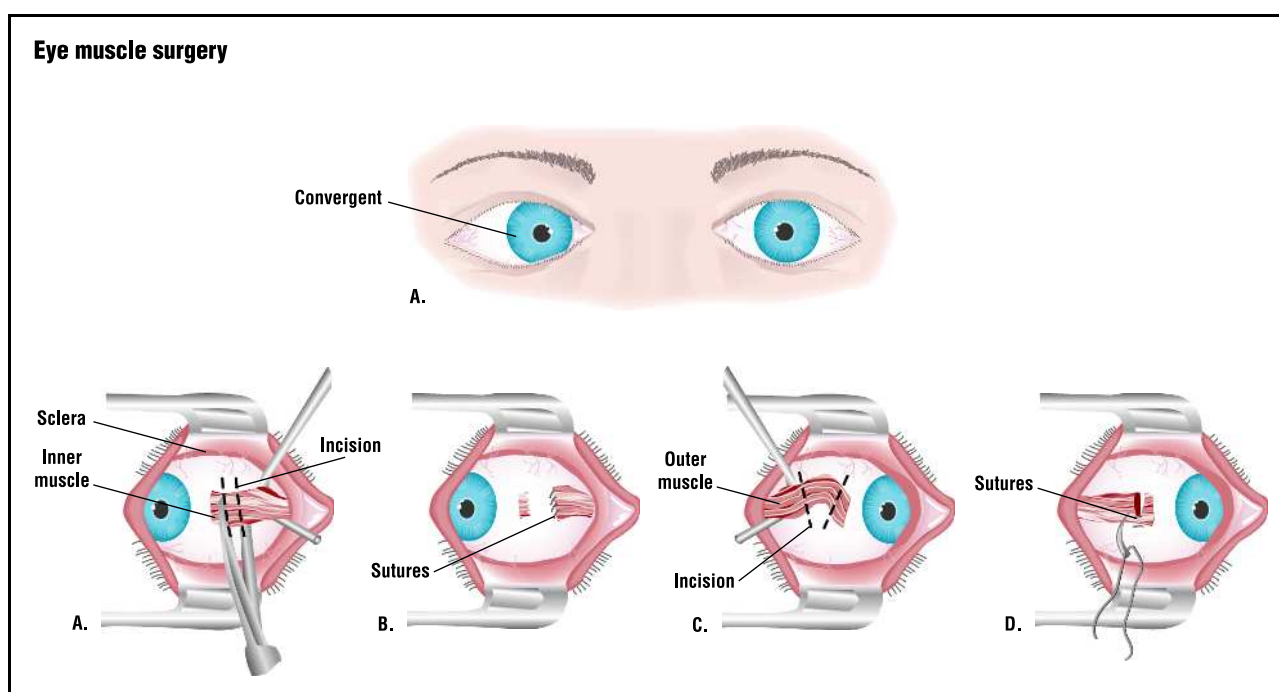
Extracorporeal shock-wave therapy see

**Lithotripsy**

## Eye muscle surgery

### Definition

Eye muscle surgery is performed to weaken, strengthen, or reposition any of the extraocular muscles (small muscles) located on the surface of the eye that move the eyeball in all directions.



**To repair a convergent gaze, the ophthalmologist cuts the muscles that move the eye from side to side (A). On one side, the muscles are attached further back on the eyeball (B). On the other, the muscle is shortened (C) and stitched (D).** (Illustration by GGS Information Services. Cengage Learning, Gale.)

## Purpose

The extraocular muscles attach via tendons to the sclera (the white, opaque, outer protective covering of the eyeball) at different places just behind an imaginary equator circling the top, bottom, left, and right of the eye. The other end of each of these muscles attaches to a part of the orbit (the eye socket in the skull). These muscles enable the eyes to move up, down, to one side or the other, or any angle in between.

Normally, both eyes move together, receiving the same image on corresponding locations on both retinas. The brain fuses these matching images into one three-dimensional image. The exception is in strabismus, which is a disorder where one or both eyes deviate out of alignment, most often outwardly (exotropia) or toward the nose (esotropia). In this case, the brain receives two different images, and either suppresses one or allows the person to see double (diplopia). By weakening or strengthening the appropriate muscles to center the eyes, a person can correct this deviation. For example, if an eye turns upward, the muscle at the bottom of the eye could be strengthened.

The main purpose of eye muscle surgery is thus to restore straight eye alignment. The surgery is performed to align both eyes so that they gaze in the same direction and move together as a team; to

improve appearance; and to promote the development of binocular vision in a young child. To achieve binocular vision, the eyes must align so that the location of the image on the retina of one eye corresponds to the location of the image on the retina of the other eye.

In addition to being used to correct strabismus, eye muscle surgery is also performed to treat other eye disorders such as nystagmus or special types of congenital strabismus such as Duane syndrome. Nystagmus is a condition in which one or both eyes move rapidly or oscillate; this condition can be improved by moving the eyes to the position of least oscillation. Duane syndrome is a disorder in which there is limited horizontal eye movement; it can sometimes be relieved by surgery that weakens an eye muscle.

## Demographics

According to doctors at the Wills Eye Hospital, Philadelphia, the most common divergent strabismus in childhood has a variable onset, often between six months and four years. The disorder occurs in 1.2% of children by seven years of age and occurs equally in males and females.

Duane syndrome commonly affects girls more often than boys, and the left eye more often than the right eye.



## KEY TERMS

**Conjunctiva**—The mucous membrane that covers the eyes and lines the eyelids.

**Duane syndrome**—A hereditary congenital syndrome in which the affected eye shows a limited capacity to move, and is deficient in convergence with the other eye.

**Extraocular muscles**—The muscles (lateral rectus, medial rectus, inferior rectus, superior rectus, superior oblique, and inferior oblique) that move the eyeball.

**Nystagmus**—An involuntary, rapid, rhythmic movement of the eyeball, which may be horizontal, vertical, rotatory, or mixed.

**Orbit**—The cavity in the skull containing the eyeball; formed from seven bones: frontal, maxillary, sphenoid, lacrimal, zygomatic, ethmoid, and palatine.

**Retina**—The inner, light-sensitive layer of the eye containing rods and cones. The retina transforms the image it receives into electrical messages sent to the brain via the optic nerve.

**Sclera**—The tough, fibrous, white outer protective covering of the eyeball.

**Strabismus**—A disorder in which two eyes cannot be directed at the same object at the same time.

Congenital nystagmus is thought to be present at birth, but is usually not apparent until the child is a few months old. Acquired nystagmus occurs later than six months of age, and can be caused by stroke, diseases such as multiple sclerosis, or even a heavy blow to the head. It is not known how many people suffer from nystagmus, but it is thought to be one in 1,000 adults, and one in 640 children in the United States, according to the Nystagmus Network.

## Description

The procedure used by the surgeon depends on the condition that needs correcting. During surgery, eye muscles can be:

- **Weakened.** This usually involves recessing the eye muscle or moving it posteriorly on the eye to elongate the muscle and allow the muscle tissue to relax.
- **Tightened.** Muscles are tightened by resection, which involves removing a piece of the muscle near its point of insertion and then reinserting the muscle into its original location. By removing a piece of muscle, the muscle is shortened and therefore strengthened.

- **Repositioned.** For some forms of strabismus, the eye muscles are neither weakened nor strengthened, but repositioned: i.e., the muscle's point of insertion is moved to a different location.

There are two methods to alter extraocular muscles. Traditional surgery can be used to strengthen, weaken, or reposition an extraocular muscle. The surgeon first makes an incision in the conjunctiva (the clear membrane covering the sclera), then puts a suture into the muscle to hold it in place, and loosens the muscle from the eyeball with a surgical hook. During a resection, the muscle is detached from the sclera, a piece of muscle is removed so that the muscle is now shorter, and the muscle is reattached to the same place. This strengthens the muscle. In a recession, the muscle is made weaker by repositioning it. More than one extraocular eye muscle might be operated on at the same time.

Eye muscle surgery is performed with the eye in its normal position and usually takes an hour and a half. At no time during the operation is the eye removed from the socket. The surgeon determines where to reattach the muscles based on eye measurements taken before surgery. Most of the time, it can hardly be seen except with magnification.

## Diagnosis/Preparation

Depth perception (stereopsis) in humans develops around the age of three months. For successful development of binocular vision and the ability to perceive three-dimensionally, eye muscle surgery should not be postponed past the age of four years. The earlier the surgery, the better the outcome, so an early diagnosis is important. Surgery may even be performed before the child is two years old.

Patients (or their caregivers) should make sure their doctors are aware of any medications that they are taking, even over-the-counter medications. Patients should not take **aspirin**, or any other blood-thinning medications for 10 days prior to surgery, and should not eat or drink after midnight the night before.

## Aftercare

After surgery, the eyes feel scratchy, but not very painful. Patients must be kept from rubbing their eyes. The eyes are also a little red and watery. There may be some hemorrhage under the conjunctival membrane over the white of the eye that usually settles over a period of two to three weeks. It usually takes on a yellowish discoloration similar to a bruise as it clears. Sometimes there is some thickening of the membranes over the eye, which can take several more weeks to clear. Very fine dissolving sutures are used to

reposition the conjunctival membrane at the end of surgery and, until these sutures dissolve, there may be some scratchiness in the eyes. This feeling usually disappears after two or three weeks.

There will also be some swelling and discharge after the surgery. The swelling is usually minor, and patients should be able to open their eyes within the next two days, as the swelling should gradually disappear.

Patients will need someone to drive them home after the operation. They should continue to avoid aspirin and other nonsteroidal anti-inflammatory agents for an additional three days, but they can take **acetaminophen** (e.g., Tylenol). Patients should discuss what medications they can or cannot take with the surgeon. Pain will subside after two or three days, and patients can resume most normal activities within a few days. Again, the period of recovery may vary with the patient, and the patient can discuss with the surgeon when to return to normal activities. Patients should not get their eyes wet for three to four days and should refrain from swimming for 10 days. Eyes receiving surgery will be red for about two weeks.

Adults and children over the age of six often experience double vision for a limited period of time after surgery. Children younger than six sometimes will have double vision for a short period of time. Double vision is rarely permanent.

Patients generally do not have to wear patches after surgery, although occasionally a temporary patch may be recommended. They are usually required to use eye drops for a week until the follow-up examination. If the eye is healing on schedule, then the eye drops are usually discontinued at that stage. A further postoperative appointment is usually made for six to eight weeks later, by which time the eye will have stabilized.

After surgery for strabismus, the patient usually needs corrective lenses and eye exercises (vision therapy) if binocular vision is to develop.

## Risks

As with any surgery, there are risks involved. Eye muscle surgery is relatively safe, but very rarely a cut muscle cannot be retrieved. This, and other serious reactions, including those caused by anesthetics, can result in vision loss in the affected eye. Occasionally, retinal or nerve damage occurs. Permanent double vision is also a risk of eye muscle surgery. The success rate of this surgery varies from person to person and depends on each person's particular condition.

Some infrequent complications include, but are not limited to, allergy to the sutures, bleeding, and change in pupil size.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Eye muscle surgery is performed by surgeons with specialized training in eye surgery. These physicians are usually board-certified ophthalmologists and fellowship-trained pediatric and/or adult strabismus specialists.

The surgery is almost always performed as outpatient surgery; that is, the patient comes into the hospital or day surgery facility the morning of the surgery and goes home the same day.

The major risk of eye muscle surgery is failure to achieve a satisfactory alignment of the eyes. This may be an under-correction or an over-correction, with the eyes turning the other way after the operation. Surgeons aim to achieve perfect alignment, but this is not always possible. If the alignment is still unsatisfactory at the final postoperative visit, then a second operation may be required.

Infection is an unusual postoperative complication and can be treated with antibiotic drops.

Because an incision is made through the conjunctiva and muscle, there is always some residual scarring. Usually, this is detectable only under a microscope, although it may be possible to see it on close examination.

As with any eye surgery, there is a potential risk of visual loss from strabismus operations, but this is a very rare complication.

## Normal results

Normal results of eye muscle surgery are an improved alignment of the eyes and improved cosmetic appearance without complications. The surgery usually has a very good outcome.

## Morbidity and mortality rates

Cosmetic improvement is likely with success rate estimates varying from about 65–85%. According to the latest statistics from 1998, binocular vision is improved in young children about 35% of the time following eye muscle surgery. Between 15% and 35% of patients have either no improvement or a worsening of their condition. A second operation may rectify less-than-perfect outcomes.

## QUESTIONS TO ASK THE DOCTOR

- What is the chance of needing a second operation?
- What are the possible risks and complications?
- Will I need eyeglasses?
- How much eye muscle surgery do you perform each year?
- Are there alternatives to surgery?
- Is a patch worn after surgery?
- Are there any scars after surgery?

### Alternatives

Surgery is not the only treatment to correct eye muscle disorders. Options and outcomes vary considerably based on several factors such as the presence of double vision. Nonsurgical treatment is also available, such as orthoptics and vision therapy.

#### Orthoptics

Orthoptics is a medical term for the eye muscle training programs provided by orthoptists and optometrists. Vision therapy programs include orthoptics, but there are broad differences between vision therapy and orthoptics. Orthoptics dates back to the 1850s and is limited in scope to eye muscle training and the cosmetic straightening of eyes. Orthoptics treat muscle problems by considering only strength; it does not focus on neurological and visual-motor factors as vision therapy does. Treatment is home based.

#### Vision therapy

Vision therapy is an individualized, supervised, non-surgical treatment program designed to correct eye movements and visual-motor deficiencies. Vision therapy sessions include procedures designed to enhance the brain's ability to control:

- eye alignment
- eye teaming
- eye focusing abilities
- eye movements
- visual processing

Visual-motor skills and endurance may be developed through the use of specialized computer and optical devices, including therapeutic lenses, prisms, and filters. During the final stages of therapy, the patient's newly acquired visual skills are reinforced and made automatic through repetition and by integration with motor and cognitive skills.

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Eye surgery see **Ophthalmologic surgery**  
 Eyeball removal see **Enucleation, eye**  
 Eyelid plastic surgery see **Blepharoplasty**  
 Eyelid surgery see **Tarsorrhaphy**

# F

## Face lift

### Definition

Face lift surgery is a cosmetic procedure that involves removing sagging skin and tightening muscle tissue of the face and neck to counter signs of aging. The procedure is also called facialplasty, rhytidoplasty, and cervicofacial rhytidectomy.

### Purpose

The purpose of face lift surgery is to improve the appearance of the face by repositioning the skin and tightening some of the underlying muscle and tissue. The procedure is designed to counter sagging and looseness in skin and muscle tissue that becomes more pronounced as individuals age. Face lift surgery will not eliminate all facial wrinkles. For example, wrinkles around the mouth and eyes may benefit little from face lift surgery. Also, additional procedures including **blepharoplasty**, chemical peel, botox injections, or **dermabrasion** may be necessary to achieve desired results.

### Demographics

The American Society for Aesthetic Plastic Surgery estimated that nearly 6.9 million cosmetic surgical and nonsurgical procedures were performed in the United States in 2002. The number of face lift procedures increased by 6% from the previous year (2001). Among members of the American Academy of Cosmetic Surgery, 15,478 face lift procedures were performed. The average fee for a face lift in 2002 was \$7,000. The American Society of Plastic Surgeons reported that a total of 1,852,012 cosmetic procedures and 9,138,275 nonsurgical procedures were performed in the United States in 2006, totaling almost 11 million procedures. Of that number, 104,055 were face lift procedures.

### Description

A face lift takes about two hours and may be performed as an outpatient procedure or it may require hospitalization. General or local anesthetics will be used to sedate the patient. Typically, patients receiving **local anesthesia** will augment it with “twilight anesthesia,” an intravenous sedative that helps to lower their awareness of the procedure being performed. An anesthesiologist will be present to administer the anesthetics and assist in monitoring and maintaining the patient’s vital life functions.

The surgeon makes an incision within the hairline just above the ear. The incision continues down along the front edge of the ear, around the earlobe, and then up and behind the ear extending back into the hairline. The location of this incision is designed to hide any sign of the procedure later. The same procedure is repeated on the other side of the face. The surgeon separates the skin of the face from its underlying tissue, moving down to the cheek and into the neck area and below the chin. Fat deposits over the cheeks and in the neck may be removed surgically or with **liposuction** at this time. The surgeon tightens certain bands of muscle and tissue that extend up from the shoulder, below the chin, and up and behind the neck. If these muscles and tissue are not tightened, the looseness and sagging appearance of the skin will return. The surgeon trims excess skin from the edges of the original incision and the skin is pulled back into place. The incision is closed with sutures or **staples**.

### Diagnosis/Preparation

Prior to the procedure, candidates meet with the surgeon to discuss the procedure, clarify the results that can be achieved, and the potential problems that can occur. Having realistic expectations is important in any cosmetic procedure. People will learn, for example, that although a face lift can improve the contour of the face and neck, other procedures will be necessary to reduce



## KEY TERMS

**Hematoma**—A complication of surgery in which a collection of blood forms below the skin.

**Rhytidectomy**—Wrinkle excision. It is an older, alternative term for a face lift.

**Twilight anesthesia**—An intravenous mixture of sedatives and other medications that decreases one's awareness of the procedure being performed.

the appearance of many wrinkles. Candidates will be advised to stop taking **aspirin**, birth control pills or female hormones, and other medications affecting blood clotting two weeks before the procedure. Some physicians prescribe vitamin C and K to promote healing. Candidates are advised to stop smoking and to avoid exposure to passive smoke at least two weeks before and after the procedure. Some surgeons also recommend taking **antibiotics** prior to surgery to limit the risk of infection. Often a steroid injection is administered before or after the procedure to reduce swelling.

### Aftercare

A pressure bandage is applied to the face to reduce the risk of hematoma, which is a pocket of blood below the skin. The person may spend a few hours resting in a **recovery room** to ensure that no bleeding has occurred. The individual then returns home. Some surgeons recommend that people stay in a reclining position for the 24 hours immediately following surgery, consuming a liquid diet, and avoiding flexing or bending the neck. Ice packs for the first few days can help to reduce swelling and lower the risk of hematoma. Individuals continue taking antibiotics until the first **stitches** come out about five days after the procedure. The remaining sutures are removed seven to ten days later. Many people return to work and limited activities within two weeks of the procedure.

### Risks

Candidates with other medical conditions should consult with their primary care physician before undergoing a face lift. Lung problems, heart disease, and certain other conditions can lead to a higher risk of complications. Persons who use medications that affect blood clotting (including female hormones, aspirin, and some non-aspirin pain relievers) should stop taking these medications prior to surgery to lower the risk that a hematoma will form. A hematoma is the most frequent complication of face lifts. Most hematomas

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Face lifts are performed by surgeons with specialized training in plastic and reconstructive surgery. They are most commonly performed in outpatient facilities or in private professional offices. The procedure may also be performed in a hospital.

form within 48 hours of surgery. The typical sign is pain or swelling affecting one side of the face but not the other.

Another risk is nerve damage. Sometimes it can affect a person's ability to raise an eyebrow, or distort the smile, or result in limited sensation in the earlobe; however, most of these nerve injuries repair themselves within two to six months.

### Normal results

Some swelling and bruising is normal following a face lift. There should be a noticeable improvement in the contour of the face and neck. Some fine wrinkling of the skin may be improved, but deep wrinkles are likely to require another cosmetic procedure to improve their appearance.

### Morbidity and mortality rates

In general, mortality and morbidity rates for face lifts and similar facial cosmetic procedures are very low. Almost all cases of mortality following facial **cosmetic surgery** involve patients who were treated for facial disfigurement because they had been severely burned or attacked by animals. Moreover, many plastic surgeons do not consider morbidity and mortality rates to be as significant as other factors in evaluating the success of facial cosmetic procedures. One group of researchers at the University of Washington maintains that "[t]he most important measures of outcome in facial cosmetic surgery are quality of life and patient satisfaction, in contrast to other, more objective measures such as complications or mortality rates."

### Alternatives

Isometric exercises are recommended as non-surgical alternatives to face lift procedures.

Injections of Botox (botulinum toxin) have been used to achieve the same results as a face lift. Botulinum toxin is a compound produced by the spores and

## QUESTIONS TO ASK THE DOCTOR

- How will I be evaluated as a potential candidate for a facelift?
- What will I look like after the surgery?
- When will I be able to resume normal activities after my procedure?
- Will my incisions be noticeable and how long will they take to heal?
- Is the surgeon board certified in plastic and reconstructive surgery?
- How many face lifts has the surgeon performed?
- May I see some before and after photos of the surgeon's facelift procedures?
- What is the surgeon's complication rate?

growing cells of the organism that causes botulism, *Clostridium botulinum*. The toxin causes muscle paralysis. It was first used clinically in the 1960s to treat neurological disorders but also proved to be effective in paralyzing the facial muscles that cause crow's feet and frown wrinkles. Botulinum toxin, or Botox, was approved by the U.S. Food and Drug Administration (FDA) in April 2002 as a treatment for facial lines and wrinkles. Botox treatments must be repeated in approximately six months.

Coherent ultrapulse carbon dioxide laser treatment is a promising new treatment alternative to traditional face lift procedures. As of 2003, this equipment has been used by a few major institutions.

Some plastic surgeons have used a procedure called fat rebalancing to achieve outcomes similar to a traditional face lift procedure. Fat rebalancing involves relocation of fatty tissue from distant sites on the body to the face.

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- American Academy of Facial Plastic and Reconstructive Surgery, 310 S. Henry Street, Alexandria, VA, 22314, (703) 229 9291, <http://www.aafprs.org/>.
- American Board of Plastic Surgery, Seven Penn Center, Suite 400 1635 Market Street, Philadelphia, PA, 19103 2204, (215) 587 9322, <http://www.abplsurg.org/>.
- American College of Surgeons, 633 North Saint Claire Street, Chicago, IL, 60611, (312) 202 5000, <http://www.facs.org/>.
- American Society for Aesthetic Plastic Surgery, 11081 Winners Circle, Los Alamitos, CA, 90720, (888) 272 7711, <http://www.surgery.org/>.
- American Society for Dermatologic Surgery, 5550 Meadowbrook Drive, Suite 120, Rolling Meadows, IL, 60008, (847) 956 0900, <http://www.asds.net>.
- American Society of Plastic and Reconstructive Surgeons, 444 E. Algonquin Road, Arlington Heights, IL, 60005, (847) 228 9900, <http://www.plasticsurgery.org>.

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## Fallopian tube implants

### Definition

In the female reproductive tract there are two ovaries and two fallopian tubes. The fallopian tube is the path through which the egg passes after ovulation and potentially on the way to fertilization. If the fallopian tube is blocked, then the egg cannot pass through to become fertilized. One method of contraception is the

use of fallopian tube implants. These are tiny metal springs that are placed in each fallopian tube. Scar tissue forms around these springs and blocks the transport of the egg through the fallopian tube.

### Purpose

The purpose of fallopian tube implants is to create a permanent method of contraception. Many women who choose tubal implants for permanent contraception do so because they do not desire the side effects or risks of other methods of birth control.

### Precautions

After tubal implant surgery another method of birth control needs to be used until it is confirmed that the fallopian tubes are in fact blocked, which is usually confirmed approximately three months after the fallopian tube implants are inserted.

### Description

Fallopian tube implants are inserted without surgery. The procedure is done on an outpatient basis and does not usually take more than 30-60 minutes. During the procedure, the woman is placed in the same position as during a yearly pelvic exam. On occasion a physician may insert laminaria into the cervix several hours prior to the procedure, to gradually open the cervix. Laminaria are small sticks of dehydrated seaweed that slowly absorb moisture and gradually expand to open the cervix. If laminaria is not used prior to the procedure, then during the procedure, instruments are used to gradually open the cervix. A catheter is placed through the cervical opening and into the fallopian tube where the small metal spring is placed. This is repeated for the other fallopian tube. After the procedure an x ray is performed to make sure that both implants are properly placed.

### Preparation

No special preparation for the procedure is needed. It is important, however, to make certain that the decision to have fallopian tube implants has been thoroughly discussed because this method of contraception is permanent.

### Aftercare

After the procedure menstrual-like cramping may occur. As stated above, an x ray is performed after the procedure to make sure that the implants are properly placed. Approximately three months after the procedure, a follow-up visit should be planned. During this follow-up visit, a hysterosalpingogram will be performed. For a hysterosalpingogram, dye is injected into the uterus as the physician watches on the x ray

to see if the dye is able to flow through the fallopian tubes. If the fallopian tube implants work, then the dye will be stopped in each fallopian tube, showing that the tubes have been blocked. On occasion, fallopian tube implants may be difficult to insert, or the hysterosalpingogram shows that the implant did not block the fallopian tube, in which case, the fallopian tube implant procedure would need to be repeated. Until it is verified that the fallopian tubes are blocked, another method of birth control needs to be used.

### Risks

Fallopian tube implants are a new method of birth control that became available in 2002, therefore, there are no long-term statistics available on how effective they are at preventing pregnancy. Other methods of tubal contraception are not 100% effective at preventing pregnancy. There has been one reported confirmation of a pregnancy after a tubal implant and after confirmation by hysterosalpingogram that the fallopian tube were blocked. If a tubal implant fails, there is an increased risk for ectopic pregnancy. An ectopic pregnancy occurs when the fertilized egg implants in the fallopian tube or in a place other than the uterus. Fallopian tube implants do not affect the menstrual cycle, and therefore, if a woman misses her menstrual period, or has other symptoms of pregnancy, she should contact her physician immediately.

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Our Bodies Ourselves Health Resource Center, 34 Plympton Street, Boston, MA 02118. (617) 451-3666. <http://www.ourbodiesourselves.org/>.

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Fallopian tube ligation see **Tubal ligation**

Fallopian tube removal see **Salpingostomy**

## Fasciotomy

### Definition

Fasciotomy is a surgical procedure that cuts away the fascia to relieve tension or pressure.

### Purpose

Fascia is thin connective tissue covering, or separating, the muscles and internal organs of the body. It varies in thickness, density, elasticity, and composition, and is different from ligaments and tendons.

The fascia can be injured either through constant strain or through trauma. Fasciitis is an inflammation of the fascia. The most common condition for which fasciotomy is performed is plantar fasciitis, an inflammation of the fascia on the bottom of the foot that is sometimes called a heel spur or stone bruise.

Plantar fasciitis is caused by long periods on one's feet, being overweight, or wearing shoes that do not support the foot well. Teachers, mail carriers, runners, and others who make heavy use of their feet are especially likely to suffer from plantar fasciitis.

Plantar fasciitis results in moderate to disabling heel pain. If nine to 12 months of conservative treatment (reducing time on feet, **nonsteroidal anti-inflammatory drugs**, arch supports) under the supervision of a doctor does not result in pain relief, a fasciotomy may be performed. Fasciotomy removes a small portion of the fascia to relieve tension and pain. Connective tissue grows back into the space left by the incision, effectively lengthening the fascia.

When a fasciotomy is performed on other parts of the body, the usual goal is to relieve pressure from a compression injury to a limb. This type of injury often occurs during contact sports or after a snake bite. Blood vessels of the limb are damaged. They swell and leak, causing inflammation. Fluid builds up in the area contained by the fascia. A fasciotomy is performed to relieve this pressure and prevent tissue **death**. Similar injury occurs in high voltage electrical burns but cause deep tissue damage.

### Demographics

People who are likely to need a fasciotomy include the following:

- athletes who have sustained one or more serious impact injuries;
- people who spend long periods of time on their feet;
- people with severe burns;

## KEY TERMS

**Endoscope**—A tube that contains a tiny camera and light, that is inserted in the body to allow a doctor to see inside without making a large incision.

**Fascia**—Thin connective tissue covering or separating internal organs of the body; it is different from ligaments and tendons.

**Plantar fasciitis**—An inflammation of the fascia on the bottom of the foot.

- persons who are overweight; and
- snakebite victims.

There is a slight male predominance among people undergoing a fasciotomy.

### Description

Fasciotomy in the limbs is usually performed by a surgeon under general or regional anesthesia. An incision is made in the skin, and a small area of fascia is removed where it will best relieve pressure. Then the incision is closed.

Plantar fasciotomy is an endoscopic (performed with the use of an endoscope) procedure. The doctor makes two small incisions on either side of the heel. An endoscope is inserted in one incision to guide the doctor. A tiny knife is inserted in the other. A portion of the fascia near the heel is removed. The incisions are then closed.

### Diagnosis/Preparation

In the case of injury, fasciotomy is performed on an emergency basis, and the outcome of the surgery depends largely on the general health of the injured person. Plantar fasciotomies are appropriate for most people whose foot problems cannot be resolved in any other way.

Little preparation is needed before a fasciotomy. When the fasciotomy is related to burn injuries, the fluid and electrolyte status of the affected person are constantly monitored.

### Aftercare

Aftercare depends on the reason for the fasciotomy. People who have endoscopic plantar fasciotomy can walk without pain almost immediately, return to wearing their regular shoes within three to five days,



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Fasciotomy in a limb is usually performed by a general surgeon. The typical location is an outpatient facility using regional anesthesia. For persons with burns or others who require extensive fasciotomy, the procedure is performed in a hospital operating room under general anesthesia.

Plantar fasciotomy is performed by a foot specialist in a professional office or outpatient surgical clinic under local anesthesia. The procedure requires 20 minutes to one hour.

and return to normal activities within three weeks. Most will need to wear arch supports in their shoes.

Persons who require fasciotomy as a result of an injury or snake bite are usually able to resume their normal activities in a few weeks.

### Risks

The greatest risk with endoscopic plantar fasciotomy is that the arch will drop slightly as a result of this surgery, causing other foot problems. Risks involved with other types of fasciotomy are those associated with the administration of anesthesia and the development of blood clots or postsurgical infections.

### Normal results

Fasciotomy in the limbs reduces pressure, thus reducing tissue death. Endoscopic plantar fasciotomy has a success rate in excess of 95%.

### Morbidity and mortality rates

The most common morbidity in a fasciotomy is an incomplete response that requires a repeat fasciotomy procedure. Mortality is very rare and usually due to a problem related to the original condition.

### Alternatives

Conservative, non-operative treatment for plantar fasciitis consists of nonsteroidal anti-inflammatory drugs for several weeks. For persons who spend excessive time on their feet, a change of occupation or the use of arch supports may be useful. Overweight individuals may consider weight reduction to reduce the stress placed on their feet. For persons bitten by a

## QUESTIONS TO ASK THE DOCTOR

- Is the surgeon board certified in general or podiatric surgery?
- How many fasciotomy procedures has the surgeon performed?
- What is the surgeon's complication rate?

poisonous snake, there are no acceptable alternatives to a fasciotomy, and there are rarely acceptable alternatives to fasciotomy for a person who has been burned.

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## ORGANIZATIONS

American Academy of Orthopaedic Surgeons, 6300 N. River Road, Rosemont, IL, 60018 4262, (847) 823 7186, (800) 346 AAOS, (847) 823 8125, <http://www.aaos.org>.

American College of Foot and Ankle Surgeons, 8725 West Higgins Road, Suite 555, Chicago, IL, 60631 2724, (773) 693 9300, (800) 421 2237, [info@acfas.org](mailto:info@acfas.org), <http://www.acfas.org/>.

American College of Surgeons, 633 North Saint Claire Street, Chicago, IL, 60611, (312) 202 5000, <http://www.facs.org/>.

American Orthopaedic Foot and Ankle Society, 6300 N. River Road, Suite 510, Rosemont, IL, 60018, (800) 235 4855, [aofas@aofas.org](mailto:aofas@aofas.org), <http://www.aofas.org>.

American Podiatric Medical Association, 9312 Old Georgetown Road, Bethesda, MD, 20814, (301) 581 9200, <http://www.apma.org>.

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## Femoral hernia repair

### Definition

A femoral hernia repair, or herniorrhaphy, is a surgical procedure performed to reposition tissue that has come out through a weak point in the abdominal wall near the groin. In general, a hernia is a protrusion of a loop or piece of tissue through a weak spot or opening in the abdominal wall. There are several different kinds of hernias; they are named according to their location. A femoral hernia is one that occurs in a person's groin near the thigh. In a child, a femoral hernia is usually the result of incomplete closing of this area during development in the womb.

### Purpose

Femoral hernia repair is done to reduce the patient's risk of a future surgical emergency. A hernia may be congenital (present at birth) or may develop later in life because of a weakness in the abdominal wall. If the opening is very small, the amount of tissue that can push through it is small, and the person may barely be aware of the problem. One complication that may arise, however, is that the tissue that comes out through the opening can become incarcerated, or trapped. If the herniated tissue has its blood supply diminished because of pressure from other nearby organs or structures, it is referred to as strangulated. Strangulation may lead to gangrene, which means that the affected tissue can die and be invaded by bacteria.

Femoral hernias are more likely than other hernias to become incarcerated or strangulated because the affected tissue pushes through a relatively small and closely confined space. Because of the increased risk of eventual strangulation and gangrene, the patient's doctor may recommend surgical repair of the hernia.

### Demographics

Femoral hernias are a relatively uncommon type, accounting for only 3% of all hernias. While femoral hernias can occur in both males and females, almost all of them develop in women because of the wider bone structure of the female pelvis. Femoral hernias usually grow larger over time; any activity that involves straining, such as heavy lifting or a chronic cough, may cause the hernia to enlarge. Poor abdominal muscle tone, obesity, and pregnancy also increase a woman's risk of developing a femoral hernia. Most femoral hernias develop on only one side of the patient's abdomen, but about 15% of femoral hernias are bilateral. These bilateral hernias are more likely to become strangulated. An additional 20% of femoral hernias become incarcerated.

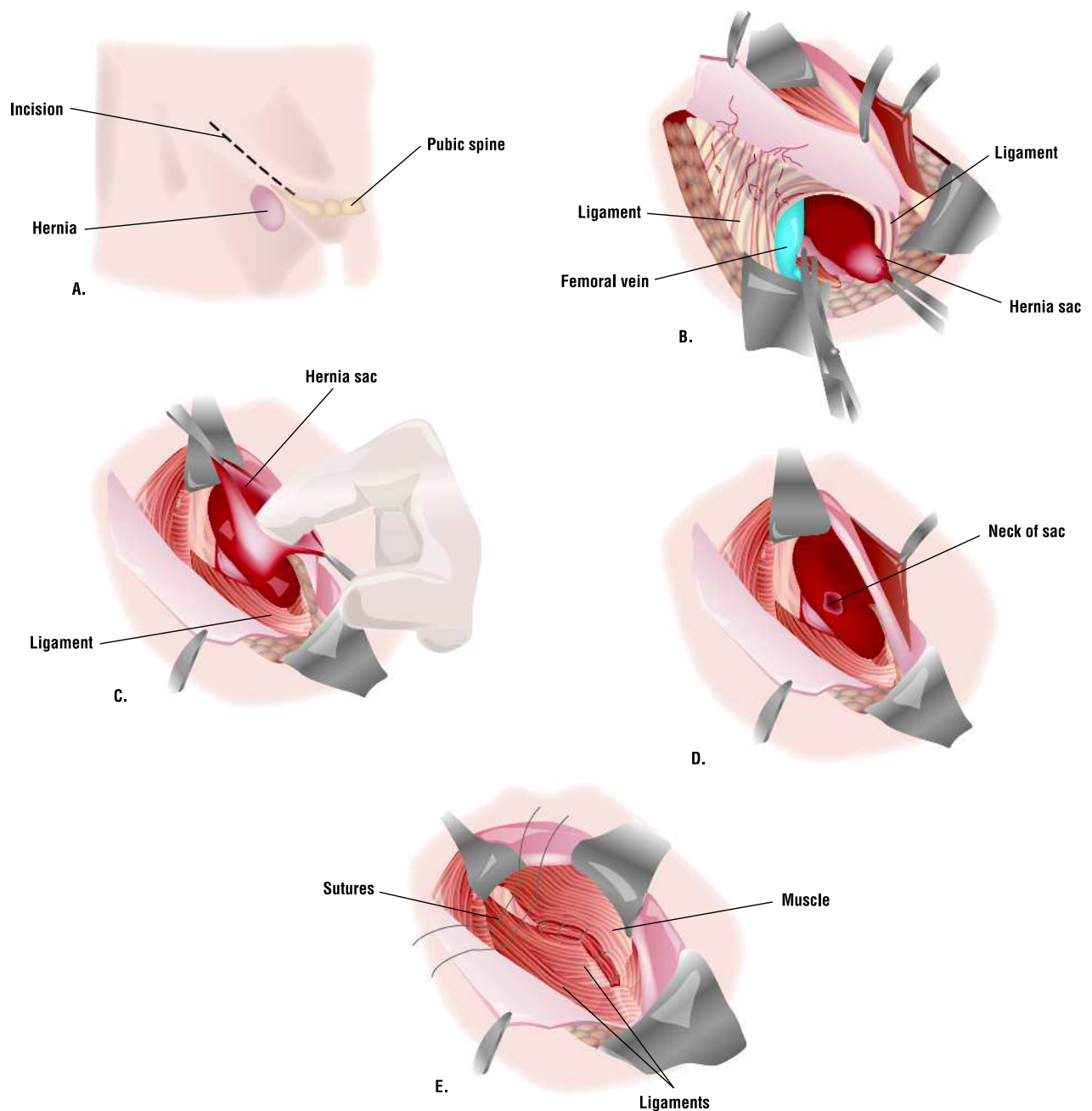
Femoral hernias are more common in adults than in children. Those that do occur in children are more likely to be associated with a connective tissue disorder or with conditions that increase intra-abdominal pressure. Seventy percent of pediatric cases of femoral hernias occur in infants under the age of one.

### Description

Femoral hernia repair may be performed under either general or **local anesthesia**. The repair of the hernia involves a cut, or incision, in the groin area (near the thigh, adjacent to the femoral artery). The surgeon locates the hernia, and reduces it by pushing the protruding tissue back inside the abdominal cavity. A hernia is referred to as reducible when the tissue that has come out through the opening can be pushed back and the opening closed. If incarceration or strangulation has occurred, the hernia is referred to as irreducible.

The procedure may be performed using the traditional open method, which requires a larger surgical incision, or by a laparoscopic approach. A laparoscopic procedure is performed through a few very small incisions. The hole in the abdominal wall may be closed with sutures, or by the use of a fine sterile **surgical mesh**. The mesh, which provides additional strength, is sewn into the abdominal wall with very small **stitches**. Some surgeons may choose to use the

### Femoral hernia repair



To repair a femoral hernia, an incision is made in the groin area near the hernia (A). Skin and ligaments are pulled aside to expose the hernia (B). The hernia sac is opened, and the contents are pushed back into the abdominal cavity (C). The neck of the sac is tied off, and excess tissue is removed (D). Layers of skin and tissues are repaired (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

mesh when repairing a larger hernia. A hernia repair done with a mesh insert is called a tension-free procedure because the surgeon does not have to put tension

on the layer of muscle tissue in order to bring the edges of the hole together. A laparoscopic hernia repair takes about 40 minutes to complete.

## KEY TERMS

**Bilateral**—Occurring on both the right and left sides of the body.

**Femoral**—Pertaining to the thigh region.

**Gangrene**—The death of a considerable mass of tissue, usually associated with loss of blood supply and followed by bacterial infection.

**Hernia**—The protrusion of a loop or piece of tissue through an incision or abnormal opening in other tissues. A femoral hernia is one that develops near the upper thigh in the groin area.

**Herniorrhaphy**—The medical term for a hernia repair.

**Incarceration**—The abnormal confinement of a section of the intestine or other body tissues. A femoral hernia may lead to incarceration of part of the intestine.

**Intra-abdominal pressure**—Pressure that occurs within the abdominal cavity. Pressure in this area builds up with coughing, crying, and the pressure exerted when bearing down with a bowel movement.

**Reduction**—The correction of a hernia, fracture, or dislocation.

**Strangulation**—A condition in which a vessel, section of the intestine, or other body part is compressed or constricted to the point that blood cannot circulate.

## Diagnosis/Preparation

### Diagnosis

A femoral hernia is usually diagnosed during a **physical examination**. In many cases, the patient will consult the doctor because of pain in the groin area or the inside of the upper thigh. The pain or discomfort of a femoral hernia may come and go, increasing when the person coughs or strains. If the pain is severe, the patient may go to an emergency room. In young children, symptoms of an incarcerated femoral hernia include severe irritability, abdominal pain, cramping, and vomiting. Adult patients may have also felt a mass in the groin that may be tender when it is pressed. Patients in severe pain may be given a sedative or pain-killing medication so that the doctor can examine the groin area and try to guide the herniated tissues back through the abdominal opening with gentle manual pressure.

In adult patients, the doctor will rule out the possibility that the pain is caused by an enlarged lymph node, a lipoma, or an inguinal hernia. Imaging studies are not generally used in diagnosing a hernia unless the doctor suspects that the hernia is incarcerated or strangulated. A strangulated hernia can be distinguished from an incarcerated hernia by the presence of fever, pain that persists after the doctor has reduced the hernia manually, and pain that is more severe than warranted by the examination findings.

### Preparation

If the doctor suspects that the hernia is strangulated, he or she will give the patient a broad-spectrum antibiotic (usually cefoxitin) intravenously before the patient is taken to the **operating room**.

Adults scheduled for a nonemergency herniorrhaphy are given standard blood tests and a **urinalysis**. They should not eat breakfast on the morning of the procedure, and they should wear loose-fitting, comfortable clothing that they can easily pull on after the surgery without straining their abdomen.

### Aftercare

Aftercare depends on several factors: the patient's age and general health status; the type of surgery (open or laparoscopic); and the type of anesthesia administered. Immediately after the procedure, the patient will be taken to the recovery area of the surgical center and monitored for signs of excessive bleeding, infection, uncontrolled pain, or shock. An uncomplicated femoral hernia repair is usually performed on an outpatient basis, which allows the patient to go home within a few hours of the surgery.

The patient will be given instructions about **incision care**, which will depend on the type of surgery and the way in which the incision was closed. Sometimes a transparent dressing is placed on the wound that the patient can remove about three days after the procedure. Very small incisions, such as those used for laparoscopic surgery, may be closed with Steri-strips® instead of sutures. The incision should be kept dry, so patients should take a sponge bath rather than a shower or tub bath for several days after surgery.

Adults should avoid heavy lifting for several weeks after a hernia repair. The surgeon can give the patient advice about specific weight limits on lifting. Contact sports and vigorous **exercise** should be avoided for about three weeks after a femoral hernia repair. Many patients will be able to return to most of their daily activities in a few days, with complete



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

This procedure is performed by a general surgeon. As with any procedure, the more experience the surgeon has with the particular surgery being performed, the better the expected outcome. A femoral hernia repair is usually performed on an outpatient, or ambulatory, basis in a hospital. After a few hours of recovery in the surgical center, the patient is able to return home.

recovery taking about a month in patients without other medical conditions.

### Risks

All surgical procedures have associated risks, both surgical and anesthesia-related. Bleeding and infection are the two primary surgical risks. The risk of infection for an uncomplicated femoral hernia repair is about 1%. Anesthesia-related risks include reactions to the anesthetic agents, including interactions with over-the-counter and herbal preparations, as well as potential respiratory problems. There is a small risk of recurrence of a femoral hernia. In addition, female patients are at some risk of injury to the nerves and blood supply of their reproductive organs, because femoral hernias develop in a part of the abdominal wall that is close to the uterus and ovaries.

### Normal results

Normal results with timely diagnosis and repair of a femoral hernia are a smooth recovery with no recurrence of the hernia.

### Morbidity and mortality rates

The mortality rate following an uncomplicated femoral hernia repair is essentially zero. The mortality rate for repair of a strangulated hernia that has necessitated a **bowel resection** is higher, however, ranging from 5–19%. Morbidity following an uncomplicated herniorrhaphy is low; one Danish study reported that the most common complication, reported by 8% of patients, was pain during procedures performed under local anesthesia. A British study of laparoscopic hernia repairs found that only 22 out of 3017 patients reported recurrence of the hernia. The incidence of postoperative swelling and bruising was 8%.

## QUESTIONS TO ASK THE DOCTOR

- How many femoral hernia repairs have you performed?
- Am I a candidate for laparoscopic surgery?
- How many femoral hernia repairs have you performed with a laparoscope?
- What kinds of complications have your patients experienced?
- How long is my recovery likely to take?
- What limitations will there be on my daily activities, such as returning to work, driving, or lifting a toddler?

### Alternatives

There are no medical or surgical alternatives to a femoral hernia repair other than watchful waiting. There is some risk that the hernia will enlarge, however, which increases the risk of incarceration or strangulation. Moreover, the complications and risks of surgery increase with incarcerated or strangulated hernias. Once a hernia is suspected or diagnosed, it should be evaluated by a surgeon within a month to lower the risk of complications.

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American Academy of Family Physicians. 11400 Tomahawk Creek Parkway, Leawood, KS 66211 2672. (913) 906 6000. E mail: fp@aafp.org. www.aafp.org.

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American College of Surgeons. 633 North St. Clair Street, Chicago, IL 60611 3231. (312) 202 5000. Fax: (312) 202 5001. www.facs.org.

**OTHER**

Hernia Resource Center. www.herniainfo.com.

National Library of Medicine. www.nlm.nih.gov.

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Femoropopliteal bypass see **Peripheral vascular bypass surgery**

Fetal lung maturity test see **Lipid tests**

## Fetal surgery

### Definition

Fetal surgery allows doctors to treat certain abnormalities of the fetus that might otherwise be fatal or cause significant problems if permitted to progress.

### Purpose

Approximately 3% of babies born in the United States each year have a complex birth defect. Parents are often left with the options of choosing to abort the fetus or treat the condition after birth. Certain birth defects, however, are complicated by the labor and delivery process; others may progress quickly after birth to cause significant disability or **death**. Fetal surgical techniques offer early intervention in order to treat such defects before they become more serious. The first open fetal surgery took place at the University of California at San Francisco (UCSF) in 1981.

Some of the fetal abnormalities that may be treated by fetal surgery are:

- **Myelomeningocele.** Also called spina bifida, myelomeningocele is a condition in which the spine fails to close properly during early fetal development. The spinal cord may protrude or be exposed through an opening in the lower back. Paralysis, neurological problems, bowel and bladder problems, and hydrocephalus (fluid buildup in the brain) may result.

Myelomeningocele affects one out of every 1,000 babies born in the United States.

- **Congenital diaphragmatic hernia (CDH).** In babies with CDH, the diaphragm (the thin muscle that separates the chest from the abdomen) doesn't develop properly. The abdominal organs may enter the chest cavity through a hole (hernia) and cause pulmonary hyperplasia (underdeveloped lungs). CDH occurs in about one out of every 2,000 births.
- **Urinary tract obstruction.** The urethra (the tube that carries urine from the bladder to the outside of the body) may become obstructed *in utero* or fail to develop normally. When this happens, urine can back up into the kidneys and destroy tissue or cause the bladder to become enlarged. The amount of amniotic fluid also decreases because fetal urine is its major component. Pulmonary hypoplasia usually results because the lungs rely on amniotic fluid in their development.
- **Congenital cystic adenomatoid malformation of the lung (CCAM).** CCAM is a large mass of malformed lung tissue that does not function properly. As a result of its large size, it may put pressure on the heart and lead to heart failure. Lung development is also affected, and pulmonary hyperplasia may result.
- **Twin/twin transfusion syndrome (TTTS).** In some twin pregnancies, the two fetuses will share a placenta. TTTS occurs in approximately 15% of these twins when blood volume between the fetuses is unequal, causing abnormally low blood volume in the donor twin and abnormally high blood volume in the "recipient" twin. There is often a large difference in size between the twins. Approximately 70–80% of fetuses suffering from TTTS will die without intervention.
- **Sacroccygeal teratoma (SCT).** This usually benign fetal tumor develops at the base of the spine (coccyx) and affects approximately one in 35,000 to 40,000 newborns in the United States. The tumor may become very large (sometimes as large as the fetus) and filled with blood vessels, causing stress on the heart.

### Description

What fetal surgical technique is used depends on the specific condition of the fetus and its severity. The fetoscopic temporary tracheal occlusion procedure is used to treat CDH. The trachea is temporarily blocked (occluded) by a small balloon to trap fluid in the lungs (that normally escapes into the amniotic fluid); buildup of the fluid enlarges the lungs and stimulates their growth, pushing any abdominal organs that have moved into the chest cavity back into the abdomen. The occlusion is removed immediately after birth of

## KEY TERMS

**Cesarean section**—A surgical procedure in which incisions are made through a woman's abdomen and uterus to deliver her baby.

**Hernia**—The protrusion of an organ or other structure through an opening in the wall that normally contains it.

**Hydrocephalus**—The buildup of cerebrospinal fluid in the brain.

**Hysterotomy**—Surgical incision of the uterus.

**Oligohydramnios**—Low levels of amniotic fluid during pregnancy.

**Placenta**—The organ that develops along with the fetus to connect the fetus to the mother.

**Pulmonary hyperplasia**—Underdeveloped lungs.

**Tocolytics**—Drugs administered to stop or delay the onset of labor.

the baby. The procedure is performed endoscopically. Rather than make a large incision into the abdomen and uterus, the surgeon inserts telescopic instruments through a tiny 1 in (2.5 cm) incision and uses them to perform the surgery. Other conditions that are treated with fetoscopic surgery are TTTS (to remove abnormal connections between blood vessels with a laser) and urinary tract obstruction (to insert a wire mesh tube called a stent into the bladder to allow urine to exit the body).

Open fetal surgery is used for conditions that cannot be treated endoscopically. An incision is made through the abdomen and the uterus is partially removed from the body. Amniotic fluid is drained from the uterus and kept in a warmer for replacement after completion of the surgery. An incision is made in the uterus (called a hysterotomy). In order to minimize bleeding of the uterus, an instrument called a uterine stapler is used to make an incision while simultaneously placing **staples** around the perimeter of the incision to prevent bleeding. Surgery is then performed on the fetus through the opening in the uterus to locate the abnormality and remove or fix it. Open fetal surgery is used for CCAM (to remove the cystic mass), myelomeningocele (to close the exposed spine), and SCT (to remove the tumor). Because of the nature of open fetal surgery, delivery for this child and all subsequent children of the mother will have to be performed by **cesarean section**.

## Diagnosis/Preparation

Detection of many birth defects is possible through the use of sophisticated imaging and diagnostic techniques such as:

- **Ultrasound.** This imaging technique uses a machine that transmits high frequency sound waves to visualize structures in the human body, including the uterus and fetus. Ultrasound is used to determine the size, position, and age of the fetus; to measure the amount of amniotic fluid; and to assess the fetus for any congenital abnormalities.
- **Chorionic villus sampling (CVS).** Cells are collected from the placenta with a thin plastic tube inserted through the cervix (opening to the uterus) or a needle inserted through the abdomen. The cells may then be analyzed for possible genetic disorders.
- **Alpha-fetoprotein (AFP) testing.** AFP is a protein made by the developing fetus. Large amounts of AFP in the mother's bloodstream may indicate certain fetal abnormalities.
- **Amniocentesis.** A needle is inserted through the woman's abdomen and into the uterus to procure a sample of amniotic fluid. Fetal cells in the fluid are then analyzed for possible genetic disorders.

Once a congenital abnormality has been diagnosed, the condition will be assessed to determine if the fetus is eligible for fetal surgery. Generally only the most severe conditions that are certain to cause fetal death or significant disability are treated with fetal surgery. If fetal surgery is indicated, the parents will meet with the team of health care providers that will be involved in the surgery.

To prepare for the surgery, the steroid betamethasone will be given in order to speed up the development of the fetus's lungs. A complete history and **physical examination** will be performed. A monitor will be used to track uterine contractions and fetal heart rate. The patient will be instructed to refrain from eating and drinking after midnight the day of surgery, and will sign a surgical consent. Blood samples may be taken for laboratory tests and to type match the patient's blood in case a blood **transfusion** is necessary. An intravenous (IV) catheter will be used to infuse fluids and/or medications to the patient.

## Aftercare

Postoperative recovery generally takes from five to 10 days. The patient will be closely monitored to ensure that she does not go into premature labor. She may be put on bed rest to minimize this risk. Some signs of premature labor include contractions, cramping, lower back or abdominal pain or pressure, vaginal bleeding,

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Fetal surgery is a highly specialized procedure that is offered at only a handful of hospitals around the United States. Among those health care providers who will have a role in the surgery are:

- a perinatologist (a medical doctor specializing in the care and treatment of the fetus/infant during the time shortly before and after birth)
- a pediatric surgeon (a surgeon specializing in the treatment of children)
- a fetal treatment coordinator (a nurse who will coordinate the patient's care, including communication with the medical team and arranging various tests)
- a sonographer (a person who is trained to perform ultrasounds and interpret their results)
- an anesthesiologist (a medical doctor specializing in the science and application of techniques to decrease or eliminate pain)
- operating room nurses
- clinical nurses

and leaking of fluid from the vagina. Tocolytics are drugs given to delay or stop labor; some commonly administered tocolytics are terbutaline, indocin, and magnesium sulfate. **Antibiotics** will usually be administered to prevent postsurgical infection.

### Risks

Some risks associated with fetal surgery include infection of the incision or lining of the uterus, premature labor and delivery, bleeding, gestational diabetes, leakage of amniotic fluid, and infertility, as well as those complications associated with anesthesia.

### Normal results

The results of fetal surgery depend on the reason for the procedure. Successful results of fetal surgery generally include halting the progression of the congenital malformation and perhaps reversing some of the potential complications that would arise without intervention.

### Morbidity and mortality rates

One study of open fetal surgery used to repair myelomeningocele indicated that the risk of going

## QUESTIONS TO ASK THE DOCTOR

- Why is fetal surgery recommended in my case?
- What alternatives to fetal surgery are available to me?
- What are the costs associated with fetal surgery? Will my insurance cover the procedure?
- What will be the results if there is no medical intervention?
- Will my own obstetrician be able to care for me for the rest of my pregnancy or will I have to remain near the surgical center?

into premature labor was significantly increased among women who had had the procedure (50% compared to 9% of similar cases with no fetal surgery performed). There was also an increased risk of oligohydramnios or low amniotic fluid (48% compared to 4% of similar cases with no fetal surgery performed). Because of the high risk of premature labor associated with fetal surgery, some fetuses have died during premature birth.

### Alternatives

There are some alternative procedures that are offered for treating specific birth defects, depending on their severity. Fetal surgery is generally recommended only for the most severe defects. For example, myelomeningocele may be treated by closing of the lesion soon after delivery. SCTs and CCAMs may also be removed soon after the baby is born. Parents are often given the option of aborting the fetus (termed therapeutic abortion); or they may decide to refrain from medical intervention.

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Center for Fetal Diagnosis and Treatment, Children's Hospital of Philadelphia. 34th Street and Civic Center Boulevard, Philadelphia, PA 19104 4399. (800) IN UTERO. <http://fetalsurgery.chop.edu>.



Fetal Diagnosis & Therapy, Vanderbilt University Medical Center. B 1100 Medical Center North, Nashville, TN 37232. (615) 343 5227.

Fetal Treatment Center, University of California at San Francisco. 513 Parnassus Ave., HSW 1601, San Francisco, CA 94143 0570. (800) RX FETUS. <http://www.fetus.ucsf.edu>.

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## Fetoscopy

### Definition

Fetoscopy is a procedure to evaluate or treat the fetus during pregnancy.

### Purpose

There are two different types of fetoscopy: external and endoscopic.

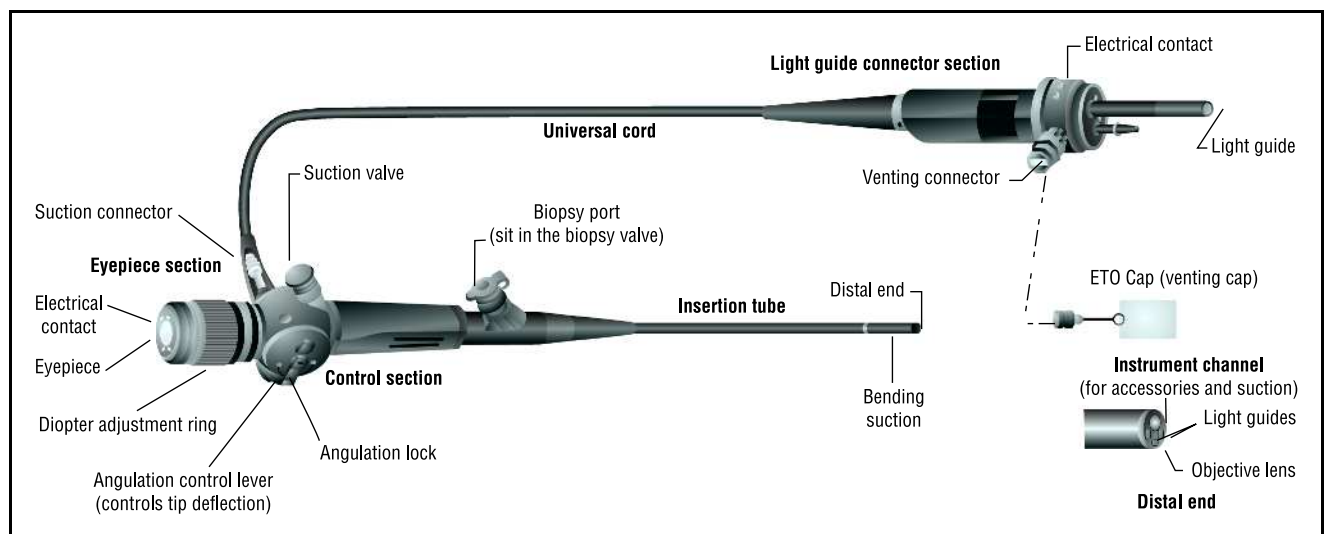
#### External fetoscopy

An external fetoscope resembles a **stethoscope**, but with a headpiece. It is used externally on the mother's abdomen to auscultate (listen to) the fetal heart sounds after about 18 weeks gestation (18 weeks gestation is the twentieth week of pregnancy). It also allows a birth attendant to monitor the fetus intermittently and ensure that the baby is tolerating labor without the mother having to be attached to a continuous fetal monitor.

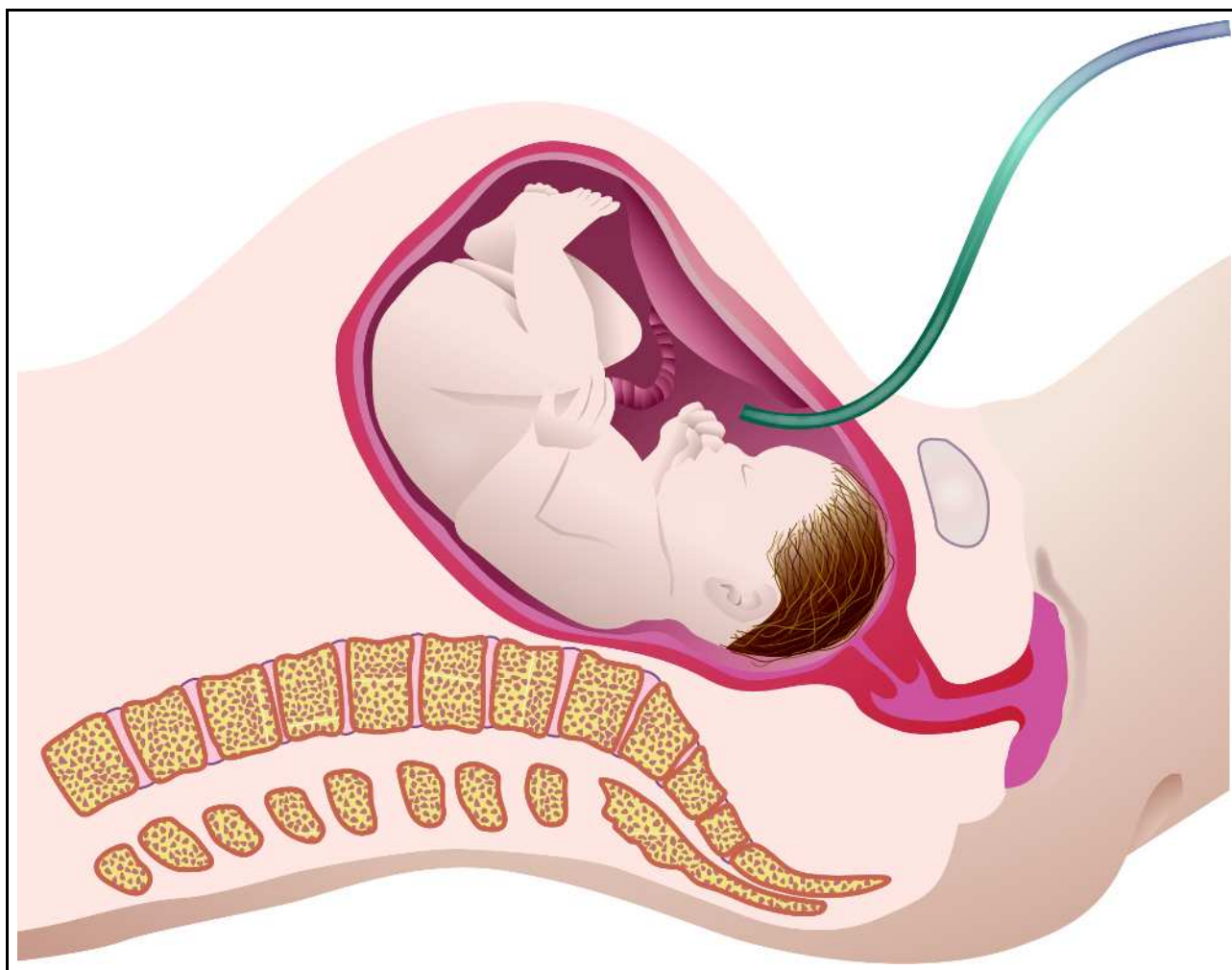
#### Endoscopic fetoscopy

The second type of fetoscope is a fiber-optic endoscope. An endoscope is a thin fiber-optic tube with a tiny camera and a surgical tool at the end. The fetoscope is inserted into the uterus either transabdominally (through the abdomen) or transcervically (through the cervix) to visualize the fetus, to obtain fetal tissue samples, or to perform **fetal surgery**.

Approximately 3% of babies born in the United States each year have a complex birth defect. The labor and delivery process complicate certain birth defects, while others may progress quickly after birth to cause significant disability or **death**. Fetal surgical techniques using the endoscopic fetoscope (sometimes called an operative fetoscopy) offer early intervention



A modern fetoscope, much like an endoscope, allows physicians to hear, see, and manipulate what is going on inside many parts of the body. (Illustration by GGS Information Services. Cengage Learning, Gale.)



**The insertion tube of a fetoscope inside the uterus.** (Illustration by GGS Information Services. Cengage Learning, Gale.)

in order to treat such defects before they are life-threatening.

Some of the fetal abnormalities that may be treated by endoscopic fetoscopy include:

- **Congenital diaphragmatic hernia (CDH).** In babies with CDH, the diaphragm (the thin muscle that separates the chest from the abdomen) does not develop properly. The abdominal organs may enter the chest cavity through a hole (hernia) and cause pulmonary hyperplasia (underdeveloped lungs). CDH occurs in about one out of every 2,000–3,000 births and accounts for about 8% of all major congenital defects.
- **Urinary tract obstruction.** The urethra (the tube that carries urine from the bladder to the outside of the body) may become blocked *in utero* or fail to develop normally. When this happens, urine can back up into the kidneys and destroy tissue or cause the bladder to become enlarged. The amount of amniotic fluid also decreases because fetal urine is its major component. Pulmonary hypoplasia usually results because the lungs rely on amniotic fluid in their development.
- **Twin/twin transfusion syndrome (TTTS).** In about 75% of twin pregnancies, the two fetuses share a single placenta (called a monochorionic pregnancy). TTTS occurs in approximately 15% of these twins when blood volume between the fetuses is unequal. This causes abnormally low blood volume in the donor twin and abnormally high blood volume in the recipient twin. There is often a large difference in physical size between the twins. Approximately 70–80% of fetuses with TTTS will die without intervention.
- **Acardiac twin.** This condition also occurs in monochorionic pregnancies, but one twin develops normally while the other develops without a heart. The twin without a heart receives its blood supply from

## KEY TERMS

**Auscultation**—Use of the sense of hearing to evaluate such internal organs as the heart or bowel. While the practitioner may simply use his or her ears directly, most commonly auscultation is performed with an instrument, such as a fetoscope or stethoscope.

**Hydramnios**—The excessive production of amniotic fluid due to either fetal or maternal conditions.

**Monochorionic pregnancy**—A pregnancy in which twin fetuses share a placenta.

**Pulmonary hypoplasia**—Underdeveloped lungs.

**Supine**—Lying horizontally on one's back.

the normal twin, whose heart must now work harder to pump blood through both fetuses. Approximately 50–75% of acardiac twins will die as a result. An acardiac twin occurs in 1% of monochorionic pregnancies or one out of 35,000 pregnancies.

### Demographics

External fetoscopy may be used to determine the fetal heart rate in any woman with a viable pregnancy, although certain circumstances may compromise its quality (a noisy environment, an obese mother, or hydramnios [excess amniotic fluid]).

No demographic data are available regarding patients undergoing operative fetoscopy, since it is a relatively new procedure being performed at only a handful of hospitals around the United States. In the developed world, external fetoscopies have in many cases been replaced by diagnostic **ultrasound** tests.

### Description

The external fetoscope is used to listen to fetal heart tones for rate and rhythm. The earpieces and the headpiece allow auscultation via both air and bone conduction. External fetoscopy is inexpensive, non-invasive, and does not require electricity. It is difficult, however, to clearly hear the fetal heart tones before 18–20 weeks gestation. Doppler ultrasound can detect fetal heart tones around weeks 10–12.

Endoscopic fetoscopy uses a very thin fiber-optic scope. Developed in the 1970s, the endoscope was originally inserted transabdominally to visualize the fetus for gross abnormalities suspected by ultrasound or to obtain tissue and blood samples. The procedure was performed after about 18 weeks gestation. Even

with practitioner expertise, associated fetal loss was 3–7%. During the 1980s, ultrasound-guided needle sampling of cord blood replaced fetoscopy when samples of fetal blood were required.

As laparoscopic and microsurgical techniques have become more common and the instrumentation has become more advanced technologically, fetoscopy has improved for fetal diagnostic and therapeutic purposes. Fetal surgery performed through an open maternal abdomen has a higher risk of complications, such as infection, premature rupture of membranes, preterm labor, or fetal death. If surgery is performed via fetoscopy, which requires a very small transabdominal incision, the risks are much smaller. Techniques have advanced enough to allow some fetoscopy to be performed in the first trimester via the mother's cervix. The term “obstetrical endoscopy” may be used for surgery on the placenta, umbilical cord, or on the fetal membranes. The term “endoscopic fetal surgery” is used for procedures such as the repair of a fetal congenital diaphragmatic hernia or obstructed bladder.

### Diagnosis/Preparation

The use of external fetoscopy requires access to the maternal abdomen, with the mother lying supine or in a semi-seated position. Afterwards, the mother is able to get up and resume a normal activity level.

Preparation for endoscopic fetoscopy depends on the extent of the procedure and whether it is performed transcervically or transabdominally. For example, obtaining a small fetal tissue sample is a smaller procedure than fetal surgery. Other factors include outpatient versus inpatient stay and anesthesia (both maternal and fetal). For some procedures medication may be administered to temporarily decrease fetal movement to lower the risk of fetal injury. Maternal anesthesia may be local, regional, or general.

### Aftercare

External fetoscopy does not require aftercare. The care following fetal endoscopic use will depend on the extent of the procedure and the type of anesthesia used. If the procedure is done on an outpatient basis, the mother and fetus will be monitored for a period before discharge. More extensive surgery will require inpatient hospital **postoperative care**.

### Risks

The only potential complication with external fetoscopy is the possibility of missing an abnormal

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Healthcare professionals who may use the external fetoscope include a nurse practitioner, nurse midwife, and obstetrician. External fetoscopy may be performed in any setting with the pregnant woman lying supine or in a semi-sitting position. Endoscopic fetoscopy requires a high level of skill and experience by fetal surgeons and is performed in a hospital setting. During the procedures, a radiology technician may perform an ultrasound, and a laboratory technician may be involved in blood sampling. Nurses will participate in both outpatient and inpatient procedures.

heart rate or rhythm. Its usefulness and accuracy depend on the skill of the practitioner.

Endoscopic fetoscopy has the potential for causing infection in the fetus and/or mother, premature rupture of the amniotic membranes, premature labor, and fetal death. When endoscopic fetal surgery is done instead of open-uterus fetal surgery, the risks to the mother and fetus are decreased. This reduction occurs because the incision is significantly smaller, with less potential blood loss, decreased uterine irritability, and decreased risk of early miscarriage.

### Normal results

The normal fetal heart rate is 120–160 beats per minute, regardless of the method used for auscultation (external fetoscopy or Doppler ultrasound). Some variability of fetal heart rate is expected, as the heart rate increases with fetal activity and slows with fetal rest.

Results expected using endoscopic fetoscopy will vary depending on the procedure undertaken. The goal is for the maximum benefit with the minimum of risk or complication to both the mother and fetus.

### Morbidity and mortality rates

There is no morbidity or mortality associated with external fetoscopy. In the case of endoscopic fetoscopy, the risk of fetal loss is estimated to be between 3% and 5%. The procedure is therefore usually recommended only for the more severe cases of fetal disorders that may be treated during pregnancy.

## QUESTIONS TO ASK THE DOCTOR

- Why is fetoscopy recommended in my case?
- What alternatives to fetoscopy are available to me?
- For endoscopic fetoscopy, what will be the results if there is no medical intervention?
- For endoscopic fetoscopy, will the procedure be performed on an outpatient basis? What type of anesthesia will be used?

### Alternatives

A healthcare provider may listen to the fetal heart rate by means of a handheld Doppler device, which uses ultrasound to amplify the heartbeat. A continuous electronic fetal monitor may also be used to track the fetal heart rate and maternal uterine contractions. It is held against the mother's abdomen by means of elastic straps.

Open fetal surgery is an alternative to internal fetoscopy. It is used for conditions that cannot be treated endoscopically. An incision is made through the abdomen and the uterus is partially removed from the body. Amniotic fluid is drained from the uterus and kept in a warmer for replacement after completion of the surgery. An incision is made in the uterus, a procedure called a hysterotomy. In order to minimize bleeding of the uterus, an instrument called a uterine stapler is used to make an incision while simultaneously placing **staples** around the perimeter of the incision to prevent bleeding. Surgery is then performed on the fetus through the opening in the uterus to locate the abnormality and remove or repair it. There is a greater risk of infection, premature labor, and leakage of amniotic fluid with open fetal surgery than there is with fetoscopy.

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American College of Obstetricians and Gynecologists. 409 12th St., SW, PO Box 96920. Washington, DC 20090 6920. (202) 638 5577. <http://www.acog.com> (accessed March 22, 2008).

Fetal Treatment Center, University of California San Francisco. 513 Parnassus Ave., HSW 1601, San Francisco, CA 94143 0570. (800) RX FETUS or (415) 353 8489. <http://www.fetus.ucsf.edu> (accessed March 22, 2008).

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## Fibrin sealants

### Definition

Fibrin sealants are a type of surgical tissue adhesive derived from human and animal blood products. The ingredients in these sealants interact during application to form a stable clot composed of a blood protein called fibrin. Fibrin sealants are also called fibrin glues. They have been used in Japan and Western Europe since the 1980s, but were not approved for use in the United States until 1998 due to the Food and Drug Administration's (FDA) concerns about virus contamination. As of 2007, all fibrin sealants used in the United States are made from blood plasma taken from carefully screened donors and rigorously tested to eliminate hepatitis viruses, HIV-1, and parvovirus.

### Purpose

Originally developed during World War II to stop bleeding from battle injuries, fibrin sealants are presently used during surgery for several different purposes, including:

- to control bleeding in the area where the surgeon is operating
- to speed wound healing

- to seal off hollow body organs or cover holes made by standard sutures
- to provide slow-release delivery of medications to tissues exposed during surgery
- to reduce blood loss from skin grafting during operations to treat severe burns
- to deliver localized doses of antibiotics to lower the risk of infection after surgery

Fibrin sealants have several advantages over older methods of hemostasis (stopping bleeding): they speed up the formation of a stable clot; they can be applied to very small blood vessels and to areas that are difficult to reach with conventional sutures; they reduce the amount of blood lost during surgery; they lower the risk of postoperative inflammation or infection; and they are conveniently absorbed by the body during the healing process. They are particularly useful to minimize blood loss during surgery for severe burns, for minimally invasive procedures, and for treating patients with blood clotting disorders. Fibrin sealants are being replaced for some specialized purposes by newer wound adhesives known as cyanoacrylates. Fibrin sealants have a major advantage over cyanoacrylates, however, in that they are less likely to cause allergic reactions or inflammation that slows wound healing.

### Description

All fibrin sealants in use as of 2007 have two major ingredients: purified fibrinogen (a protein) and purified thrombin (an enzyme) derived from human or bovine (cattle) blood. Many sealants have two additional ingredients: human blood factor XIII and a substance called aprotinin, which is derived from cows' lungs. Factor XIII is a compound that strengthens blood clots by forming cross-links between strands of fibrin. Aprotinin is a protein that inhibits the enzymes that break down blood clots.

### Preparation

The preparation and application of fibrin sealants are somewhat complicated. The thrombin and fibrinogen are freeze-dried and packaged in vials that must be warmed before use. The two ingredients are then dissolved in separate amounts of water. Next, the thrombin and fibrinogen solutions are loaded into a double-barreled syringe that allows them to mix and combine as they are sprayed on the incision. Pieces of surgical gauze or fleece may be moistened with the sealant solutions to cover large incisions or stop heavy bleeding.

## KEY TERMS

**Aprotinin**—A protein derived from cows' lungs included in some fibrin sealants to prevent the fibrin clot from dissolving.

**Coagulation cascade**—The process of blood clotting. The cascade itself is a series of chemical reactions involving blood proteins and enzymes that occurs wherever there is a break in a blood vessel. The end product of the cascade is a protein called fibrin.

**Collagen**—A fibrous protein found in the skin and other connective tissues of mammals. It is used to make patches coated with fibrinogen and thrombin as a wound sealant.

**Factor XIII**—A substance found in blood that forms cross-links between strands of fibrin during the process of blood coagulation. Factor XIII is an ingredient in some types of fibrin sealants. It is also known as fibrin stabilizing factor.

**Fibrin**—A blood protein formed as the end result of the coagulation cascade. Fibrin is formed from fibrinogen when it interacts with thrombin.

**Fibrinogen**—A blood protein made in the liver that is broken up into shorter molecules by the action of thrombin to form fibrin.

**Hemostasis**—Stopping bleeding from a wound or incision. Fibrin sealants are used to speed up hemostasis.

**Plasma**—The liquid part of blood. Plasma is a clear pale yellow fluid composed primarily of water and dissolved minerals.

**Thrombin**—An enzyme found in blood plasma that helps to convert fibrinogen into fibrin.

Fibrin sealants can also be applied in the form of a patch made from collagen, a protein found in the connective tissues of humans and other mammals. The collagen is coated with fibrinogen and thrombin to make a ready-to-use rapid-acting wound sealant. The coated patches are used in **neurosurgery** as well as cardiovascular, liver, and kidney surgery.

As the thrombin and fibrinogen solutions combine, a clot develops in the same way that it would form during normal blood clotting through a series of chemical reactions known as the coagulation cascade. At the end of the cascade, the thrombin breaks up the fibrinogen molecules into smaller segments of a second blood protein called fibrin. The fibrin molecules

arrange themselves into strands that are then cross-linked by a blood factor known as Factor XIII to form a lattice or net-like pattern that stabilizes the clot.

Fibrin sealants are undergoing rapid refinement as the result of recent advances in tissue adhesives in general. In 1997, the Tissue Adhesive Center (TAC) was founded at University of Virginia Health Sciences Center in order to develop and test new fibrin sealants and other surgical glues. As of 2007, the TAC has been reorganized as a specialty center within the university's Surgical Therapeutic Advancement Center (STAC). Recent developments include a delivery system that forms a fibrin sealant from the patient's own blood within a 30-minute cycle, and uses a spray pen rather than a double-barreled syringe for applying the sealant. The use of the patient's own blood lowers the risk of allergic reactions to blood products derived from animal or donated blood.

## Normal results

Reports that have been published between 2003 and 2007 indicate that fibrin sealants are a safe and highly effective form of surgical adhesive. A survey done in 2000 at the University of Virginia hospital found that over 90% of the surgeons who had tried fibrin sealants were pleased with the results. Several American studies have reported that fibrin sealants have improved surgical outcomes significantly by shortening the time required for operations; lowering the rate of infections and other complications; minimizing blood loss during surgery; and reducing the amount of scar tissue formed over incisions. German researchers have found that fibrin sealants containing Factor XIII generally give better results than those that do not.

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#### ORGANIZATIONS

- Center for Biologics Evaluation and Research (CBER), U.S. Food and Drug Administration (FDA). 1401 Rockville Pike, Rockville, MD 20852-1448. (800) 835-4700 or (301) 827-1800. <http://www.fda.gov/cber> (accessed March 22, 2008).
- Tissue Adhesive Center, Surgical Therapeutic Advancement Center. P. O. Box 801370, Charlottesville, VA 22908. (434) 243-0315. <http://www.healthsystem.virginia.edu/internet/stac/overview/home.cfm> (accessed March 22, 2008).

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Fibroid surgery see **Myomectomy**

## Finding a surgeon

### Definitions

Finding a surgeon refers to the process of choosing a doctor with specialized training in one or more branches of surgery to perform a specific procedure. It is almost always done in the context of **elective surgery** rather than emergency operations.

### Description

#### *Changes in the healthcare professions*

Choosing a surgeon is a relatively new development in health care. Until the end of the twentieth century, many people, particularly in rural areas in the United States and Canada, relied on one doctor who treated all members of the family for most illnesses and some common surgical procedures, including **tooth extraction** and childbirth. These general practitioners often treated the same patients over a

period of many years and consequently knew their medical histories quite well. Most hospitals were so-called general hospitals, and admitted patients for a wide variety of surgical procedures. Since World War II, however, advances in medical knowledge and technology have led to increasing specialization of both health care professionals and the facilities they work in. As of 2008, three members of a family, each scheduled for a different surgical procedure, might be sent to three different hospitals and have three different surgeons perform the operations. Under these circumstances, choosing a surgeon can seem both complicated and confusing.

#### *Referral to a surgeon*

In the United States, most people with health insurance belong to a **health maintenance organization (HMO)** or similar health care plan that either assigns them to a doctor or asks them to choose from a list of primary care physicians (PCPs). PCPs are usually family practitioners, pediatricians, or internists, although some health care plans allow women to choose a gynecologist/obstetrician as their PCP. The PCP is sometimes referred to as a gatekeeper, because he or she makes decisions about referring patients to surgeons and other specialists. In some **managed care plans**, the PCP simply assigns patients to specific surgeons; in others, the patient may be given a list of surgeons to choose from. Many people use the PCP's list as a starting point for choosing their surgeon, and may ask the PCP for his or her opinion of the surgeons on the list. Some procedures, such as **cosmetic surgery**, are not covered by HMOs, however, many people consult their primary care physician about this type of surgery to obtain procedure information and a list of competent cosmetic surgeons.

In Canada, Australia, and other countries with publicly financed health care systems, patients usually have two options when surgery is considered. They may have the operation performed in a public hospital, in which case they are not likely to be able to choose their surgeon or even the date of the operation. Patients with private insurance, however, have the option of treatment in private clinics that give them some voice in selecting their surgeon. Private patients also do not have to wait as long for treatment; some estimates find that the average wait for surgery for private patients was about five weeks, but that the wait for surgery in a public hospital could be three times that long or longer. Canadian medical journals have reported advertisements promoting surgery in

## KEY TERMS

**Elective procedure**—A surgical procedure that is a matter of choice rather than emergency treatment.

**Malpractice**—A doctor or lawyer's failure in his or her professional duties through ignorance, negligence, or criminal intent.

**Primary care physician (PCP)**—A family practitioner, pediatrician, internist, or gynecologist who takes care of a patient's routine medical needs and refers him or her to a surgeon or other specialist when necessary.

**Referral**—The process of directing a patient to a specialist for further diagnostic evaluation or treatment.

the United States to Canadians who are frustrated by long waiting lists for certain operations.

### *Basic considerations in choosing a surgeon*

**TYPE OF PROCEDURE.** Surgical procedures vary considerably in complexity and the length of specialized training needed to perform them. Some can be carried out by a general surgeon, who is a physician who has completed residency training and passed an examination given by the American Board of Surgery (ABS). The ABS, which is one of 24 certifying boards that comprise the American Board of Medical Specialties (ABMS), provides a lengthy definition of the training and experience required of general surgeons. According to the ABS, a general surgeon should be competent to perform basic procedures in all of the following areas, though not necessarily the “full range and complexity of procedures” in each field.

The ABS defines the following fields as “essential in the comprehensive education of a broadly based surgeon”:

- alimentary (digestive) tract;
- abdomen and its contents;
- breast, skin, and soft tissue;
- the endocrine system;
- head and neck surgery;
- pediatric surgery;
- critical care surgery;
- surgical oncology (surgery to treat cancer);
- organ transplantation;
- trauma and burns; and
- vascular surgery.

After certification by the ABS, a surgeon may undergo additional training in one of 10 surgical specialties as defined by the American Board of Medical Specialties (ABMS):

- colon and rectal surgery;
- neurological (brain and nervous system) surgery;
- obstetrics and gynecology;
- ophthalmology (eye surgery);
- orthopedic (bone and joint) surgery;
- otolaryngology (ear, nose, and throat surgery);
- pediatric surgery;
- plastic surgery;
- thoracic (chest) surgery; and
- urology.

To complicate the picture even further, some surgical specialties are further divided into subspecialties. For example, plastic surgeons may specialize in **plastic surgery** of the hand, or plastic surgery of the face and neck. Similarly, some ear, nose, and throat specialists specialize further in pediatric otolaryngology. For this reason, one of the first questions patients should ask their primary care provider when choosing a surgeon is the degree of specialization required to perform the specific procedure. Among other considerations, specialization will affect the range of choices available to the patient regarding the hospital or clinic where the operation is performed as well as choosing the operating surgeon. Some highly specialized procedures may require patients to travel long distances to a hospital or surgical center in another city.

**ALTERNATIVES TO SURGERY.** The Agency for Healthcare Quality and Research (formerly the Agency for Health Care Policy and Research) publishes a booklet called *Questions to Ask Your Doctor Before You Have Surgery*, which can be downloaded from the Agency's web site, [www.ahrq.gov](http://www.ahrq.gov). One question discussed in the booklet concerns such nonsurgical treatments as medications or changes in diet and lifestyle. Elective surgical procedures have potential risks as well as benefits, and patients should ask about both before committing themselves to having an operation. Some health care professionals advise exploring medical options first before agreeing to surgery when both types of treatments are available for a given condition and there is time to try nonsurgical approaches.

**CREDENTIALS AND SKILL LEVEL.** It is important for patients to check a surgeon's credentials and length and depth of experience. After a doctor has received his or her M.D. or D.O. from an accredited school of medicine or osteopathy, he or she must pass a national licensure examination and a set of licensing procedures set by



each state in order to practice general medicine or surgery in that state. Most surgeons have their medical school diploma and state licensing certificate framed and displayed on an office wall where patients can see them. A patient should never hesitate to ask questions about a surgeon's credentials, a good surgeon will be happy to answer them.

The American College of Surgeons recommends that patients look for the following credentials when they consult or are referred to a surgeon:

- **Board certification.** Board certification means that the surgeon has passed a rigorous examination administered by one of the specialty boards belonging to the ABMS. The ABMS publishes an annual directory of board certified medical specialists that can be found in many hospital libraries as well as university or medical school libraries. Patients can also call their local county medical society to verify a surgeon's specialty credentials.
- **Fellowship in the American College of Surgeons.** A surgeon with the letters FACS after his or her name is a Fellow of the ACS and is a board-certified surgeon.
- **Approval for practice in accredited hospitals or other health care facilities.** Patients can verify the accreditation status of the facility where the operation is to be performed by contacting the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) for hospitals, or the Accreditation Association for Ambulatory Health Care (AAAHC) for outpatient surgery centers. These organizations are listed below under Resources.

An additional consideration is the number of procedures of a specific type that the surgeon performs on a regular basis. The more specialized the procedure, the more important it is for the surgeon to practice his or her skills. For example, the Johns Hopkins urology website states that a surgeon consulted for prostate surgery should have performed at least 150 prostate operations, and that it is preferable if he or she performs the same operation every day or several days a week. For some types of surgery, including joint replacement and cancer surgery, patients should look for a surgeon in high-volume medical centers where specialists have acquired a great deal of experience performing the specific procedure that the patient needs.

**PERSONALITY ISSUES.** In addition to a surgeon's level of skill and experience, his or her personality should be taken into consideration. Many operations require dietary changes, certain types of **exercise**, or other detailed preparations, therefore, the patient should feel comfortable about talking to the surgeon—particularly when it comes to asking important questions about the

operation itself or the surgeon's length of experience. Some patients are afraid to talk to surgeons because they have heard that surgeons have a reputation among other health professionals for being impatient, bossy, and generally lacking in "people skills." One popular article on doctors' personality styles describes the typical surgeon as fitting the "dictator" pattern, and several studies have reported that over 50% of doctors advised to seek anger management counseling are surgeons. As of 2008, however, a growing number of surgeons are recognizing that patients who take an active role in their treatment have better outcomes, and that a well-informed patient is their best ally. Patients should not hesitate to talk to several different surgeons in order to find one whose personality is a good fit with their own.

**DISCIPLINARY HISTORY.** Although only a small percentage of doctors in the United States have ever been disciplined by a professional peer review, sued for malpractice, or had their licenses suspended—about 0.5% per year—patients who are considering surgery should find out if any of the surgeons they are considering have a history of disciplinary actions taken against them. The Federation of State Medical Boards has compiled a database called DocInfo that can be searched on the Federation's web site, [www.fmsb.org](http://www.fmsb.org), for information about a specific practitioner's record.

## Preparation

### Gathering information

Patients considering elective surgery should collect some information about the procedure in question and the qualifications required to perform it before they talk to a specific surgeon. People with Internet access can obtain information about surgical operations as well as credentialing processes on the web sites of the various surgical specialty associations. Links to these associations can be found on the ABMS web site, [www.abms.org](http://www.abms.org). Many surgical specialty groups have patient education brochures and other informational material available for downloading free of charge. Most of these materials can also be obtained by writing, telephoning, or e-mailing the associations.

Other useful sources of information include hospital and **outpatient surgery** center web sites. These sites often have reader-friendly descriptions of specific procedures as well as information about the hospital or clinic's accreditation, location, and other important features.

Another good source of information about choosing a surgeon is first-person accounts of surgical procedures. There are a growing number of patient guides to plastic surgery, joint replacement surgery, oral and facial surgery, cancer surgery, and other procedures

written by people who have had these operations. Most of these books include advice on finding one's way through the referral process as well as a list of specific questions to ask surgeons in particular specialties.

### Getting recommendations

The next step in choosing a surgeon is asking other health professionals to recommend specific practitioners. As mentioned above, most patients begin with their primary care doctor. Patients who have been treated recently by a medical specialist should also ask him or her for recommendations about surgeons. For example, someone who has been seeing a specialist in pulmonary (lung) medicine for asthma treatment should ask him or her for the names of good thoracic surgeons if an operation is recommended. Many authors suggest asking the PCP or medical specialist who they would ask to do the surgical operation if they or one of their family members needed it.

Other sources of recommendations include home health care nurses or physical therapists, who are often familiar with the work of local surgeons. One expert in sports medicine has been quoted as saying, "If you want a good surgeon, ask a physical therapist. We see patients from all the surgeons. I see the same good surgeries come from the same good surgeons and the same lousy surgeries come from the same lousy surgeons. You see it all the time."

A third source of recommendations is other people who have had the same procedure that the patient is considering and who were pleased with the results.

### Advertisements

As recently as the 1960s, it was considered unprofessional for doctors or dentists to advertise themselves except for brief listings of their specialties in professional association and local telephone directories. The spread of high-pressure advertising techniques that originated in the business world and spread into medicine, however, has resulted in the production of web sites, radio announcements, and printed advertisements for doctors that can be confusing to patients who are looking for a surgeon. In particular, plastic surgeons who specialize in cosmetic procedures (face lifts, "tummy tucks," etc.) have been accused of exploiting people's vulnerabilities and fear of aging in their advertisements. The American Medical Association (AMA) has a set of guidelines, issued in 1996 and updated in 2002, that warn doctors against using publicity containing deceptive or misleading claims.

Patients looking for a surgeon should be wary of doctors who claim that they have unique skills, "secret" techniques, or an improbably large number of satisfied patients. In addition, an attractive web site or impressive advertisement should not be a substitute for a personal interview with the surgeon.

### Second opinions

Patients who are considering surgery should not be shy about getting a **second opinion** if they feel unsure about having an operation after they talk to a surgeon. In fact, many health plans require patients to seek a second opinion for certain types of elective surgery before they will approve the procedure. Some insurance plans will reimburse patients for the cost of seeking a second opinion. The Centers for **Medicare** and **Medicaid** Services (CMS), formerly the Health Care Financing Administration (HCFA), publishes a brochure (Publication No. 02173) for Medicare patients on seeking second surgical opinions.

### Resources

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- Helms, Sherry. "The Changing Face of Cosmetic Surgery." *Consumers Digest* 34, no. 4 (July–August 1995): 53–60.

#### ORGANIZATIONS

- Accreditation Association for Ambulatory Health Care, 5250 Old Orchard Road, Suite 200, Skokie, IL, 60077, (847) 853 6060, (847) 853 9028, [info@aaahc.org](mailto:info@aaahc.org), <http://www.aaahc.org>.
- Agency for Healthcare Research and Quality, 540 Gaither Road, Rockville, MD, 20850, (301) 427 1364, <http://www.ahrq.gov>.
- American Board of Medical Specialties, 1007 Church Street, Suite 404, Evanston, IL, 60201 5913, (847) 491 9091, <http://www.abms.org>.
- American Board of Surgery, 1617 John F. Kennedy Blvd., Suite 860, Philadelphia, PA, 19103 1847, (215) 568 4000, (215) 563 5718, <http://www.absurgery.org>.
- American College of Surgeons, 633 N. Saint Clair St., Chicago, IL, 60611 3211, (312) 202 5000, (800) 621 4111, (312) 202 5001, [postmaster@facs.org](mailto:postmaster@facs.org), <http://www.facs.org>.

Centers for Medicare and Medicaid Services, 7500 Security Boulevard, Baltimore, MD, 21244 1850, (410) 786 3000, (877) 267 2323, <http://www.cms.hhs.gov>.

Federation of State Medical Boards, P.O. Box 619850, Dallas, TX, 75261 9850, (817) 868 4000, (817) 868 4099, <http://www.fsmb.org>.

Health Canada/Santé Canada, A.L. 0900C2, Ottawa, Canada, K1A 0K9, (613) 957 2991, <http://www.hc-sc.gc.ca>.

Joint Commission on Accreditation of Healthcare Organizations, One Renaissance Boulevard, Oakbrook Terrace, IL, 60181, (630) 792 5000, (630) 792 5005, <http://www.jointcommission.org>.

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## Finger reattachment

### Definition

Finger reattachment (or replantation) is defined as reattachment of a finger that has been completely amputated. In general, a finger **amputation** may be defined as either complete (there is no connection between the amputated finger[s] and the rest of the hand) or incomplete (the finger is connected to the rest of the hand by tendons, skin fragments, or muscle tissue).

### Purpose

Reattachment can be surgically performed for the finger and such other detached body parts as the hand or arm. The first successful replantation of a severed finger tip was performed in 1814 by William Balfour, a British surgeon. Replantation of amputated fingers was not attempted on a widespread basis, however, until the invention of the operating microscope in the early 1960s. The first successful replantation of an entire arm was performed in 1962 on a 12-year-old boy who had been injured in a train accident. The technique used in the early 2000s to reconstruct the blood vessels in an injured hand was developed in 1965 by two Japanese surgeons, Shigeo Komatsu and Susumu Tamai. Reattachment of an amputated finger can be carried out in most large hospitals in the early 2000s.

### Demographics

There are about 30,000 cases of traumatic amputations in the United States each year; 65% of these involve the upper limbs (arms, hands, and fingers).

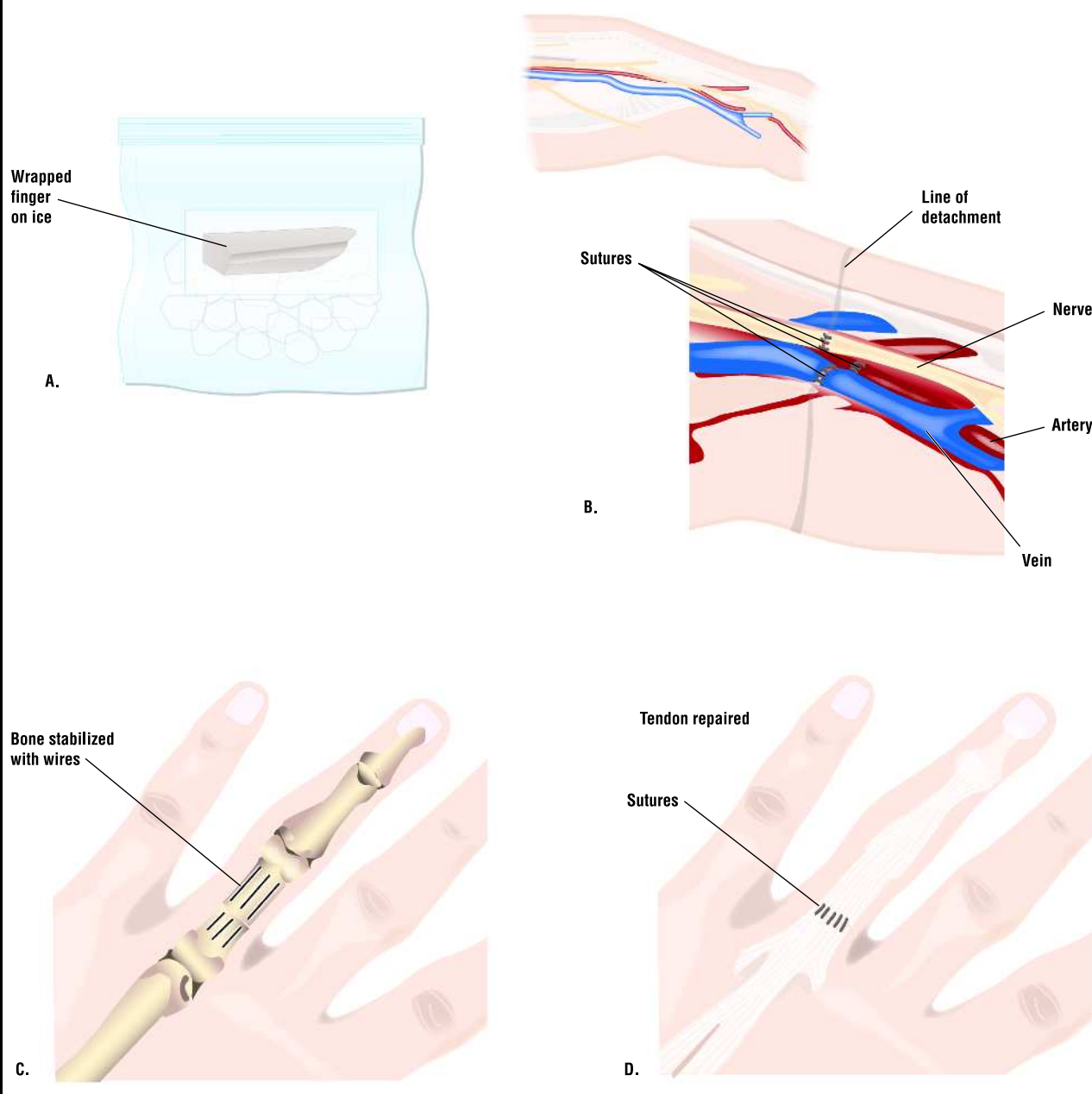
Most patients are between the ages of 15 and 40, and 80% are male. Good candidates for this procedure include persons with thumb or multiple digit amputation. Injury to multiple digits is an important patient selection criterion, since in some cases the least damaged digits may be moved to the least injured or most useful stump. Patient exclusion is neither clear-cut nor absolute; however, patients who have cut off their own fingers should receive a psychiatric evaluation before reattachment is attempted, as many of these patients later cut off the finger a second time. Generally, severe crushing or avulsing (tearing away) injuries to the fingers complicates replantation; however, venous grafts may help replace injured blood vessels. Additionally, older persons may have arteriosclerosis that frequently impairs function in blood vessels, especially in small vessels. Special efforts may be made to replant fingers if the person's livelihood (such as professional music performance) depends on absolute finger control.

### Description

To increase efficiency, the replantation team splits into two smaller teams. One sub-team in the **operating room** cleans the amputated finger with sterile solutions, places it on ice, and identifies and tags (with special surgical clips) nerves and blood vessels. Dead or damaged tissue is surgically removed with a procedure called **debridement**. The emergency room (ER) sub-team will assess the patient during a physical exam with x rays of the injured area, blood analysis, and cardiac (heart) monitoring. The patient is given fluids intravenously (IV), a tetanus injection (to prevent infection by *Clostridium tetani*, a bacterium that can invade the body through crush injuries or penetrating wounds and release a potent neurotoxin), and **antibiotics**. Usually, most finger reattachments are performed with a local anesthetic such as bupivacaine and a nerve block to numb the affected arm. Maintaining a warm **body temperature** can enhance blood flow to the affected limb.

The surgical procedure consists of several stages. The bone in the amputated finger must be shortened and fixed, which means that the bone end is trimmed. After this process, the bone is stabilized with special sutures called K-wires, and fixed pins are placed in the bone after drilling a space to insert them. This process connects the two amputated bone fragments. After bone stabilization and fixation, the extensor and flexor tendons are repaired. This step is vital, since arteries, veins, and nerves should never be surgically connected under tension. Next, the surgeon must repair (suture) severed tendons, arteries, veins, and

## Finger reattachment



To save a detached finger for reattachment surgery, it should be wrapped in a moist paper towel and put on ice (A). First the surgeon will reattach the blood vessels and nerves of the finger (B). The bone may be repaired with wires (C), and tendons are repaired (D). Skin and muscle wounds are also closed during the procedure. (Illustration by GGS Information Services. Cengage Learning, Gale.)

nerves. Healthy arteries and veins are sutured together without tension. A vein graft is used for blood vessels that cannot be reattached.

Nerve repair for finger reattachment is not complicated. Since the reattached bone parts are shorter than the original length, nerves can be reattached



## KEY TERMS

**Arteriosclerosis**—Hardening of the arteries, also called atherosclerosis.

**Avulsion**—The tearing away of a body part or tissue.

**Debridement**—Surgical removal of damaged tissues.

**Digits**—Fingers or toes.

**Guillotine amputation**—An amputation in which the severed part is cut off cleanly by a blade or other sharp-edged object.

**Prosthesis**—An artificial device to replace a missing body part.

**Replantation**—The medical term for the reattachment of an amputated digit.

**Sutures**—Stitches.

**Tetanus**—A potentially deadly disease produced by a bacterium that may infect crush injuries or penetrating wounds.

**Vasospasm**—Alternating contraction and relaxation of the muscle coating of blood vessels.

**Venous graft**—Transfer of living vein tissue within the same host (from one place of the body to another in the same person).

without tension. A microscope is used for magnified visualization of finger nerves during reattachment. When the severed ends of the nerve cannot be reattached, a primary nerve graft is performed. Finally, it is vital to cover superficial veins on the affected finger (dorsal veins) with a skin flap to prevent death of the venous vessels. The skin over the surgical field is loosely sutured with a few sutures. Any damaged tissue that may die (necrotic tissue) is removed. No tension should be placed on the skin fields during closure of the wound. Wounds are covered with small strips of gauze impregnated with petrolatum. The upper extremity is immobilized, and compression hand dressing and plaster splints are arranged to prevent slipping and movement of the affected arm.

## Diagnosis/Preparation

The diagnosis is easily made by visual inspection. The reattachment procedure is complex and involves the expertise and skill of a highly trained surgeon. There are several important factors necessary to successful replantation, including special instrumentation and transportation of the amputated finger. Surgical loupes (binocular-type eyepieces used by surgeons to magnify small structures during surgery) are necessary

for this procedure. Instruments should be at least 3.9 in (10 cm) long to allow for proper positioning in the surgeon's hands. Special clips are used to help suture blood vessels together. The best method of saving and transporting the amputated finger is to wrap it with moistened cloth (Ringer's lactate solution or saline solution) and place it on ice. Generally, the tissues will survive for about six hours without cooling. If the part is cooled, tissue survival time is approximately 12 hours. Fingers have the best outcome for transportation survival, since digits (fingers) do not have a large percentage of muscle tissue.

## Aftercare

**Postoperative care** is vital for successful finger reattachment. The hand is wrapped in a bulky compression dressing and usually elevated. If arterial flow is impaired, then the hand should be lowered, since this maneuver will promote blood flow from the heart to the reattached finger. If venous outflow is slow, the hand must be elevated. Medications to increase blood flow (peripheral vasodilators) and an anticoagulant (heparin) are used. A tranquilizer may be given to reduce unnecessary blood vessel movement (vasospasm) that can occur due to anxiety. Careful examination of the reattached digit(s) is necessary. The surgeon frequently monitors color, the capacity of blood vessels, capillary refill, and warmth to monitor replant progress. The YSI telethermometer monitors the digital (finger) temperature with small surface probes. Skin temperature falling below 86°F (30°C) indicates poor blood perfusion (poor blood and oxygen delivery to the affected area) of the replant. The cause of poor blood circulation must be investigated and corrected, if possible. The patient's room should be warm, and bed rest for two to three days is recommended. Patients must refrain from smoking and take antibiotics for one week after surgery. Follow-up consultations are necessary for continued **wound care** and rehabilitation.

Some patients may need additional surgery at a later date to free tendons from scar tissue, transfer muscle tissue to the affected finger, or improve the functioning of the nerves in the finger. In a few cases the reattached finger may have to be removed because of complete loss of function or intractable pain.

## Risks

The experienced surgeon can estimate the likelihood of complications based on the nature of the injury. Replantations that are risky, such as those with circulatory perfusion problems, have lower success rates. Generally, the most difficult replantations are those that involve children under 10, injuries caused by a ring catching in machinery (ring avulsion injury), and crush-and-tear injuries. Management of the

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The reattachment procedure itself is usually performed in a hospital operating room by a microsurgeon, who may be a plastic surgeon with five years of general surgery training, plus two years of plastic surgery training and another one or two years of training in microneurovascular surgery; or an orthopedic surgeon with one year of general surgery training, five years of orthopedic surgery training, and additional years in microsurgery training.

The patient may be cared for by a variety of emergency medical technicians, nurses, and physicians at the scene of the accident or in the hospital emergency department before replantation is performed. These health professionals may cleanse or splint the injured limb, administer pain medications, and perform other procedures to prepare the patient for surgery.

difficult replant typically includes intravenous heparin to prevent clotting of the blood, and providing a continuous nerve block in either the median or ulnar nerve (depending on which fingers are reattached). A nerve block will cause vasodilation, or expansion of the blood vessels. Vasodilation will increase blood flow, bringing with it fresh oxygenated blood. Further evaluation should include checking the patient's dressing for constriction (i.e., if the dressing was placed too snugly and is constricting local blood vessels).

There are some psychological risks to replantation, as patients are often distressed by loss of function in the affected finger(s) or by the appearance of the injured hand. Since 100% of function cannot be restored, patients may find that there are some activities or hobbies that they can no longer enjoy. In some cases, they may not be able to do the work they did before their injury and may have to seek another type of employment. Some patients may need counseling in order to deal with the changes in their life that may be forced on them by loss of function in the injured hand.

### Normal results

Normal results depend on several factors: how much of the finger was cut off; whether any joints were affected, or only the tip; whether the wound was a guillotine amputation (a clean cut by a sharp-edged object) or involved crushing or tearing; and the patient's age. In general, younger patients and non-smokers recover more function and sensation in the

## QUESTIONS TO ASK THE DOCTOR

- Are there any special precautions I should take with my pain medication?
- How should I care for the wound?
- When will I regain feeling and function in the affected finger(s)?
- Will I need physical therapy for the injury?
- How much function can I expect to regain?
- Will I be able to go back to my old job?

reattached finger. Reattachment following a guillotine amputation has a higher rate of success (more than 80%) than reattachment following a crush or avulsion amputation (55%).

There are two types of nerves involved in recovering the use of the fingers: sensory nerves (which detect heat, cold, roughness, and other sensations) and motor nerves (which govern the movement of muscles). Nerves in the fingers grow about an inch per month. The number of inches from the injury to the tip of the injured finger gives the minimum number of months after which the patient may begin to notice sensations in that fingertip. Results usually include good nerve recovery and 60–80% recovery of range of motion; cold intolerance (usually reversed in about two years); and acceptable cosmetic appearance.

### Morbidity and mortality rates

Most finger replantations involving guillotine amputations in patients younger than 40 years are successful. Replantations in patients with crush or avulsion injuries are more likely to have complications after surgery. Smokers and patients with diabetes also have poorer outcomes. Mortality from finger reattachment is very low; fatal outcomes are almost always in patients with multilevel injuries involving the head or chest as well as amputation of a finger or hand.

### Alternatives

According to the American Society for Surgery of the Hand, the surgeon will explain to the patient how much function the patient can expect to have after replantation and allow the patient to decide whether the operation itself, time spent in the hospital, and a long period of rehabilitation are worth that degree of recovery. One alternative to replantation is a prosthesis for the missing finger.

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## Fluoroquinolones

### Definition

Fluoroquinolones are a subgroup of quinolones, which are medications that kill bacteria or prevent their growth. The parent drug of the group is nalidixic acid (NegGram), a synthetic drug used to treat urinary tract infections caused by gram-negative bacteria. Bacteria are one-celled disease-causing microorganisms that commonly multiply by cell division.

### Purpose

Fluoroquinolones are a class of antimicrobials, which are medications used to treat infections caused by microorganisms. Physicians prescribe these drugs for bacterial infections in many parts of the body. For example, they are used to treat bone and joint infections, skin infections, urinary tract infections, inflammation of the prostate, serious ear infections, bronchitis, pneumonia, tuberculosis, some sexually transmitted diseases (STDs), and some infections that affect people with AIDS. Some fluoroquinolones, such as enrofloxacin (Baytril), were developed for use in veterinary practice to treat infections in household pets and farm animals but are not given to humans.

Although fluoroquinolones are normally used only to treat infections, and not for prophylaxis (prevention of infection), some of these compounds have been used before surgery, particularly if the patient is allergic to the **antibiotic** that is usually given. Fluoroquinolones have also been studied for their usefulness in eye surgery and surgery of the biliary tract.

### Description

Fluoroquinolones are available only with a physician's prescription; they are sold in tablet and

injectable forms. Examples of these medicines are moxifloxacin (Avelox), ciprofloxacin (Cipro), ofloxacin (Floxin), levofloxacin (Levaquin), lomefloxacin (Maxaquin), norfloxacin (Noroxin), enoxacin (Pentrex), and sparfloxacin (Zagam).

Newer (so-called fourth-generation) fluoroquinolones include gatifloxacin (Zymar) and gemifloxacin (Factive). Another new drug in this class, prulifloxacin, is still in clinical trials as of early 2008.

### Recommended dosage

The recommended dosage depends on the type and strength of the specific fluoroquinolone and the kind of infection for which it is being taken. Patients should consult the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

To make sure an infection clears up completely, patients should take the full course of fluoroquinolone that their doctor prescribed. It is important to not stop taking the drug just because the symptoms begin to diminish.

Fluoroquinolones work best when they are at constant levels in the blood. To help keep blood levels constant, patients should take the medicine in doses spaced evenly through the day and night without missing any doses. For best results, these medications should be taken with a full glass of water, and the patient should drink several more glasses of water every day. Drinking plenty of water will help prevent some of the medicine's side effects. Some fluoroquinolones should be taken on an empty stomach; others may be taken with meals. Patients should read the directions on the package very carefully or ask the physician or pharmacist for instructions on the best way to take a specific medicine.

### Precautions

Other than allergic reactions, few patients experience significant problems when they are given a single dose of a fluoroquinolone for surgical prophylaxis. The external use of these drugs—for example, eye drops—is also generally safe.

An important precaution to observe with any antimicrobial drug is that the unnecessary use or abuse of these medications can encourage drug-resistant strains of bacteria to develop and spread. These drug-resistant strains then become difficult or even impossible to treat. Bacteria found in hospitals appear to have become especially resilient, and are causing increasing difficulty for patients and the doctors treating them.

## KEY TERMS

**Bacterium (plural, bacteria)**—A microscopic one-celled form of life that causes many diseases and infections.

**Biliary tract**—The part of the digestive system that conveys or stores bile, consisting of the bile ducts and the gallbladder.

**Bronchitis**—Inflammation of the air passages in the lungs.

**Digestive tract**—The stomach, intestines, and other parts of the body through which food passes.

**Inflammation**—A condition characterized by pain, redness, swelling, and warmth. Inflammation usually develops in response to an injury or infection.

**Microorganism**—An organism that is too small to be seen with the naked eye.

**Pneumonia**—A disease characterized by inflammation of the lungs. Pneumonia may be caused by bacteria, viruses, or other organisms, or by physical or chemical irritants.

**Prophylaxis**—A medical intervention intended to prevent disease.

**Prostate**—A donut-shaped gland in males below the bladder that contributes to the production of semen.

**Sexually transmitted disease (STD)**—A disease that is passed from one person to another through sexual intercourse or other intimate sexual contact.

**Tendon**—A tough band of tissue that connects muscle to bone.

**Tuberculosis (TB)**—An infectious disease that usually affects the lungs, but may also affect other parts of the body. Its symptoms include fever, weight loss, and coughing up blood.

**Urinary tract**—The passage through which urine flows from the kidneys to the outside of the body.

One fear is that the overuse of fluoroquinolone medications could reduce their effectiveness against such infections as typhoid fever, hospital-acquired pneumonia, and others.

Research suggests that fluoroquinolones may cause bone development problems in children and teenagers. Infants, children, teenagers, pregnant women, and women who are breastfeeding should not take these drugs unless directed to do so by a physician.

Although such side effects are rare, some people have had severe and life-threatening reactions to



fluoroquinolones. Several drugs in this class have been withdrawn in the United States because of severe reactions. One drug, temafloxacin (Omniflox), was withdrawn less than six months after its approval in 1992 because of three patient deaths related to liver damage and destruction of red blood cells. Another fluoroquinolone, trovafloxacin (Trovan), was withdrawn from the market in 2000 when it was found to cause liver damage. The tablet form of gatifloxacin, sold under the trade name Tequin, was withdrawn in 2006 after a Canadian study published in the *New England Journal of Medicine* showed that it could produce diabetes as a side effect. Gatifloxacin is presently available only in the form of eye drops (Zymar).

Patients should call their physician at once if they have any of the following signs:

- swelling of the face and throat
- problems swallowing
- shortness of breath
- rapid heartbeat
- tingling in the fingers or toes
- itching or hives
- loss of consciousness

Some fluoroquinolones may weaken the tendons in the shoulder, hand, or heel, making these fibrous bands of tissue more likely to tear. In 2004, the Food and Drug Administration (FDA) upgraded the warnings included in package inserts for these drugs to note the possibility of tendon damage or peripheral nerve damage. Anyone who notices pain or inflammation in the shoulder, heel, or other joints should stop taking the medicine immediately and call their physician. They should rest and avoid athletic activity or vigorous **exercise** until the physician determines whether the tendons have been damaged. Tendons that are torn may require surgical repair.

Fluoroquinolones make some people feel drowsy, dizzy, lightheaded, or less alert. Anyone who takes these drugs should not drive, use machines, or do anything else that requires a high level of alertness until they have found out how the drugs affect them.

Fluoroquinolones may increase the skin's sensitivity to sunlight. Even brief exposure to sun can cause severe sunburn or a rash. During treatment with these drugs, patients should avoid exposure to direct sunlight, especially high sun between 10 A.M. and 3 P.M.; wear a hat and tightly woven clothing that covers the arms and legs; use a sunscreen with a skin protection factor (SPF) of at least 15; protect the lips with a lip balm containing sun block; and avoid the use of tanning beds, tanning booths, or sunlamps.

Patients should not take antacids that contain aluminum, calcium, or magnesium at the same time as fluoroquinolones. The antacids may keep the fluoroquinolones from working as they should. If antacids are needed, they should be taken at least two hours before or two hours after taking norfloxacin or ofloxacin, and at least four hours before or two hours after taking ciprofloxacin. Patients who are taking sucralfate (Carafate), a medicine used to treat stomach ulcers and other irritations in the digestive tract and mouth, should follow the same instructions as for taking antacids.

People who have had unusual reactions to fluoroquinolones or such related compounds as cinoxacin (Cinobac) or nalidixic acid (NegGram) in the past should let their physician know before taking the drugs again. The physician should also be told about any allergies to foods, dyes, preservatives, or other substances.

People with any of these medical problems should make sure their physicians are aware of their conditions before using fluoroquinolones:

- kidney disease
- liver disease together with kidney disease
- diseases that affect the brain or spinal cord, including hardening of the arteries in the brain; epilepsy; and other seizure disorders

Taking fluoroquinolones with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

### Side effects

The most common side effects are mild diarrhea, nausea, vomiting, stomach or abdominal pain, dizziness, drowsiness, lightheadedness, nervousness, sleep problems, and headache. These side effects occur in about 5% of patients taking fluoroquinolones. They usually go away as the body adjusts to the drug and do not require medical treatment unless they are bothersome.

More serious side effects are not common, but may occur. If any of the following side effects occur, the patient should consult a physician immediately:

- skin rash or such other skin problems as itching, peeling, hives, or redness
- fever
- agitation or confusion
- hallucinations
- shakiness or tremors
- seizures or convulsions

- tingling in the fingers or toes
- pain at the injection site that persists after the drug was injected
- pain in the calves that spreads to the heel area
- swelling of the calves or lower legs
- swelling of the face or neck
- difficulty swallowing
- rapid heartbeat
- shortness of breath
- loss of consciousness

Other rare side effects may occur. People who have unusual symptoms after taking fluoroquinolones should consult their physician at once.

### Interactions

Fluoroquinolones may interact with other medicines. When an interaction occurs, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes fluoroquinolones should give the doctor a list of all other medications that they take on a regular basis, including over-the-counter (OTC) drugs, herbal preparations, and traditional Chinese or other alternative medicines. Drugs that may interact with fluoroquinolones include:

- antacids containing aluminum, calcium, or magnesium
- medicines that contain iron or zinc, including multivitamin and mineral supplements
- sucralfate (Carafate)
- caffeine
- such blood-thinning drugs as warfarin (Coumadin)
- drugs given to open the airway (bronchodilators), including aminophylline, theophylline (Theo-Dur and other brands), and oxtriphylline (Choledyl and other brands)
- didanosine (Videx), a drug used to treat HIV infection

The list above does not include every drug that may interact with fluoroquinolones. Patients should check with a physician or pharmacist before combining fluoroquinolones with any other prescription or nonprescription (over-the-counter) medicine.

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## Forehead lift

### Definition

A forehead lift is a **cosmetic surgery** procedure intended to improve a person's appearance by correcting the shape of the eyebrows and reducing horizontal wrinkles or furrows in the skin of the forehead. It is also known as a brow lift.

### Purpose

The purpose of a forehead lift is improvement of the patient's external appearance, particularly with regard to the upper third of the face. Some people have clearly marked frown lines or drooping of the eyebrows or eyelid

caused by loosening of the tissues and muscles around the eyes during the aging process. The drooping of the eyelid is sometimes referred to as ptosis, which comes from a Greek word meaning “fall.” In some cases, these signs of aging make the person look angry, anxious, or sad. A forehead lift is not done to cure disease or repair a major wound or injury.

## Demographics

Like other cosmetic surgery procedures, forehead lifts are performed much more frequently than they were even a decade ago. According to the American Society of Plastic Surgeons (ASPS), the number of forehead lifts performed in the United States has risen 172% since 1992. These changes are attributed in part to concerns about appearance in the so-called baby boomer generation. Adults born between 1945 and 1960 are generally more image-conscious than previous generations of Americans. In addition, newer surgical techniques have made forehead lifts less painful, easier to perform, and less likely to have complications.

Most plastic surgeons recommend that a forehead lift should be done when the patient is between 40 and 60 years old, although it is sometimes done on younger patients who have very deep frown lines due to stress or have inherited very low and heavy brows. In addition, people whose facial skin has aged prematurely due to sun exposure or heavy smoking may be candidates for a forehead lift in their mid-30s. In 2002, the average age of patients of either sex who had forehead lifts done in the United States was 47.

Statistics published by the American Academy of Cosmetic Surgery (AACS) in January 2003 indicate that although more men are choosing to have cosmetic surgery than in the past, the female:male ratio for forehead lifts is still 6:1. In 2002, surgeons who are AACS members performed 7,882 forehead lifts on women compared to 1,139 procedures on men. Forehead lifts account for a little less than 1% (0.96%) of all cosmetic surgery procedures performed each year in the United States and Canada.

The American Society of Plastic Surgeons reported that a total of 1,852,012 cosmetic procedures and 9,138,275 nonsurgical procedures were performed in the United States in 2006, totaling almost 11 million procedures. Of that number, 52,525 were forehead lift procedures.

Although most forehead lifts and other facial cosmetic procedures are still performed on Caucasian patients, this type of surgery is gaining rapidly in popularity among Hispanics, Asian Americans, and African

## KEY TERMS

**Blepharoplasty**—Plastic surgery performed on the eyelids.

**Body dysmorphic disorder (BDD)**—A psychiatric condition marked by excessive preoccupation with an imaginary or minor defect in a facial feature or localized part of the body. Many people with BDD seek cosmetic surgery as a treatment for their perceived flaw.

**Botulinum toxin**—A toxin produced by the spores and growing cells of *Clostridium botulinum*. It causes muscle paralysis, therefore this toxin can be used to reduce frown lines by temporarily paralyzing the muscles in the face that contract when a person frowns or squints.

**Collagen**—A type of protein found in connective tissue that gives it strength and flexibility. Collagen derived from cattle can be injected into wrinkles or lines in the face as an alternative to cosmetic surgery.

**Cosmetic surgery**—Surgery that is intended to improve a patient's appearance or correct disfigurement. It is also called aesthetic surgery.

**Endoscope**—An instrument that allows a surgeon to look underneath skin or inside a hollow organ while performing surgery.

**Ptosis**—The medical term for drooping of the upper eyelid.

Americans. Between 1999 and 2002, the proportion of cosmetic procedures performed on Hispanics has increased by 200%, on African Americans by 323%, and on Asian Americans by 340%. As of 2003, Caucasians account for only 77% of patients having elective facial surgery, compared to 83% in 1999.

## Description

There are two main types of forehead lifts. The classic, or open, forehead lift involves a long incision along the top of the forehead and lifting of the skin of the forehead. The second type of forehead lift, known as an endoscopic lift, is performed with special instruments inserted through four or five small incisions behind the hairline.

In some cases, a forehead lift is combined with **plastic surgery** on the eyelids (**blepharoplasty**) or with a **face lift**.

### *Classic forehead lift*

The classic forehead lift takes about one to two hours and may be performed with either general or **local anesthesia**. After the patient has been anesthetized, the surgeon makes a long incision across the top of the scalp from ear to ear. The exact location of the incision depends on the condition of the facial muscles to be removed or modified and the position of the patient's hairline. The most common type of incision in an open forehead lift is a coronal incision, which is made slightly behind the hairline. A second type of incision is called a pretrichial incision. It is similar to the coronal incision except that the central part of the incision lies directly on the hairline. A third type of incision, which is used mostly on male patients with very deep forehead creases, is placed directly inside the creases in the mid-forehead.

After the incision has been made, the surgeon lifts the skin of the forehead very carefully and cuts away excess underlying tissue. Some of the muscles that cause frowning may be loosened (released) or altered. If necessary, the brows will be lifted and excess skin along the line of the incision will be trimmed away. The incision is usually closed with **stitches** or **staples**, although some surgeons use tissue glues to hold the skin in place. The patient's face is then carefully washed to prevent infection and irritation. Some surgeons prefer to cover the incision with a gauze dressing held in place by an elastic bandage, but others do not apply any dressing.

One disadvantage of the classic forehead lift from the standpoint of male patients is that men's hairstyles will not usually cover the incision scar. It is easier for women, even those who prefer to wear their hair very short, to let the hair grow for several weeks before the procedure so that it will be long enough to cover the scar.

### *Endoscopic forehead lift*

An endoscopic forehead lift is performed with the help of an endoscope, which is an instrument designed to allow the surgeon to see the tissues and other structures underneath the skin of the forehead. Instead of making one long incision, the surgeon makes four or five shorter incisions, each less than an inch (2.5 cm) long. The endoscope is inserted through one of these incisions; the others are used for the insertion of instruments for removing excess tissue and reshaping the facial muscles. If the eyebrows are being lifted, they may be kept in place in their new position by tiny stitches under the skin or fixation tacks placed behind the hairline. The incisions are closed and the patient's face washed and dressed in the same way as in the classic forehead lift.

## Diagnosis/Preparation

### *Diagnosis*

It is somewhat misleading to speak of diagnosis on the context of forehead lifts and similar procedures because cosmetic surgery is unique in one respect—it is the only type of surgery in which the patient initiates “treatment” rather than the doctor. This difference means that many plastic surgeons now screen patients for psychological stability as well as general physical fitness for surgery. Beginning in the 1970s and 1980s, psychiatrists began to see patients who were obsessed with a particular facial feature or other small part of their body, as distinct from over-concern about weight or general body shape. This condition, which is called body dysmorphic disorder (BDD), became an official psychiatric diagnostic category in 1987. Patients with BDD frequently seek plastic surgery as a solution for their dissatisfaction with their looks; however, in many cases, the “flaw” that the patient sees in his or her face is either exaggerated or nonexistent. Ironically, although men are less likely than women to request facial surgery, a higher percentage of male cosmetic surgery patients are emotionally disturbed; one survey of plastic surgeons estimated that six out of every 100 female patients and seven out of every 100 male patients meet the diagnostic criteria for BDD.

When a person consults a plastic surgeon about a forehead lift or similar procedure, the doctor will spend some time talking with the patient about his or her motives for facial surgery as well as taking a general medical and surgical history. Good candidates for facial surgery are people who have a realistic understanding of the risks as well as the benefits of this type of surgery, and equally realistic expectations of the outcome. On the other hand, the following are considered psychological warning signs:

- The patient is considering surgery to please someone else, most often a spouse or partner.
- The patient expects facial surgery to guarantee career advancement.
- The patient has a history of multiple cosmetic procedures and/or complaints about previous surgeons.
- The patient thinks that the surgery will solve all his or her life problems.
- The patient has an unrealistic notion of what he or she will look like after surgery.
- The patient seems otherwise emotionally unstable.

If the surgeon thinks that the patient is a good candidate in terms of motivation, he or she will continue the diagnostic assessment by examining the patient's face at close range. To make an initial



evaluation of the possible results of a forehead lift, the surgeon will gently lift the skin at the outer edges of the eyes above the brows in an upward direction. He or she may also ask the patient to look in a mirror and describe what they don't like about their face. Next, the surgeon will ask the patient to frown, smile, or make a variety of other facial expressions. This technique allows the surgeon to observe the activity of the patient's facial muscles. Depending on the amount of loose skin in the upper eyelid, the height of the patient's hairline, and the relative position of the eyebrows, the surgeon may recommend a blepharoplasty or other procedure instead of a forehead lift.

### *Preparation*

Preparation for a forehead lift involves practical as well as medical concerns.

**FINANCIAL CONSIDERATIONS.** Most cosmetic facial procedures are not covered by health insurance because they are regarded as nonessential elective procedures. As a result, many cosmetic surgeons request that fees be paid in full before the operation. According to the AACS, 13.4% of cosmetic surgery patients take out loans to finance their procedure. In 2002, the average cost of a forehead lift was \$3,300.

**MEDICAL AND HOME CARE ISSUES.** A patient scheduled for a forehead lift will be asked to prepare for the operation by quitting smoking and discontinuing **aspirin** or any other medications that thin the blood. The surgeon will ask for a list of all medications that the patient is taking, including alternative herbal preparations and prescription drugs, to make sure that there will be no interactions with the anesthetic.

Patients are advised to have someone drive them home after the procedure and help them with routine chores for a day or two. If the forehead lift is combined with a face lift or blepharoplasty, the surgeon may have the patient remain in the hospital overnight. Although cosmetic surgery on the face does not interfere with walking or routine physical activity, most patients tire easily for the first few days after the procedure.

### *Aftercare*

#### *Classic forehead lift*

Aftercare for a classic forehead lift is somewhat more complicated than for an endoscopic procedure. Pain or numbness around the incision is likely to last longer than for an endoscopic procedure. It is controlled with prescription medication. Patients are usually advised to keep the head elevated for two to three days after surgery to minimize swelling. **Bandages** are

removed a day or two after the procedure; stitches or staples are taken out between 10 days and two weeks after surgery. The patient is asked to rest quietly for one or two days after surgery. Most patients can return to work after a week or 10 days.

### *Endoscopic forehead lift*

Fixation devices around the eyebrows are usually removed within 10 days after endoscopic surgery. As of early 2003, new absorbable fixation tacks that do not require later removal are being used with good results.

Patients who have had either type of forehead lift should not wash their hair until the bandage or dressing is removed, usually within two days. Heavy lifting, vigorous athletic activity, sexual activity, or any type of exertion that raises the blood pressure should be avoided for five to six weeks after the surgery. The skin around the incision should be protected from direct exposure to the sun for at least six months, because the new tissue is much more vulnerable to sunburn than normal skin. Most surgeons advise patients to use a sunblock cream to protect the skin even after the first six months.

Patients can use a special camouflage makeup to cover the bruising or swelling that often occurs after surgery, although they should be careful to keep the makeup away from the incision. Most of the bruising and other signs of surgery will fade within about three weeks.

### *Risks*

Major complications of a forehead lift are unusual. The most common risks from the procedure are as follows:

- Headaches for a day or two after surgery. This complication is much more common with a classic forehead lift than with endoscopic surgery.
- Mild pain around the incision for a few days after surgery.
- Numbness or itching sensations on the top of the scalp. These may last for as long as six months after surgery.
- Mild bruising or swelling around the eyelids and cheeks.
- Hair loss or thinning in the area of the incision. The hair will usually regrow within a few weeks or months.
- A feeling of numbness or dryness in the eye.
- Loss of function of the eyelid. This complication is corrected by another operation.
- Bleeding or infection. These are rare complications with forehead lifts.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A forehead lift is a specialized procedure performed only by a qualified plastic surgeon. Plastic surgeons are doctors who have completed three years of general surgical training followed by two to three years of specialized training in plastic surgery after completing their M.D. or D.O. degree.

A forehead lift may be performed either in a hospital or in an outpatient clinic that specializes in cosmetic surgery. Most endoscopic forehead lifts are performed in outpatient facilities.

### Normal results

Normal results of a forehead lift are an improvement in appearance that is satisfying to the patient. Specifically, the forehead should look less creased or wrinkled and frown lines should be lighter. The cosmetic effects of a forehead lift last between five and 10 years, depending on the person's age and the condition of their skin when the procedure was performed.

### Morbidity and mortality rates

In general, mortality and morbidity rates for forehead lifts and similar facial cosmetic procedures are very low. Almost all cases of mortality following facial cosmetic surgery involve patients who were treated for facial disfigurement because they had been severely burned or attacked by animals. Moreover, many plastic surgeons do not consider morbidity and mortality rates to be as significant as other factors in evaluating the success of facial cosmetic procedures. One group of researchers at the University of Washington maintains that "[t]he most important measures of outcome in facial cosmetic surgery are quality of life and patient satisfaction, in contrast to other, more objective measures such as complications or mortality rates."

Several American studies have reported that the rate of complications is no higher when a forehead lift is done in combination with other facial procedures than when it is done by itself.

### Alternatives

#### *Soft tissue fillers*

Alternatives to surgical treatment for frown lines and wrinkles of the forehead include injections of filler materials under the skin to smooth wrinkles or injections of botulinum toxin to paralyze the facial muscles

## QUESTIONS TO ASK THE DOCTOR

- How many forehead lifts have you performed?
- Should I consider combining the forehead lift with a face lift?
- Am I a candidate for an endoscopic forehead lift?
- Would I benefit from nonsurgical alternatives to a forehead lift?
- How long can I expect the effects of this surgery to last?

involved in frowning or brow wrinkling. The most commonly used filler materials are collagen and fat. Collagen is a protein found in human and animal connective tissue that makes the tissue strong and flexible. Most collagen that is used for cosmetic injections is derived from cattle, which produces allergic reactions in some people. Fat injections use fat taken from the patient's abdomen, thighs, or buttocks. The fat is then reinjected under the skin of the forehead to smooth out lines and wrinkles.

One drawback of both collagen and fat injections is that the effects are not permanent. Some new injectable filler substances are said to be permanent wrinkle removers. They include Artecoll, which contains small plastic particles that supposedly stimulate the body to produce its own collagen; and Radiesse, which is made of a chemical called calcium hydroxylapatite. Still other injectable tissue fillers are made from synthetic hyaluronic acid, which has been used for a number of years to treat joint pain. Since hyaluronic acid is produced naturally in the body, allergic reactions to this type of tissue filler are relatively rare.

#### *Botulinum toxin*

Botulinum toxin is a compound produced by the spores and growing cells of the organism that causes botulism, *Clostridium botulinum*. The toxin causes muscle paralysis. It was first used clinically in the 1960s to treat neurological disorders but also proved to be effective in paralyzing the facial muscles that cause crow's feet and frown wrinkles. Botulinum toxin, or Botox, was approved by the U.S. Food and Drug Administration (FDA) in April 2002 as a treatment for facial lines and wrinkles.

Both soft tissue fillers and Botox injections are regarded as effective though temporary alternatives to a forehead lift for reducing frown lines. Collagen injections must be repeated every three to six months, while Botox injections are effective for about four months.

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## ORGANIZATIONS

- American Academy of Cosmetic Surgery, 737 North Michigan Avenue, Suite 820, Chicago, IL, 60611 5405, (312) 981 6760, <http://www.cosmeticsurgery.org>.
- American Academy of Facial Plastic and Reconstructive Surgery, 310 S. Henry Street, Alexandria, VA, 22314, (703) 229 9291, <http://www.aafprs.org/>.
- American Board of Plastic Surgery, Seven Penn Center, Suite 4001635 Market Street, Philadelphia, PA, 19103 2204, (215) 587 9322, <http://www.abplsurg.org/>.
- American College of Surgeons, 633 North Saint Claire Street, Chicago, IL, 60611, (312) 202 5000, <http://www.facs.org/>.
- American Society for Aesthetic Plastic Surgery, 11081 Winners Circle, Los Alamitos, CA, 90720, (888) 272 7711, <http://www.surgery.org/>.
- American Society of Plastic and Reconstructive Surgeons, 444 E. Algonquin Road, Arlington Heights, IL, 60005, (847) 228 9900, <http://www.plasticsurgery.org>.

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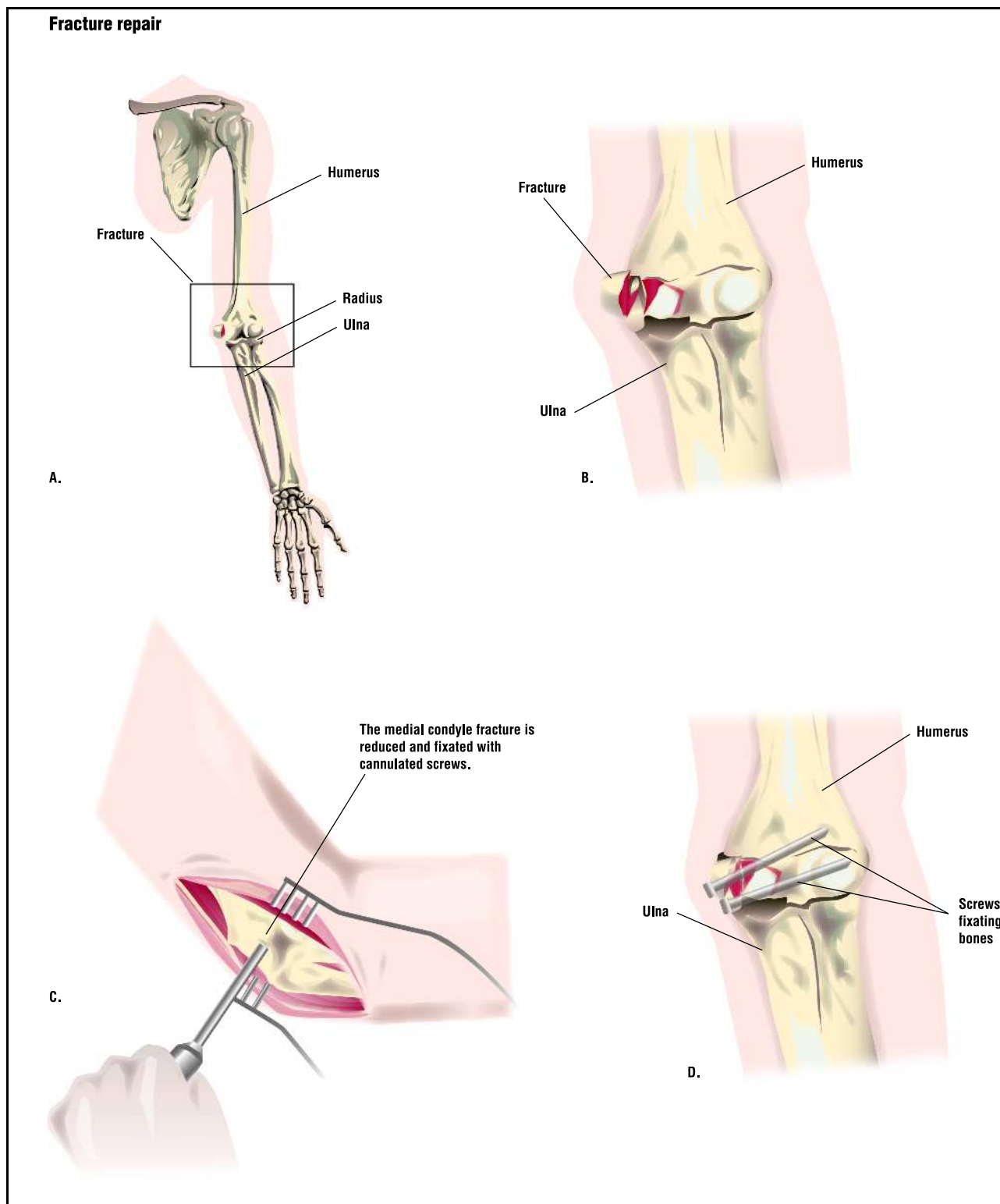
## Fracture repair

### Definition

Bone is the hardest tissue in the human body, but when bones are subjected to forces that exceed their strength, they may break. The likelihood that a bone will break depends on the location of the bone in the body, the thickness of the bone, and the circumstances under which the force was applied. The most commonly broken bones are those in the wrist, hip, and ankle. The terms "break" and "fracture" mean the same thing. Fracture repair is the process of rejoining and realigning the ends of broken bones, usually performed by an orthopedist, general surgeon, or family doctor. In cases of an emergency, first aid measures should be used to provide temporary realignment and immobilization until proper medical help is available.

### Purpose

Fracture repair is required when there is a need to restore the normal alignment and function of a broken bone. Throughout the stages of fracture healing, the bones must be held firmly in the correct position. In the event that a fracture is not properly repaired, misalignment of the bone may occur, resulting in possible physical dysfunction of the bone, adjacent joint, or region of the body.



In this patient, a fall has resulted in fractures in the bones of the elbow (B). To repair the fracture, an incision is made in the elbow area (C), and the bones are fixed with screws to aid proper healing (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)



## KEY TERMS

**Compound fracture**—A fracture in which the broken end or ends of the bone have penetrated through the skin; also known as an open fracture.

**Staphylococcal infection**—An infection caused by any of several pathogenic species of *Staphylococcus*, commonly characterized by the formation of abscesses in the skin or other organs.

**Streptococcal infection**—An infection caused by a pathogenic bacterium of one of several species of the genus *Streptococcus* or their toxins. Almost any organ in the body may be involved.

### Demographics

The incidence of fractures that occur in the United States can only be estimated because fractures are not always reported. The average person sustains two to three fractured bones during the course of a lifetime. A reasonable estimate is approximately nine million fractures per year.

Fractures are slightly more common in children and adolescents than in young adults due to the levels and kinds of activities in which they engage. Fractures become more common in adults as they age due to changes in bone structure and generally diminished levels of physical activity.

### Description

Fracture repair is accomplished by means of applied **traction**, surgery, and immobilizing affected bones. The bone fragments are aligned as closely as possible to their normal position without injuring the skin. Metal wires or screws may be needed to align smaller bone fragments. Once the broken ends of the bone are set, the affected area is immobilized for several weeks and kept rigid with a sling, plaster cast, brace, or splint. With the use of traction, muscles pulling on the fracture site are neutralized by weights attached to a series of ropes running over pulleys. Strategically implanted electrical stimulation devices have proven beneficial in healing a fracture site, especially when the fracture is healing poorly and repair by other means is difficult.

### Diagnosis/Preparation

Fractures are commonly diagnosed on the basis of history of trauma or the presence of pain. An x ray is usually taken to confirm the diagnosis.

Precautions for fracture repair include any relevant factors in an individual's medical condition and history. These include allergic reactions to anesthesia and the presence of bleeding disorders that may complicate surgery.

Preparation often begins with emergency splinting to immobilize the body part or parts involved. When fracture repair is necessary, the procedure is often performed in a hospital, but can also be successfully done in an outpatient surgical facility, doctor's office, or emergency room. Before any surgery for fracture repair, blood and urine studies may be performed. X rays may be obtained. It must be noted, however, that not all fractures are immediately apparent on an initial x-ray examination. In such a case, when a fracture is highly suspected, the extent of the fracture can be properly diagnosed by repeating the x rays 10–14 days later. Depending upon the situation, local or **general anesthesia** may be used during fracture repair.

### Aftercare

Immediately following surgical repair of a fracture, x rays may be again taken through the cast or splint to evaluate whether the rejoined pieces are in a good position for healing. The x ray can be performed either before the application of the splint or at least before an individual is awakened from the general anesthesia. Persons need to **exercise** caution and not place excess pressure on any part of the cast until it is completely dry. Excess pressure on the operative site should also be avoided until complete healing has taken place and the injury has been re-examined by the physician or surgeon. If the cast becomes exposed to moisture, it may soften and require repair. For this reason, plastic has largely replaced plaster as the casting material of choice. The injured region should be elevated or propped up whenever possible to reduce the possibility of swelling.

### Risks

Surgical risks of fracture repair are greater in persons over 60 years of age because the bones often require more time to properly heal. Obesity may place extra stress on the fracture site, affecting healing and possibly increasing the risk of re-fracturing the same bone. The healing process after fracture repair may also be slowed by smoking, poor nutrition, alcoholism, and chronic illness. Some medications may affect the fracture site, causing poor union; such medications include anti-hypertensives and steroids such as cortisone.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Fracture repair is usually performed by an orthopedic surgeon, general surgeon, or family physician. In cases of an emergency, first aid measures should be used for temporary realignment and immobilization until proper medical help can be obtained. Relatively uncomplicated fractures may be immobilized in a physician's office. More commonly, fractures are treated in a hospital setting.

Possible complications following fracture repair include excessive bleeding, improper fit of joined bone ends, pressure on nearby nerves, delayed healing, and a permanent incomplete healing (union) of the fracture. If there is a poor blood supply to the fractured site and one of the portions of broken bone is not adequately supplied with blood, the bony portion may die and healing of the fracture will not take place. This complication is called aseptic necrosis. Poor immobilization of the fracture from improper casting that permits motion between the bone parts may prevent healing and repair of the bone, and result in possible deformity. Infection can interfere with bone repair. This risk is greater in the case of a compound fracture (a bone fracture involving a portion of bone that breaks through the surface of skin). Compound fracture sites provide ideal conditions for severe infections by *Streptococcus* and *Staphylococcus* bacteria. Occasionally, fractured bones in the elderly may never heal properly. The risk is increased when nutrition is poor.

### Normal results

Once the procedure for fracture repair is completed, the body begins to produce new tissue to bridge the fracture site and rejoin the broken pieces. At first, this tissue (called a callus) is soft and easily injured. Later, the body deposits bone minerals (primarily compounds containing calcium) until the callus becomes a solid piece of bone. The fracture site is thus further strengthened with extra bone. It usually takes about six weeks for the pieces of a broken bone to knit (heal) together. The exact time required for healing depends on the type of fracture and the extent of damage. Before the use of x rays, fracture repair was not always accurate and frequently resulted in crippling deformities. With modern x-ray technology, physicians can view the extent of the fracture, check the setting following the repair, and be certain after the

## QUESTIONS TO ASK THE DOCTOR

Candidates for fracture repair should consider asking the following questions:

- What type of fracture do I have?
- Is the surgeon properly trained in the proposed method of fracture repair?
- How many similar procedures has the surgeon performed?

procedure that the bones have not moved from their intended alignment. Children's bones usually heal more rapidly than do the bones of adults.

### Morbidity and mortality rates

Morbidity associated with fracture repair includes damage to nerves or primary blood vessels that are adjacent to the fracture site. Improper alignment causing deformity is an abnormal outcome that is relatively rare due to presently available medical technology.

Mortality associated with fractures is also rare. It is usually associated with infections or contamination acquired during the fracture process.

### Alternatives

There are no alternatives to proper fracture repair. Problems associated with allowing a fracture to heal without intervention include misalignment, deformity, loss of function, and pain.

Magnetic fields are occasionally used to stimulate healing when conventional techniques are not effective.

### Resources

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**ORGANIZATIONS**

- American Academy of Orthopaedic Surgeons, 6300 N. River Road, Rosemont, IL, 60018 4262, (847) 823 7186, (800) 346 AAOS, (847) 823 8125, <http://www.aaos.org>.
- American College of Surgeons, 633 North Saint Claire Street, Chicago, IL, 60611, (312) 202 5000, <http://www.facs.org/>.
- American Society for Bone and Mineral Research, 2025 M Street, NW, Suite 800, Washington, DC, 20036 3309, (202) 367 1161, <http://www.asbmr.org/>.
- Orthopedic Trauma Association, 6300 N. River Road, Suite 727, Rosemont, IL, 60018 4226, (847) 698 1631, <http://www.ota.org/links.htm>.

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Functional endoscopic sinus surgery see  
**Endoscopic sinus surgery**

Fundoplication surgery see **Gastroesophageal reflux surgery**

Funnel chest repair see **Pectus excavatum repair**

Furosemide see **Diuretics**

# G

Gallbladder removal see **Cholecystectomy**

Gallbladder ultrasound see **Abdominal ultrasound**

## Gallstone removal

### Definition

Also known as cholelithotomy, gallstone removal is a procedure that rids the gallbladder of calculus buildup.

### Purpose

The gallbladder is not a vital organ. It is located on the right side of the abdomen underneath the liver. The gallbladder's function is to store bile, concentrate it, and release it during digestion. Bile is supposed to retain all of its chemicals in solution, but commonly one of them crystallizes and forms sandy or gravel-like particles, finally collecting into gallstones. The formation of gallstones causes gallbladder disease (cholelithiasis).

Chemicals in bile will form crystals as the gallbladder draws water out of the bile. The solubility of these chemicals is based on the concentration of three chemicals: bile acids, phospholipids, and cholesterol. If the chemicals are out of balance, one or the other will not remain in solution. Dietary fat and cholesterol are also implicated in crystal formation.

As the bile crystals aggregate to form stones, they move about, eventually blocking the outlet and preventing the gallbladder from emptying. This blockage results in irritation, inflammation, and sometimes infection (cholecystitis) of the gallbladder. The pattern is usually one of intermittent obstruction due to stones moving in and out of the way. Meanwhile, the gallbladder becomes more and more scarred. Sometimes,

infection fills the gallbladder with pus, which is a serious complication.

Occasionally, a gallstone will travel down the cystic duct into the common bile duct and get stuck there. This blockage will back bile up into the liver as well as the gallbladder. If the stone sticks at the ampulla of Vater (a narrowing in the duct leading to the pancreas), the pancreas will also be blocked and will develop pancreatitis.

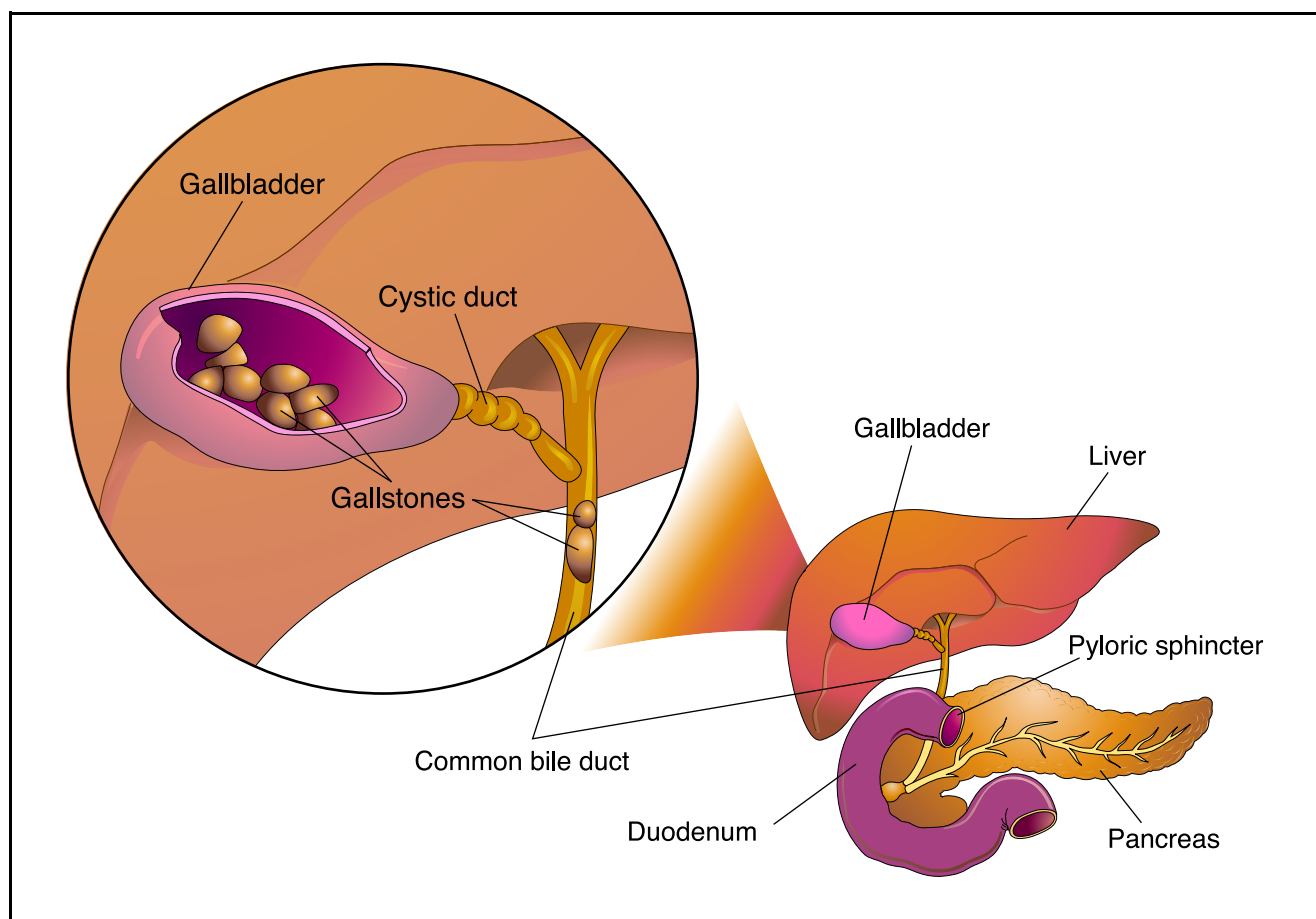
Gallstones will cause a sudden onset of pain in the upper abdomen. Pain will last for 30 minutes to several hours. Pain may move to the right shoulder blade. Nausea with or without vomiting may accompany the pain.

### Demographics

Gallstones are approximately two times more common in females than in males. Overweight women in their middle years constitute the vast majority of patients with gallstones in every racial or ethnic group. An estimated 10% of the general population has gallstones. The prevalence for women between ages 20 and 55 is about 20%, and is higher after age 50 (25–30%). Women between the ages of 20 and 60 years are three times more likely to have gallstones than are men. Certain people, in particular the Pima tribe of Native Americans in Arizona, have a genetic predisposition to forming gallstones. Scandinavians also have a higher than average incidence of this disease.

There seems to be a strong genetic correlation with gallstone disease, because stones are more than four times as likely to occur among first-degree relatives. Since gallstones rarely dissolve spontaneously, the prevalence increases with age. Obesity is a well-known risk factor since being overweight causes chemical abnormalities that lead to increased levels of cholesterol. Gallstones are also associated with rapid weight loss secondary to dieting. Pregnancy is a risk factor since increased estrogen levels result in an increased





**Gallstone removal, also known as cholelithotomy, usually involves the surgical removal of the entire gallbladder, but in recent years the procedure done by laparoscopy has resulted in smaller surgical incisions and faster recovery time. (Illustration by Electronic Illustrators Group. Cengage Learning, Gale.)**

cholesterol secretion and abnormal changes in bile. However, while an increase in dietary cholesterol is not a risk factor, an increase in triglycerides is positively associated with a higher incidence of gallstones. Diabetes mellitus is also believed to be a risk factor for gallstone development.

### Description

Surgery to remove the entire gallbladder with all its stones is usually the best treatment, provided the patient is able to tolerate the procedure. A relatively new technique of removing the gallbladder using a laparoscope has resulted in quicker recovery and much smaller surgical incisions than the 6-in (15-cm) gash under the ribs on the right that had previously been the standard procedure; however, not everyone is a candidate for this approach. If the procedure is not expected to have complications, laparoscopic **cholecystectomy** is performed. Laparoscopic surgery

requires a space in the surgical area for visualization and instrument manipulation. The laparoscope with attached video camera is inserted. Several other instruments are inserted through the abdomen to assist the surgeon to maneuver around other nearby organs during surgery. The surgeon must take precautions not to accidentally harm anatomical structures in the liver. Once the cystic artery has been divided and the gallbladder dissected from the liver, the gallbladder can be removed.

If the gallbladder is extremely diseased (inflamed, infected, or has large gallstones), the abdominal approach (open cholecystectomy) is recommended. This surgery is usually performed with an incision in the upper midline of the abdomen or on the right side of the abdomen below the rib (right subcostal incision).

If a stone is lodged in the bile ducts, additional surgery must be done to remove it. After surgery, the surgeon will ordinarily insert a drain to collect bile

## KEY TERMS

**Bilirubin**—A pigment released from red blood cells.

**Cholecystectomy**—Surgical removal of the gallbladder.

**Cholelithotomy**—Surgical incision into the gallbladder to remove stones.

**Contrast agent**—A substance that causes shadows on x rays (or other images of the body).

**Cystic artery**—An artery that brings oxygenated blood to the gallbladder.

**Endoscope**—An instrument designed to enter body cavities.

**Jaundice**—A yellow discoloration of the skin and eyes due to excess bile that is not removed by the liver.

**Laparoscopy**—Surgery performed through small incisions with pencil-sized instruments.

**Triglycerides**—Chemicals made up mostly of fat that can form deposits in tissues and cause health risks or disease.

until the system is healed. The drain can also be used to inject contrast material and take x rays during or after surgery.

A procedure called endoscopic retrograde cholangiopancreatography (ERCP) allows the removal of some bile duct stones through the mouth, throat, esophagus, stomach, duodenum, and biliary system without the need for surgical incisions. ERCP can also be used to inject contrast agents into the biliary system, providing finely detailed pictures.

Patients with symptomatic cholelithiasis can be treated with certain medications, a technique called oral bile acid litholysis or oral dissolution therapy. This technique is especially effective for dissolving small cholesterol-composed gallstones. Current research indicates that the success rate for oral dissolution treatment is 70–80% with floating stones (those predominantly composed of cholesterol). Approximately 10–20% of patients who receive medication-induced litholysis can have a recurrence within the first two or three years after treatment completion.

Extracorporeal shock wave **lithotripsy** is a treatment in which shock waves are generated in water by lithotripters (devices that produce the waves). There are several types of lithotripters available for gallbladder removal. One specific lithotripter involves the use of piezoelectric crystals, which allow the shock waves

to be accurately focused on a small area to disrupt a stone. This procedure does not generally require analgesia (or anesthesia). Damage to the gallbladder and associated structures (such as the cystic duct) must be present for stone removal after the shock waves break up the stone. Typically, repeated shock wave treatments are necessary to completely remove gallstones. The success rate of the fragmentation of the gallstone and urinary clearance is inversely proportional to stone size and number: patients with a small solitary stone have the best outcome, with high rates of stone clearance (95% are cleared within 12–18 months), while patients with multiple stones are at risk for poor clearance rates. Complications of shock wave lithotripsy include inflammation of the pancreas (pancreatitis) and acute cholecystitis. Gallstones do recur after lithotripsy; the rate of recurrence after the first year is 6–7%, and after five years the rate of recurrence is 31–44%.

A method called contact dissolution of gallstone removal involves direct entry (via a percutaneous transhepatic catheter) of a chemical solvent (such as methyl tertbutylether, MTBE). MTBE is rapidly removed unchanged from the body via the respiratory system (exhaled air). Side effects in persons receiving contact dissolution therapy include foul-smelling breath, dyspnea (difficulty breathing), vomiting, and drowsiness. Treatment with MTBE can be successful in treating cholesterol gallstones regardless of the number and size of stones. Studies indicate that the success rate for dissolution is well over 95% in persons who receive direct chemical infusions that can last 5–12 hours.

## Diagnosis/Preparation

Diagnostically, gallstone disease, which can lead to gallbladder removal, is divided into four diseases: biliary colic, acute cholecystitis, choledocholithiasis, and cholangitis. Biliary colic is usually caused by intermittent cystic duct obstruction by a stone (without any inflammation), causing a severe, poorly localized, and intensifying pain on the upper right side of the abdomen. These painful attacks can persist from days to months in patients with biliary colic.

Persons affected with acute cholecystitis caused by an impacted stone in the cystic duct also suffer from gallbladder infection in approximately 50% of cases. These people have moderately severe pain in the upper right portion of the abdomen that lasts longer than six hours. Pain with acute cholecystitis can also extend to the shoulder or back. Since there may be infection inside the gallbladder, the patient may also have fever. On the right side of the abdomen below the

last rib, there is usually tenderness with inspiratory (breathing in) arrest (Murphy's sign). In about 33% of cases of acute cholecystitis, the gallbladder may be felt in the abdomen with palpation (feeling for tenderness). Mild jaundice can be present in about 20% of cases.

Persons with choledocholithiasis, or intermittent obstruction of the common bile duct, often do not have symptoms; but, if present they are indistinguishable from the symptoms of biliary colic.

A more severe form of gallstone disease is cholangitis, which causes stone impaction in the common bile duct. In about 70% of cases, these patients present with Charcot's triad (pain, jaundice, and fever). Patients with cholangitis may have chills, mild pain, lethargy, and delirium, which indicate that infection has spread to the bloodstream (bacteremia). The majority of patients with cholangitis will have fever (95%), tenderness in the upper right side of the abdomen, and jaundice (80%).

In addition to a **physical examination**, preparation for laboratory (blood) and special tests is essential to gallstone diagnosis. Patients with biliary colic may have elevated bilirubin and should have an **ultrasound** study to visualize the gallbladder and associated structures. An increase in the **white blood cell count** (leukocytosis) can be expected for both acute cholecystitis and cholangitis (seen in 80% of cases). Ultrasound testing is recommended for acute cholecystitis patients, whereas ERCP is the test usually indicated to assist in a definitive diagnosis for both choledocholithiasis and cholangitis. Patients with either biliary colic or choledocholithiasis are treated with elective laparoscopic cholecystectomy. Open cholecystectomy is recommended for acute cholecystitis. For cholangitis, emergency ERCP is indicated for stone removal. ERCP therapy can remove stones produced by gallbladder disease.

### Aftercare

Without a gallbladder, stones rarely recur. Patients who have continued symptoms after their gallbladder is removed may need an ERCP to detect residual stones or damage to the bile ducts caused by the original stones. Occasionally, the ampulla of Vater is too tight for bile to flow through and causes symptoms until it is opened up.

### Risks

The most common medical treatment for gallstones is the surgical removal of the gallbladder

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The procedure is performed in a hospital by a physician who specializes in general surgery and has extensive experience in the surgical techniques required.

(cholecystectomy). Risks associated with gallbladder removal are low, but include damage to the bile ducts, residual gallstones in the bile ducts, or injury to the surrounding organs. With open cholecystectomy, bile duct damage occurs at a rate of 1 per 1,000 patients; for laparoscopic cholecystectomy, the bile duct damage rate is 1–5 per 1,000 patients.

### Normal results

Most patients undergoing laparoscopic cholecystectomy may go home the same day of surgery, and may immediately return to normal activities and a normal diet, while most patients who undergo open cholecystectomy must remain in the hospital for five to seven days. After one week, they may resume a normal diet, and in four to six weeks they can expect to return to normal activities.

### Morbidity and mortality rates

Cholecystectomy is generally a safe procedure, with an overall mortality rate of 0–1 per 1,000. Infections occur in less than 1 per 1,000 patients undergoing laparoscopic cholecystectomy. Heart problems during the procedures occur at a rate of 5 per 1,000 for arrhythmias and 1 per 1,000 for actual heart attack. Pregnant women who must undergo cholecystectomy have a high rate of fetal loss: 40 per 1,000 when no pancreatitis is present and as high as 600 per 1,000 when pancreatitis is present. The improved technique of laparoscopic cholecystectomy accounts for 90% of all cholecystectomies performed in the United States; the improved technique reduces time missed away from work, patient hospitalization, and postoperative pain.

### Alternatives

There are no other acceptable alternatives for gallstone removal besides surgery, shock wave fragmentation, or chemical dissolution.

## QUESTIONS TO ASK THE DOCTOR

- How long must I remain in the hospital following gallstone removal?
- How do I care for the my incision site?
- How soon can I return to normal activities following gallstone removal?

### Resources

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## Ganglion cyst removal

### Definition

Ganglion cyst removal, or ganglionectomy, is the removal of a fluid-filled sac on the skin of the wrist, finger, or sole of the foot. The cyst is attached to a tendon or a joint through its fibers and contains synovial fluid, which is the clear liquid that lubricates the joints and tendons of the body. The surgical procedure is performed in a doctor's office. It entails aspiration, or draining fluid from the cyst with a large hypodermic needle. The cyst may also be excised (removed by cutting).

### Purpose

Ganglion cysts are sacs that contain the synovial fluid found in joints and tendons. They are the most common forms of soft tissue growth on the hand and are distinguished by their sticky liquid contents. The cystic structures are attached to tendon sheaths via a long thin tube-like arm. About 65% of ganglion cysts occur on the upper surface of the wrist, with another 20–25% on the volar (palm) surface of the hand. Most

of the remaining 10–15% of ganglion cysts occur on the sheath of the flexor tendon. In a few cases, the cysts emerge on the sole of the foot.

Ganglion cysts have appeared in medical writing from the time of Hippocrates (c. 460–c. 375 B. C.). Their exact cause is unknown. There are some indications, however, that ganglion cysts result from trauma to or deterioration of the tissue lining in the joints that secretes synovial fluid.

Ganglion cysts can emerge quite quickly, and can disappear just as fast. They are benign growths, usually causing problems in the functioning of the joints or tendons of the hand or finger only when they are large. Many people do not seek medical attention for ganglion cysts unless they cause pain, affect the movement of the nearby tendons, or become particularly unsightly.

An old traditional treatment for a ganglion cyst was to hit it with a Bible, since the cysts can burst when struck. Today, cysts are removed surgically by aspiration but often reappear. Surgical excision is the most reliable treatment for ganglion cysts, but aspiration is the more common form of therapy.

### Demographics

Ganglion cysts account for 50–70% of all soft tissue tumors of the hand and wrist. They are most likely to occur in adults between the ages of 20 and 50, with the female: male ratio being about three to one. Most ganglion cysts are visible; however, some are occult (hidden). Occult cysts may be diagnosed because the patient feels pain in that part of the hand or has noticed that the tendon cannot move normally. In about 10% of cases, there is associated trauma.

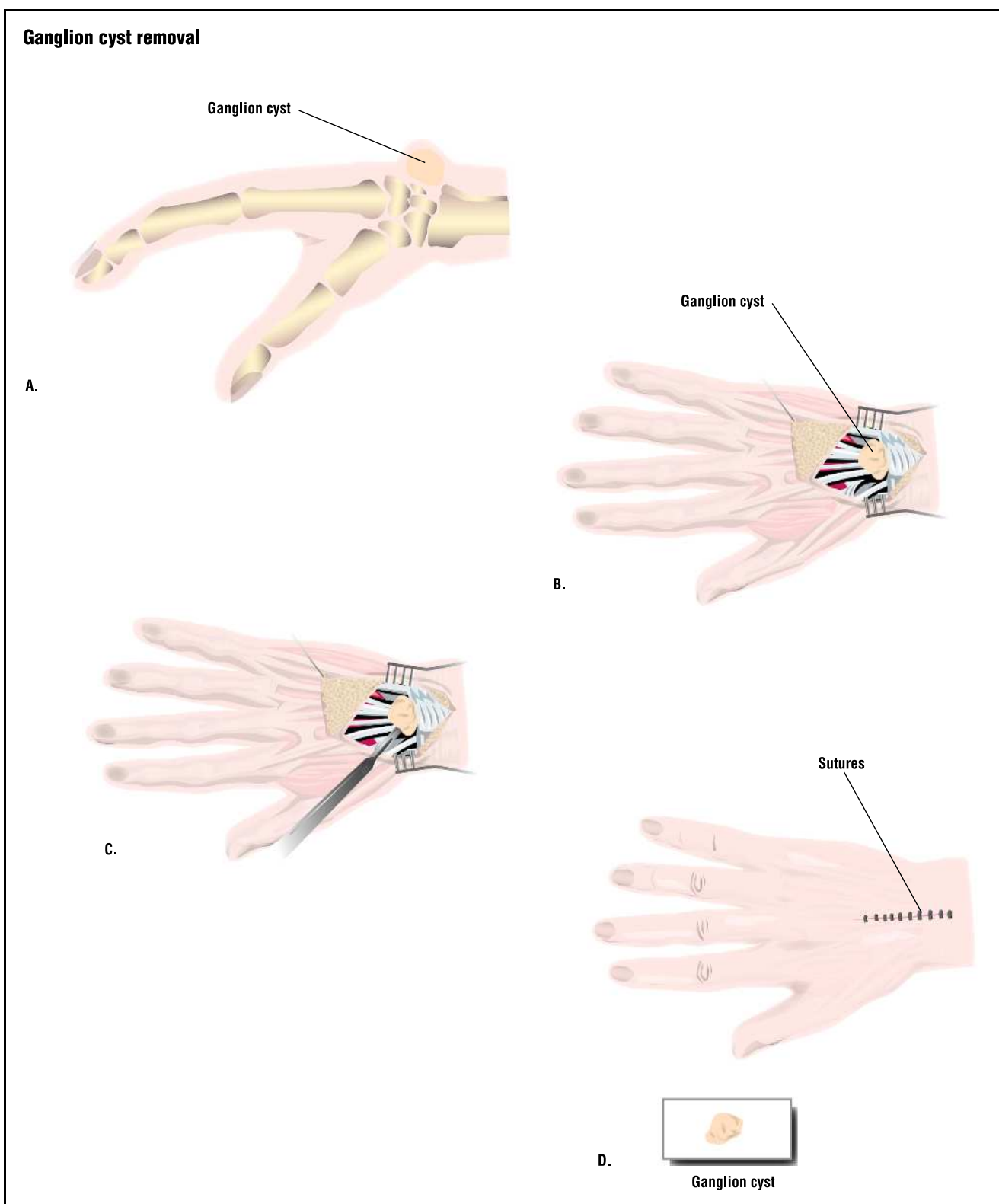
### Description

Patients are given a local or regional anesthetic in a doctor's office. Two methods are used to remove the cysts. Most physicians use the more conservative procedure, which is known as aspiration.

#### Aspiration

- An 18- or 22-gauge needle attached to a 20–30-mL syringe is inserted into the cyst. The doctor removes the fluid slowly by suction.
- The doctor may inject a corticosteroid medication into the joint after the fluid has been withdrawn.
- A compression dressing is applied to the site.
- The patient remains in the office for about 30 minutes.





A ganglion cyst is usually attached to a tendon or muscle in the wrist or finger (A). To remove it, the skin is cut open (B), the growth is removed (C), and the skin is sutured closed (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Aspiration**—A surgical procedure in which the physician uses a thick needle to draw fluid from a joint or from a sac produced by a growth or by infection.

**Cyst**—An abnormal saclike growth in the body that contains liquid or a semisolid material.

**Excision**—Removal by cutting.

**Ganglion**—A knot or knot-like mass; it can refer either to groups of nerve cells outside the central nervous system or to cysts that form on the sheath of a tendon.

**Ganglionectomy**—Surgery to excise a ganglion cyst.

**Occult**—Hidden; concealed from the doctor's direct observation. Some ganglion cysts are occult.

**Synovial fluid**—A transparent alkaline fluid resembling the white of an egg. It is secreted by the synovial membranes that line the joints and tendon sheaths.

**Volar**—Pertaining to the palm of the hand or the sole of the foot.

### Excision

Some ganglion cysts are so large that the doctor recommends excision. This procedure also takes place in the physician's office with local or regional anesthetic.

Excision of a ganglion cyst is performed as follows:

- The physician palpates, or feels, the borders of the sac with the fingers and marks the sac and its periphery.
- The sac is cut away with a scalpel.
- The doctor closes the incision with sutures and applies a bandage.
- The patient is asked to remain in the office for at least 30 minutes.

### Diagnosis/Preparation

Ganglion cysts are fairly easy to diagnose because they are usually visible and pliable to the touch. They are distinguished from other growths by their location near tendons or joints and by their fluid consistency. Ganglion cysts are sometimes confused with a carpal boss (a bony, non-mobile spur on the top of the wrist), but can usually be distinguished by the fact that they can be moved and are usually less painful for the patient.

The doctor may schedule one or more imaging studies of the hand and wrist. An x ray may reveal

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Aspiration or excision to treat ganglion cysts is done by primary care doctors as well as orthopedic surgeons. The procedures may be performed in the doctor's office or at an outpatient clinic.

bone or joint abnormalities. **Ultrasound** may be used to diagnose the presence of occult cysts.

### Aftercare

Patients should avoid strenuous physical activity for at least 48 hours after surgery and report any signs of infection or inflammation to their physician. A follow-up appointment should be scheduled within three weeks of aspiration or excision. Excision may result in some stiffness after the surgery and some difficulties in flexing the hand because of scar tissue formation.

### Risks

Aspiration has very few complications as a treatment for ganglion cysts; the most common aftereffects are infection or a reaction to the cortisone injection. Complications of excision include some stiffness in the hand and scar formation. Ganglion cysts recur after excision in about 5–15% of cases, usually because the cyst was not completely removed.

### Normal results

Aspirated ganglion cysts disappear and cause no further symptoms in 27–67% of cases. They may, however, reoccur and require repeated aspiration. Aspiration combined with an injection of cortisone has more success than aspiration by itself. Excision is a much more reliable procedure, however, and the stiffness that the patient may experience after the procedure eventually goes away. The formation of a small scar is normal.

### Morbidity and mortality rates

The only risks for ganglion cyst removal are infections or inflammation due to the cortisone injection. There is a small risk of damage to nearby nerves or blood vessels.

### Alternatives

Alternatives to aspiration and excision in the treatment of ganglion cysts include watchful waiting

## QUESTIONS TO ASK THE DOCTOR

- May I continue to exercise and continue my other regular activities with this cyst?
- Would you recommend removal rather than aspiration?
- How effective is aspiration in preventing these cysts from recurring?
- How successful have excisions been with your patients?

and resting the affected hand or foot. It is quite common for ganglion cysts to fade away without any surgical treatment.

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## Gastrectomy

### Definition

Gastrectomy is the surgical removal of all or part of the stomach.

### Purpose

Gastrectomy is performed most often to treat the following conditions:

- stomach (gastric) cancer
- bleeding gastric ulcer

- perforation of the stomach wall
- noncancerous tumors

### Demographics

According to the World Health Organization (WHO), stomach cancer is the second leading cause of cancer deaths in the world, accounting for about 8.8% of all deaths from cancer. (Lung cancer accounts for 17.8% of cancer deaths). Although stomach cancer is a worldwide problem, the incidence rates vary considerably in different countries. In the 2000s, the highest **death** rates from stomach cancer are found in Japan, South America, especially Chile, and parts of the former Soviet Union. In the United States, the American Cancer Society expected about 21,300 new cases of stomach cancer to be diagnosed and 11,000 deaths to be attributed to the disease. Since gastrectomy is most often done to treat stomach cancer, gastrectomy rates should mirror stomach cancer rates.

### Description

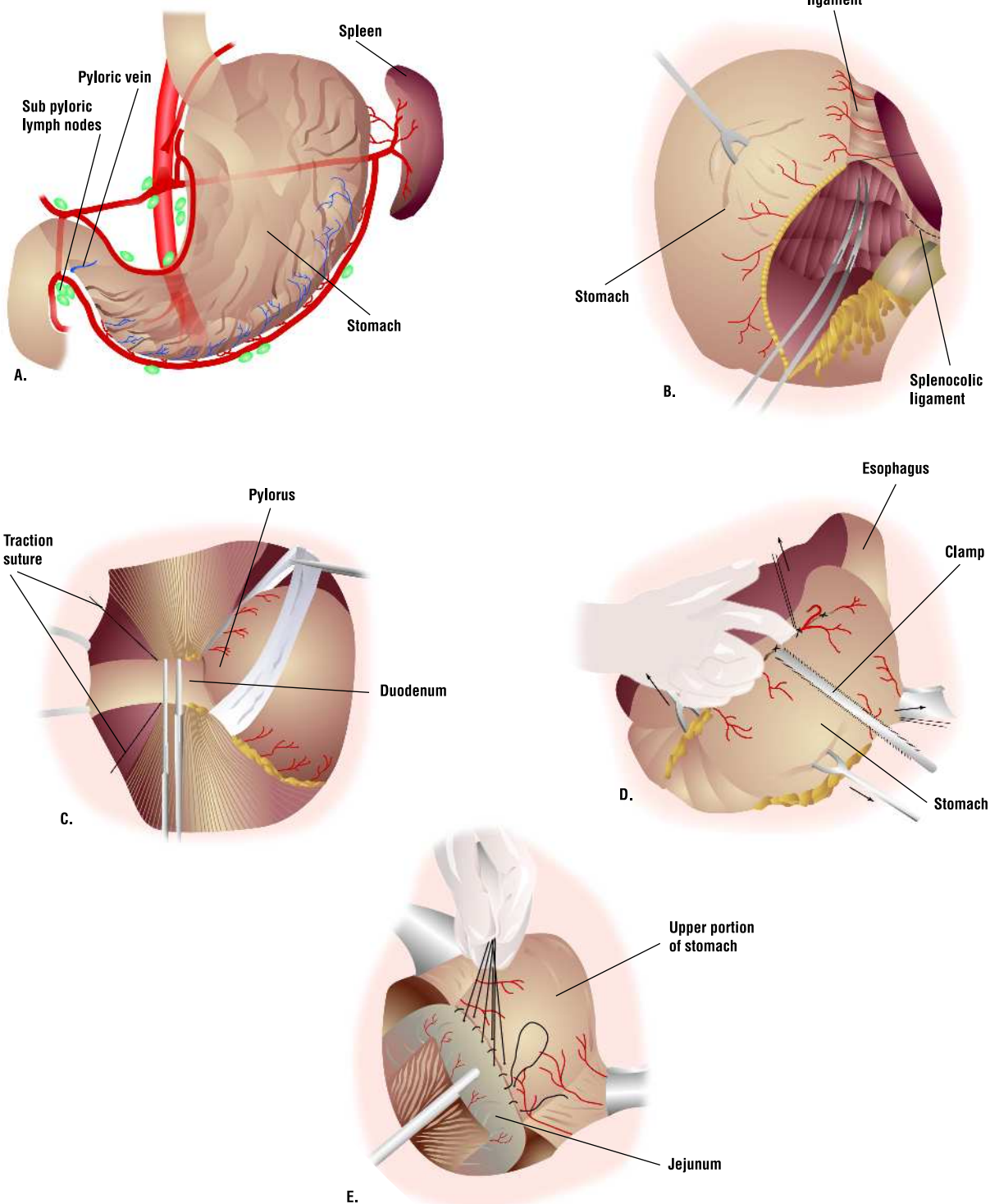
#### *Gastrectomy for cancer*

Surgery is the only curative treatment for gastric (stomach) cancer. If the cancer is diagnosed early and limited to one part of the stomach, the tumor and only part of the stomach may be removed (partial or subtotal gastrectomy.) More often, the entire stomach is removed (total gastrectomy) along with the surrounding lymph nodes. When the entire stomach is removed, the esophagus is attached directly to the small intestine.

A gastrectomy is performed under **general anesthesia**. Once the patient is anesthetized, a urinary catheter is usually inserted to monitor urine output. A thin nasogastric tube is inserted into the nose, through the esophagus, and into the stomach. The abdomen is cleansed with an antiseptic solution. The surgeon makes a large incision from just below the breastbone down to the navel. The surgeon then removes all or part of the stomach and attaches connects either the remaining piece of stomach or the esophagus to the small intestine.

Gastrectomy for gastric cancer is almost always done using the traditional open surgery technique, which requires a wide incision to open the abdomen. However, some surgeons use a laparoscopic technique that requires only a small incision. The laparoscope is connected to a tiny video camera that relays a picture of the abdomen to a monitor to guide the surgeon who then operates through this incision.

## Gastrectomy



To remove a portion of the stomach in a gastrectomy, the stomach is accessed via an incision in the abdomen. The ligaments connecting the stomach to the spleen and colon are severed (B). The duodenum is clamped and separated from the bottom of the stomach, or pylorus (C). The end of the duodenum will be stitched closed. The stomach itself is clamped, and the portion to be removed is severed (D). The remaining stomach is attached to the jejunum, another portion of the small intestine (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)



## KEY TERMS

**Adenocarcinoma**—A form of cancer that involves cells from the lining of the walls of many different organs of the body.

**Antrectomy**—A surgical procedure for ulcer disease in which the antrum, a portion of the stomach, is removed.

**Biopsy**—Surgical removal of a small piece of tissue so that it can be examined under the microscope for malignancy (cancer).

**Laparoscopy**—The examination of the inside of the abdomen through a lighted tube (endoscope) inserted through a small incision, sometimes accompanied by surgery.

**Lymphoma**—Malignant tumor of lymphoblasts derived from B lymphocytes, a type of white blood cell.

The potential benefits of laparoscopic surgery include less postoperative pain, decreased hospitalization, and earlier return to normal activities. The use of laparoscopic gastrectomy is limited, however. Only patients with early-stage gastric cancers or those whose surgery is intended only as palliative treatment (pain and symptomatic relief rather than cure) are considered for this minimally invasive technique.

### *Gastrectomy for ulcers*

Gastrectomy is also used occasionally in the treatment of severe peptic ulcer disease or its complications. While the vast majority of peptic ulcers (gastric ulcers in the stomach or duodenal ulcers in the duodenum) are managed with medication, partial gastrectomy is sometimes required for peptic ulcer patients who have complications. These include patients who do not respond satisfactorily to medical therapy, those who develop a bleeding or perforated ulcer, and those who develop pyloric obstruction (a blockage to the exit from the stomach). The surgical procedure for severe ulcer disease is also called an **antrectomy**. An antrectomy is a limited form of gastrectomy in which the antrum, or lower portion of the stomach that produces digestive juices, is removed.

### Diagnosis/Preparation

Before undergoing gastrectomy, patients require a variety of tests such as x rays, computed tomography (CT) scans, ultrasonography, or endoscopic biopsies

(microscopic examination of tissue) to confirm the diagnosis and localize the tumor or ulcer. **Laparoscopy** and tissue biopsy may be used to diagnose a malignancy or to determine the extent of a tumor that is already diagnosed. When a tumor is strongly suspected, laparoscopy is often performed immediately before the surgery to remove the tumor. This avoids the need to anesthetize the patient twice, and sometimes avoids the need for surgery completely if the tumor found through laparoscopy is deemed inoperable.

### Aftercare

After gastrectomy surgery, patients are taken to the recovery unit and **vital signs** are closely monitored by the nursing staff until the anesthesia wears off. Patients commonly feel pain from the incision, and pain medication is prescribed to provide relief and is usually delivered intravenously (IV, directly into a vein). Upon waking from anesthesia, patients have an intravenous line, a urinary catheter, and a nasogastric tube in place. They cannot eat or drink immediately following surgery. In some cases, oxygen is delivered through a mask that fits over the mouth and nose. The nasogastric tube is attached to intermittent suction to keep what remains of the stomach empty.

If the whole stomach has been removed, the tube goes directly to the small intestine and remains in place until bowel function returns. This can take two to three days and is monitored by listening with a **stethoscope** for bowel sounds. When bowel sounds return, the patient can drink clear liquids. If the liquids are tolerated, the nasogastric tube is removed and the diet is gradually changed from liquids to soft foods, and then to more solid foods. Dietary adjustments may be necessary, as certain foods may now be difficult to digest. Overall, gastrectomy surgery usually requires a stay of 7–10 days in the hospital and recuperation time of at least several weeks.

### Risks

Surgery for peptic ulcer is effective, but it may result in a variety of postoperative complications. Following gastrectomy surgery, as many as 30% of patients have significant symptoms. An operation called highly selective **vagotomy**, in which a nerve that stimulates the stomach is cut, is now preferred for ulcer management, as it is safer than gastrectomy.

After a gastrectomy, several abnormalities may develop that produce symptoms related to food intake. They happen largely because the stomach, which serves as a food reservoir, has been reduced in its capacity by the surgery. Other surgical procedures

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A gastrectomy is performed by a board-certified surgeon trained in gastroenterology, the branch of medicine that deals with the diseases of the digestive tract. An anesthesiologist is responsible for administering anesthesia. The operation is always performed in a hospital setting.

that often accompany gastrectomy for ulcer disease can also contribute to later symptoms. These other surgical procedures include vagotomy, which lessens acid production and slows stomach emptying, and **pyloroplasty**, which enlarges the opening between the stomach and small intestine to facilitate emptying of the stomach.

Some patients experience lightheadedness, heart palpitations (racing heart), sweating, nausea, and vomiting after a meal. These may be symptoms of dumping syndrome, as food is rapidly moved into the small intestine from the remaining stomach or directly from the esophagus. Dumping syndrome is treated by adjusting the diet and pattern of eating, for example, eating smaller, more frequent meals, and limiting liquids.

Patients who have abdominal bloating and pain after eating, followed frequently by nausea and vomiting, may have afferent loop syndrome, a serious condition that must be corrected surgically. Patients who have early satiety (feeling of fullness after eating), abdominal discomfort, and vomiting may have bile reflux gastritis (also called bilious vomiting), which is also surgically correctable. Many patients experience weight loss after gastrectomy.

Reactive hypoglycemia is a condition that results when blood sugar levels become too high after a meal, stimulating the release of insulin, occurring about two hours after eating. Should this occur after gastrectomy, changing to a high-protein diet and smaller meals is advised.

Ulcers recur in a small percentage of patients after partial gastrectomy for peptic ulcer. Recurrence is usually within the first few years after surgery. Further surgery is usually necessary.

Vitamin and mineral supplementation is necessary after gastrectomy to correct certain deficiencies, especially vitamin B<sub>12</sub>, iron, and folate. Vitamin D and calcium are also needed to prevent and treat the bone

## QUESTIONS TO ASK THE DOCTOR

- What happens on the day of surgery?
- What type of anesthesia will be used?
- How long will it take to recover from the surgery?
- When can I expect to return to work and/or resume normal activities?
- What are the risks associated with a gastrectomy?
- How many gastrectomies do you perform in a year?
- What is the rate of postsurgical complications among your patients?
- Will there be a scar?

problems that often occur. These include softening and bending of the bones, which can produce pain and osteoporosis, which is a loss of bone mass. According to one study, the risk for spinal fracture after gastrectomy may be as high as 50%.

### Normal results

Overall, survival after gastrectomy for gastric cancer varies greatly by the stage of disease at the time of surgery. For early gastric cancer, the five-year survival rate is as high as 77%. For late-stage disease, the five-year survival rate is only 3%. The five-year survival rate for cancers in the lower stomach is better than for those found in the upper stomach, and the survival rate for gastric lymphoma is better than for gastric adenocarcinomas.

Most studies have shown that patients can have an acceptable quality of life after gastrectomy for a potentially curable gastric cancer. Many patients maintain a healthy appetite and eat a normal diet. Others lose weight and do not enjoy meals as much as before gastrectomy. Some studies show that patients who have total gastrectomies have more disease-related or treatment-related symptoms after surgery and poorer physical function than patients who have subtotal gastrectomies. There does not appear to be much difference, however, in emotional status or social activity level between patients who have undergone total versus subtotal gastrectomies.

### Morbidity and mortality rates

Depending on the extent of surgery, the risk for postoperative death after gastrectomy for gastric cancer has been reported as 1–3%, and the risk of non-fatal complications as 9–18%.

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## Gastric acid inhibitors

### Definition

Gastric acid inhibitors are medications that reduce the production of stomach acid. They are different from antacids, which act on stomach acid after it has been produced and released into the stomach.

### Purpose

Gastric acid inhibitors are used to treat conditions that are either caused or made worse by the presence of acid in the stomach. These conditions include gastric ulcers; gastroesophageal reflux disease (GERD); and Zollinger-Ellison syndrome, which is marked by atypical gastric ulcers and excessive amounts of stomach acid. Gastric acid inhibitors are also widely used to protect the stomach from drugs or conditions that may cause stomach ulcers. Medications that may cause ulcers include steroid compounds and **nonsteroidal anti-inflammatory drugs** (NSAIDs), which are often used to treat arthritis. Gastric acid inhibitors offer some protection against the stress ulcers that are associated with some types of illness and with surgery.

### Description

There are two types of gastric acid inhibitors, H<sub>2</sub>-receptor blockers and **proton pump inhibitors**. H<sub>2</sub>-receptor blockers are a type of antihistamine.

Histamine, in addition to its well-known effects in colds and allergies, also stimulates the stomach to produce more acid. The receptors (nerve endings) that respond to the presence of histamine are called H<sub>2</sub> receptors, to distinguish them from the H<sub>1</sub> receptors involved in causing allergy symptoms. The most common H<sub>2</sub>-receptor blockers are cimetidine (Tagamet), famotidine (Pepcid), nizatidine (Axid), and ranitidine (Zantac).

The proton pump inhibitors (PPIs) are drugs that block an enzyme called hydrogen/potassium adenosine triphosphatase in the cells lining the stomach. Blocking this enzyme stops the production of stomach acid. These drugs are more effective in reducing stomach acid than the H<sub>2</sub>-receptor blockers. The PPIs include such medications as omeprazole (Prilosec), esomeprazole (Nexium), lansoprazole (Prevacid), pantoprazole (Protonix) and rabeprazole (AcipHex).

### Recommended dosages

The recommended dosage depends on the specific drug, the purpose for which it is being used, and the route of administration, whether oral or intravenous. Patients should check with the physician who prescribed the medication or the pharmacist who dispensed it. If the drug is an over-the-counter preparation, patients should read the package labeling carefully, and discuss the correct use of the drug with their physician or pharmacist. This precaution is particularly important with regard to the H<sub>2</sub>-receptor blockers, because they are available in over-the-counter (OTC) formulations as well as prescription strength. The two are not interchangeable; OTC H<sub>2</sub>-receptor blockers are only half as strong as the lowest available dose of prescription-strength versions of these drugs.

Patients should not use the over-the-counter preparations as an alternative to seeking professional care. For some conditions, particularly stomach ulcers, acid-inhibiting drugs may relieve the symptoms, but will not cure the underlying problems, which require both acid reduction and antibiotic therapy.

Gastric acid inhibitors work best when they are taken regularly, so that the amounts of stomach acid are kept low at all times. Patients should check the package directions or ask the physician or pharmacist for instructions on the best way to take the medicine.

### Precautions

There are relatively few adverse reactions when gastric acid inhibitors are used for one to two doses before or just after surgery. The side effects listed below are most often seen with long-term use.

## KEY TERMS

**Enzyme**—A biological compound that causes changes in other compounds.

**Gastroesophageal reflux disease (GERD)**—A condition in which the contents of the stomach flow backward into the esophagus. There is no known single cause.

**Nonsteroidal anti-inflammatory drugs (NSAIDs)**—Drugs that relieve pain and reduce inflammation but are not related chemically to cortisone. Common drugs in this class are aspirin, ibuprofen (Advil, Motrin), naproxen (Aleve, Naprosyn), ketoprofen (Orudis), and several others.

**Platelets**—Disk-shaped structures found in blood that play an active role in blood clotting. Platelets are also known as thrombocytes.

**Receptor**—A sensory nerve ending that responds to chemical or other stimuli of various kinds.

**Stress ulcers**—Stomach ulcers that occur in connection with some types of physical injury, including burns and invasive surgical procedures.

**Thrombocytopenia**—A disorder characterized by a drop in the number of platelets in the blood.

**Zollinger-Ellison syndrome**—A condition marked by stomach ulcers, with excess secretion of stomach acid and tumors of the pancreas.

### *H<sub>2</sub>-receptor blockers*

Although the H<sub>2</sub>-receptor blockers are very safe drugs, they are capable of causing thrombocytopenia, a disorder in which there are too few platelets in the blood. This deficiency may cause bleeding problems, since platelets are essential for blood clotting. Platelet deficiencies can only be recognized by blood tests; there are no symptoms that the patient can see or feel. In addition to affecting platelet levels, the H<sub>2</sub>-receptor blockers may cause changes in heart rate, making the heart beat either faster or slower than normal. Patients should call a physician immediately if any of these signs occur:

- tingling of the fingers or toes;
- difficulty breathing;
- difficulty swallowing;
- swelling of the face or lips;
- rapid heartbeat; or
- slow heartbeat.

In addition to these signs, the H<sub>2</sub>-receptor blockers may cause the following unwanted reactions:

- headache;
- diarrhea;
- dizziness;
- drowsiness;
- nausea;
- depression;
- skin rash; or
- vomiting.

In addition, cimetidine is an inhibitor of male sex hormones; it may cause loss of libido, breast tenderness and enlargement, and impotence.

Ranitidine may cause loss of hair or severe skin rashes that require prompt medical attention. In rare cases, this drug may cause a reduction in the **white blood cell count**.

Before using H<sub>2</sub>-receptor blockers, people with any of these medical problems should make sure their physicians are aware of their conditions:

- kidney disease;
- liver disease; or
- medical conditions associated with confusion or dizziness.

### *Proton pump inhibitors*

The proton pump inhibitors are also very safe, but have been associated with rare but severe skin reactions. Patients should be sure to report any rash or change in the appearance of the skin when taking these drugs. The following adverse reactions are also possible:

- stomach cramps;
- weakness;
- chest pain;
- constipation;
- diarrhea;
- dizziness;
- drowsiness;
- gas pains;
- headache;
- nausea with or without vomiting;
- itching; and
- blood in urine.

The PPIs make some people feel drowsy, dizzy, lightheaded, or less alert. Anyone who takes these drugs should not drive, use heavy machinery, or do anything else that requires full alertness until they have found out how the drugs affect them.



Before using proton pump inhibitors, people with liver disease should make sure their physicians are aware of their condition.

Taking gastric acid reducers with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

### Side effects

The most common side effects of both types of gastric acid reducer are mild diarrhea, nausea, vomiting, stomach or abdominal pain, dizziness, drowsiness, lightheadedness, nervousness, sleep problems, and headache. The frequency of each type of problem varies with the specific drug selected and the dose. These problems usually go away as the body adjusts to the drug and do not require medical treatment unless they are bothersome.

Serious side effects are uncommon with these medications, but may occur. Patients should consult a physician immediately if they notice any of the following:

- skin rash or such other skin problems as itching, peeling, hives, or redness;
- fever;
- agitation or confusion;
- hallucinations;
- shakiness or tremors;
- seizures or convulsions;
- tingling in the fingers or toes;
- pain at the injection site that lasts for some time after the injection;
- pain in the calves that spreads to the heels;
- swelling of the calves or lower legs;
- swelling of the face or neck;
- difficulty swallowing;
- rapid heartbeat;
- shortness of breath; or
- loss of consciousness.

Other side effects may occur in rare instances. Anyone who has unusual symptoms after taking gastric acid inhibitors should get in touch with his or her physician.

### Interactions

Gastric acid inhibitors may interact with other medicines. When an interaction occurs, the effects of one or both of the drugs may change or the risk of side effects may be increased. Anyone who takes gastric

acid inhibitors should give their physician a list of all the other medicines that he or she is taking.

Of the drugs in this class, cimetidine has the highest number of drug interactions, and specialized reference works should be consulted for guidance about this medication.

The drugs that may interact with H<sub>2</sub>-receptor blockers include:

- itraconazole (Sporanox);
- ketoconazole (Nizoral);
- warfarin (Coumadin);
- dofetilide (Tikosyn); and
- drugs given to open the airway (bronchodilators), including aminophylline, theophylline (Theo-Dur and other brands), and oxtriphylline (Choledyl and other brands).

Drugs that may interact with proton pump inhibitors include:

- itraconazole (Sporanox);
- ketoconazole (Nizoral);
- phenytoin (Dilantin) and other anticonvulsant drugs;
- cilostazol (Pletal); and
- voriconazole (Vfend).

The preceding lists do not include every drug that may interact with gastric acid inhibitors. Patients should consult a physician or pharmacist before combining gastric acid inhibitors with any other prescription or nonprescription (over-the-counter) medicine.

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American Society for Gastrointestinal Endoscopy, 1520 Kensington Road, Suite 202, Oak Brook, IL, 60523, (630) 573 0600, <http://www.asge.org>.

American Society of Health System Pharmacists, 7272 Wisconsin Avenue, Bethesda, MD, 20814, (301) 657 3000, <http://www.ashp.org>.

Society for Gastroenterology Nurses and Associates, 401 North Michigan Avenue, Chicago, IL, 60611 4267, (800) 245 7462, <http://www.sгна.org>.

U.S. Food and Drug Administration, 5600 Fishers Lane, Rockville, MD, 20857 0001, (888) INFO FDA, <http://www.fda.gov>.

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## Gastric bypass

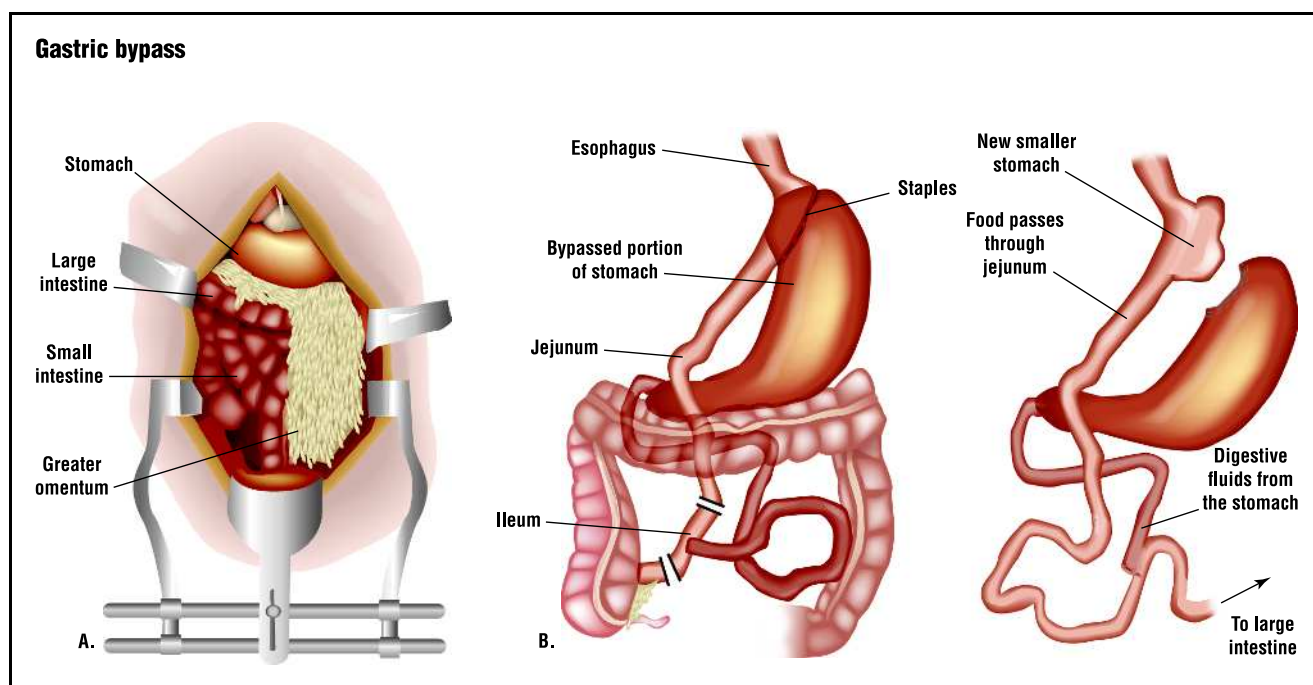
### Definition

A gastric bypass is one type of elective bariatric (weight-loss) surgery done on the digestive system to help morbidly obese people lose weight. Gastric bypass surgery is also called malabsorptive surgery because it creates an alternate route for food traveling through the digestive system that bypasses a section of the small intestine where many nutrients are absorbed.

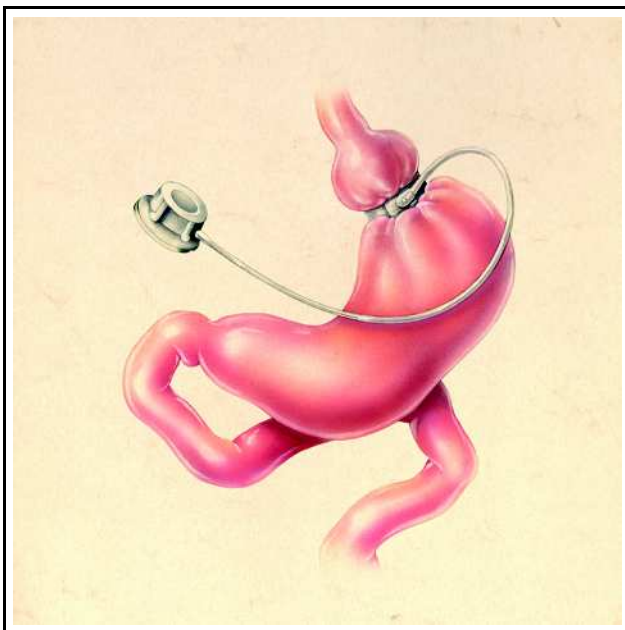
### Purpose

Gastric bypass surgery is intended to treat severe (morbid) obesity in people who have tried unsuccessfully to lose weight and whose excess weight threatens their health and well being. Obesity is defined by the body mass index (BMI). The BMI calculation compares weight to height. Adults age 20 and older are evaluated as follows:

- BMI below 18.5: underweight
- BMI 18.5–24.9: normal weight
- BMI 25.0–29.9: overweight



In this Roux-en-Y gastric bypass, a large incision is made down the middle of the abdomen (A). The stomach is separated into two sections. Most of the stomach will be bypassed, so food will no longer go to it. A section of jejunum (small intestine) is then brought up to empty food from the new smaller stomach (B). Finally, the surgeon connects the duodenum to the jejunum, allowing digestive secretions to mix with food further down the jejunum. (Illustration by GGS Information Services. Cengage Learning, Gale.)



**An adjustable gastric band.** (Kevin A. Somerville / Phototake. Reproduced by permission.)

- BMI 30 and above: obese
- BMI 40 and above: morbidly or severely obese

Obesity is linked to an increased likelihood of developing over 20 different diseases and disorders, including high blood pressure (hypertension), type 2 diabetes, heart disease, stroke, deep vein blood clots, fatty liver disease, sleep apnea, heartburn, gastroesophageal reflux disease (GERD), gallstone disease, arthritis, colon cancer, breathing problems, and depression. Gastric bypass surgery reduces the amount of nutrients that are absorbed from food. It is performed in conjunction with bariatric restriction surgery in which the size of the stomach is reduced through surgical application of a band or stomach **staples** that close off a portion of the stomach. People who have had restriction surgery can eat only small amounts at a time before feeling full. Reduced food intake along with reduced nutrient absorption can lead to dramatic weight loss.

### Demographics

Obesity is the second leading cause (after tobacco use) of preventable **death** in the United States. The number of overweight and obese Americans has steadily increased since 1960. According to the National Institutes of Health, in 2006, 34% of Americans were overweight and 27% were obese. Of these, 15 million were morbidly obese, however, less than 1% chose to undergo a surgical weight-loss procedure.

The number of all surgical weight-loss procedures has increased rapidly. In 1995, only 20,000 weight-loss surgeries were performed in the United States. By 2006, 170,000 of these surgeries were done, and the number is expected to continue to increase. In 2006, the United States government agreed to pay for certain bariatric surgeries for individuals who qualified for **Medicare**. At that time, about 395,000 Americans ages 65–69 were medically eligible for obesity surgery. This number is expected to grow to 475,000 persons by 2010. With Medicare coverage, it is likely that more older people will have weight-loss surgery. In 2006, the average patient having bariatric surgery was a woman in her late 30s who weighed about 300 pounds (135 kg).

### Description

There are several different variations on gastric bypass, all of which are malabsorptive surgeries designed to lower caloric intake by reducing the amount of nutrients absorbed by the digestive system. These include:

- gastric bypass with long gastrojejunostomy
- Roux-en-Y (RNY) gastric bypass
- transected (Miller) RNY bypass
- laparoscopic RNY bypass
- vertical (Fobi) gastric bypass
- distal RNY bypass
- biliopancreatic (BPD) diversion

All bariatric procedures create an alternate route for food through the digestive system so that the food bypasses part of the intestine. These procedures are accompanied by a procedure to reduce the size of the stomach so that less food can be comfortably consumed. Choice of procedure relies on the patient's overall health status and on the surgeon's judgment and experience.

In the **operating room**, the patient is put under **general anesthesia** by the anesthesiologist. Once the patient is asleep, an endotracheal tube is placed through the mouth into the trachea (windpipe) to connect the patient to a respirator during surgery. A urinary catheter is also placed in the bladder to drain urine during surgery and for the first two days after surgery. This also allows the surgeon to monitor the patient's hydration. A nasogastric (NG) tube is also placed through the nose to drain secretions and is typically removed the morning after surgery.

The most common gastric bypass operation is the Roux-en-Y (RNY) gastric bypass. In this surgery, a small stomach pouch is created by stapling and banding the stomach. The pouch is about the size of an egg

## KEY TERMS

**Gastrojejunostomy**—A surgical procedure in which the stomach is surgically connected to the jejunum (middle portion of the small intestine).

**Gastroesophageal reflux disease (GERD)**—A condition in which gastric juice from the stomach backs up into the bottom of the esophagus and causes irritation, inflammation, or erosion of the cells lining the esophagus.

**Heartburn**—A pain in the center of the chest behind the breastbone caused by the contents of the stomach flowing backwards (refluxing) into the lower end of the esophagus and causing irritation.

**Hernia**—The protrusion of a loop or section of an organ or tissue through an abnormal opening.

**Laparoscopy**—The examination of the inside of the abdomen through a lighted tube (endoscope), sometimes accompanied by surgery done through a small incision.

**Malabsorption**—Poor absorption of materials in the digestive system.

**Morbidly obese**—Definition of a person who is 100 lb (45 kg) or more than 50% overweight and has a body mass index above 40.

**Osteoporosis**—A condition found in older individuals in which bones decrease in density and become fragile and more likely to break. It can be caused by lack of vitamin D and/or calcium in the diet.

**Sleep apnea**—A temporary interruption in breathing during sleep.

**Small intestine**—Consists of three sections: duodenum (nearest the stomach), jejunum, and ileum (nearest the colon or large intestine). Different nutrients are absorbed in different sections of the small intestine.

**Type 2 diabetes**—Sometimes called adult-onset diabetes, this disease prevents the body from properly using glucose (sugar), but can often be controlled with diet and exercise.

and initially can hold 1–2 oz (30–60 ml), as compared to the 40–50 oz (1.2–1.5 l) held by a normal stomach. It is created along the more muscular side of the stomach, which makes it less likely to stretch over time.

Next, a Y-shaped piece of intestine is attached to the pouch on one end, and the jejunum, or middle part of the small intestine, on the other. This allows food to

bypass the duodenum, or first part of the small intestine, where nutrients are absorbed. The food then continues normally through the rest of the small intestine and the large intestine.

The RNY gastric bypass can also be performed laparoscopically. The result is the same as an open surgery RNY, except that instead of opening the patient with a long incision on the stomach, surgeons make a small incision and insert a pencil-thin optical instrument called a laparoscope, to project a picture to a TV monitor. The laparoscopic RNY results in smaller scars, as usually only three to four small incisions are made. The average time required to complete the laparoscopic RNY gastric bypass is approximately two hours.

The great advantage of Roux-en-Y gastric bypass is that individuals lose, on average, 60–70% of their excess weight and are able to maintain the weight loss for 10 years or more. As a result, most obesity-related health problems are substantially reduced or cured when weight is lost and that weight loss is maintained. As of 2006, Medicare would usually pay for this surgery.

However, Roux-en-Y surgery also has some serious disadvantages, including:

- This surgery is more difficult for the surgeon than restrictive surgeries, and involves permanently altering the digestive system.
- Many vitamins and minerals are absorbed in the part of the small intestine bypassed by this surgery. The individual must commit to a lifetime of taking nutritional supplements to prevent serious vitamin and mineral deficiencies.
- Tearing, bleeding, and infection at the sites where the incisions and reconnections are potentially fatal complications.
- Dumping syndrome may occur in response to meals high in sugar. Dumping occurs when food moves too fast through the intestine and causes symptoms of nausea, bloating, weakness, sweating, fainting, and diarrhea.

Biliopancreatic diversion (BPD), another type of malabsorptive surgery, bypasses an even longer section of the small intestine. In BPD, about two-thirds of the stomach is surgically withdrawn, leaving a pouch that can hold about 3 cups of food. A bypass is then created to the ileum, or final portion of the small intestine. In all, about 9 ft (3 m) of intestine are bypassed. As a result, many fewer calories and nutrients are absorbed. The main advantage of BPD is the large amount of excess weight—between 75% and 80%—that is lost over the first two years and the health benefits that this loss brings. As of 2006, Medicare would usually



pay for this surgery. Disadvantages are the same as for Roux-en Y surgery, but nutrient deficiencies are greater. Because fat is poorly digested as a result of this surgery, bowel movements are frequent and stools are especially foul smelling.

### Diagnosis/Preparation

A diagnosis of obesity relies on a body weight assessment based on the body mass index (BMI) and waist circumference measurements. Waist circumference exceeding 40 in (101 cm) in men and 35 in (89 cm) in women increases disease risk. Gastric bypass as a weight-loss treatment is considered only for morbidly obese patients whose health is impaired by their obesity. To be candidates for gastric bypass surgery, individuals need to have failed at serious attempts to lose weight in the past, be in good mental health, demonstrate an understanding of the risks associated with this surgery, and be willing to make a lifetime commitment to changing eating habits.

Before the surgery, the patient will undergo a physical and psychological examination and receive nutritional counseling. To prepare for the surgery itself, an intravenous (IV) line is placed, and the patient may be given a sedative to help relax before going to the operating room.

### Aftercare

Patients experience postoperative pain and the other common discomforts of major surgery, such as the NG tube and a dry mouth. Pain is managed with medication. A large dressing covers the surgical incision on the abdomen of the patient and is usually removed by the second day in the hospital. Short showers 48 hours after surgery are usually allowed. Patients are also fitted with special socks to improve blood flow in their legs and prevent blood clot formation. At the surgeon's discretion, some patients may have a **gastrostomy** tube (g-tube) inserted during surgery to drain secretions from the larger bypassed portion of the stomach. After a few days, it will be clamped and will remain closed. When inserted, the g-tube usually remains for another four to six weeks. It is kept in place in the unlikely event that the patient may need direct feeding into the stomach.

By the evening after surgery or the next day at the latest, patients are usually able to sit up or walk around. Gradually, physical activity may be increased, with normal activity resuming three to four weeks after surgery. Patients are also taught breathing exercises and are asked to cough frequently to clear their lungs of mucus. Postoperative pain medication is prescribed to ease discomfort and initially administered by an

epidural. At the time patients are discharged from the hospital, they will be given oral medications for pain. Most patients will typically have a three-day hospital stay if their surgery is uncomplicated.

After gastric bypass or BPD, the individual does not eat anything for one or two days, giving the bowel time to rest. During this time, all nutrition is given intravenously. Once the person begins eating, the diet will include:

- liquids such as juice, broth, milk, or diluted cooked cereal for two or three days
- pureed foods that have the texture of baby food for two or three weeks while the stomach heals; these foods must be smooth and contain no large pieces
- soft foods such as ground meat and soft-cooked fruits and vegetables for about eight weeks
- regular food can be eaten in very small amounts

Most people begin by eating six tiny meals a day. These meals should be high in protein. Food must be chewed thoroughly. Liquids are drunk between meals, not with them. Vitamin and mineral supplements are essential.

### Risks

Gastric bypass surgery has many of the same risks associated with other major abdominal operations. Life-threatening complications or death are rare, occurring in less than 1% of patients. Significant side effects, such as wound healing problems, difficulty in swallowing food, infections, and extreme nausea, can occur in 10–20% of patients. Blood clots after major surgery are rare, but extremely dangerous; if they occur, they may require re-hospitalization and anti-coagulants (blood-thinning medications).

Some risks are specific to gastric bypass surgery, including:

- **Dumping syndrome.** Usually occurs when sweet foods are eaten or when food is eaten too quickly. When the food enters the small intestine, it causes cramping, sweating, and nausea.
- **Abdominal hernias.** These are the most common complications, requiring follow-up surgery. Incisional hernias occur in 10–20% of patients and require follow-up surgery.
- **Narrowing of the stoma.** The stoma, or opening between the stomach and intestines, can sometimes become too narrow, causing vomiting. The stoma can be repaired by an outpatient procedure that uses a small endoscopic balloon to stretch it.
- **Gallstones.** They develop in more than a third of obese patients undergoing gastric surgery. Gallstones

are clumps of cholesterol and other matter that accumulate in the gallbladder. Rapid or major weight loss increases a person's risk of developing gallstones.

- Leakage of stomach and intestinal contents. Leakage of stomach and intestinal contents from the staple and suture lines into the abdomen can occur. This is a rare occurrence and sometimes seals itself. If not, another operation is required.

**Nutritional deficiencies.** People who have gastric bypass surgery or BPD need extensive nutritional counseling and must take vitamin and mineral supplements for the rest of their lives. Most iron and calcium is absorbed in the duodenum, the first part of the intestine that is bypassed by these operations. Calcium deficiency can lead to osteoporosis, and iron deficiency can cause anemia.

In BPD, only 25% of the fat in food is absorbed because so much of the small intestine is bypassed. The fat-soluble vitamins A, D, E, and K are absorbed along with fat. When the body absorbs too little fat, inadequate amounts of these fat-soluble vitamins are absorbed, so dietary supplements containing these vitamins must be taken. Other vitamins that may not be absorbed in adequate amounts are vitamin B<sub>12</sub>, folic acid, and vitamin B<sub>1</sub> (thiamine). Research published in the journal *Neurology* in March 2007 found that a very small number of people developed a brain disorder called Wernicke encephalopathy 4–12 weeks after bariatric surgery. This disorder is caused by a deficiency of vitamin B<sub>1</sub>. Most of the people who developed the disorder had failed to take their vitamin supplements as prescribed after surgery.

### Normal results

Most people who have surgery for obesity lose anywhere from 50–80% of their excess weight. However, quite a few put pounds back on beginning several years after surgery. The main reason for weight gain is noncompliance with their nutrition and **exercise** plan. Also, over time the size of the stomach pouch in restrictive surgeries tends to stretch, allowing people to eat more and still feel comfortable. On the positive side, people who lose weight through surgery almost always see great improvement in any obesity-related diseases they have.

### Alternatives

#### *Surgical alternatives*

Lap-band and adjustable gastric band restrictive surgery used alone represent alternatives to gastric

bypass surgery. Lap-Band surgery achieves restriction by placing a saline (salt water) filled bag around the stomach, pinching off a portion of it leaving only a small pouch at the top. The exit to the pouch is narrowed so that the rate at which the pouch empties is slowed. Because the pouch is so small, the individual can only eat about half a cup of food at a time without feeling nauseated. Since there is no cutting, stapling, or stomach rerouting involved, the procedure is the least invasive of all weight-loss surgeries. Patients generally experience less pain and scarring, and their hospital stay is shorter than with malabsorptive surgeries. In addition, a port allows access to the saline bag, so that the size of the stomach pouch can be adjusted without additional surgery. This surgery is reversible; the band or saline bag can be removed and the digestive system will function normally. Weight loss averages 50–65% of the excess body weight during the first two years. The procedure is often covered by Medicare.

Gastric band surgery uses a different technique to reduce the size of the stomach. The United States Food and Drug Administration (FDA) approved this surgery in 2001. Its long-term effects have not been studied.

**Vertical banded gastroplasty (VBG)** is also known as stomach stapling. This surgery is performed less often than lap-band surgery. With VBG, part of the stomach is stapled shut, making it smaller so that individuals feel full sooner. The advantage of VBG is that the procedure is quick and has few complications. Disadvantages are that average weight loss is less than with other weight-loss surgeries, and staples can pull out allowing small leaks between the stomach and the abdomen to develop. Infection is possible, but rare (less than 1%).

#### *Nonsurgical alternatives*

Diet and nutrition counseling is the main nonsurgical method of weight loss. Diet therapy involves instruction on how to adjust a diet to reduce the number of calories eaten. Reducing calories moderately is essential in achieving gradual and steady weight and in maintaining the loss. Strategies of diet and nutrition therapy include teaching individuals about the calorie content of different foods, food composition (fats, carbohydrates, and proteins), reading nutrition labels, types of foods to buy, and how to prepare foods. To be healthful, a diet must provide balanced nutrition along with calorie reduction.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A board-certified bariatric surgeon or a general surgeon who has specialized in the surgical treatment of obese patients performs gastric bypass surgery. An anesthesiologist is responsible for administering anesthesia. The operation is performed in a hospital setting. A registered dietitian usually provides dietary counseling before and after the procedure.

Physical activity, especially when combined with a healthy low-calorie diet is another nonsurgical way to lose weight. Moderate physical activity, progressing to 30 minutes or more five or more days a week, is recommended for weight loss. Physical activity has also been reported to be a key part of maintaining weight loss. Abdominal fat and, in some cases, waist circumference can be modestly reduced through physical activity. Strategies of successful weight loss through long-term physical activity involve selecting enjoyable activities that can be scheduled into a regular daily routine.

Behavior therapy aims to improve diet and physical activity patterns and develop habits and new behaviors that promote weight loss. Behavioral therapy strategies for weight loss and maintenance include keeping a food and exercise diary, identifying high-risk situations such as having high-calorie foods in the house and learning to avoid these situations, using non-food rewards for specific actions such as exercising regularly, developing realistic goals and modifying false beliefs about weight loss and body image, developing a social support network (family, friends, or colleagues), and joining a support group that will encourage weight loss in a positive and motivating manner.

Drug therapy is another nonsurgical alternative option for treating obesity. The United States Food and Drug Administration (FDA) has approved three prescription drugs for treating obesity: orlistat (Xenical), phentermine (an appetite suppressant available under more than a dozen trade names), and sibutramine (Meridia in the United States, Reductil in Europe). In 2007, orlistat became available in the United States as an over-the-counter (nonprescription) drug under the name Alli. These drugs alone are not magic bullets for weight loss and should be used in addition to calorie reduction and regular exercise.

## QUESTIONS TO ASK THE DOCTOR

- What type of bariatric surgery is best for me?
- What benefits can I expect from this surgery?
- When can I expect to return to work and/or resume normal activities?
- What are the risks associated with the type of gastric bypass surgery I plan to have?
- How many gastric bypass surgery do you perform in a year?
- What is the rate of post-surgery complications among your patients?
- Will my insurance cover this procedure?
- What are the alternatives to this surgery?

## Resources

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- American Society for Bariatric Surgery. 7328 West University Avenue, Suite F, Gainesville, FL 32607. (352) 331 4900. <http://www.asbs.org> (accessed March 30, 2008).
- Weight control Information Network (WIN). 1 WIN Way, Bethesda, MD 20892 3665. Telephone: (877)946 4627 or (202) 828 1025. Fax: (202) 828 1028. <http://win.niddk.nih.gov> (accessed March 30, 2008).

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## Gastroduodenostomy

### Definition

A gastroduodenostomy is a surgical reconstruction procedure by which a new connection between the stomach and the first portion of the small intestine (duodenum) is created.

### Purpose

A gastroduodenostomy is a gastrointestinal reconstruction technique. It may be performed in cases of stomach cancer, a malfunctioning pyloric valve, gastric obstruction, and peptic ulcers.

As a gastrointestinal reconstruction technique, it is usually performed after a total or partial **gastrectomy** (stomach removal) procedure. The procedure is also referred to as a Billroth I procedure. For benign diseases, a gastroduodenostomy is the preferred type of reconstruction because of the restoration of normal gastrointestinal physiology. Several studies have confirmed the advantages of the procedure, because it preserves the duodenal passage. Compared to a gastrojejunostomy (Billroth II) procedure, meaning the surgical connection of the stomach to the jejunum, gastroduodenostomies have been shown to result in less modification of pancreatic and biliary functions, as well as in a decreased incidence of ulceration and inflammation of the stomach (gastritis). However, gastroduodenostomies performed after gastrectomies for cancer have been the subject of controversy. Although there seems to be a definite advantage of performing gastroduodenostomies over gastrojejunostomies, surgeons have become reluctant to perform gastroduodenostomies because of possible obstruction at the site of the surgical connection due to tumor recurrence.

As for gastroduodenostomies specifically performed for the surgical treatment of malignant gastric tumors, they follow the general principles of oncological surgery, aiming for at least 0.8 in (2 cm) of margins around the tumor. However, because gastric adenocarcinomas tend

to metastasize quickly and are locally invasive, it is rare to find good surgical candidates. Gastric tumors of such patients are thus only occasionally excised via a gastroduodenostomy procedure.

Gastric ulcers are often treated with a distal gastrectomy, followed by gastroduodenostomy or gastrojejunostomy, which are the preferred procedures because they remove both the ulcer (mostly on the lesser curvature) and the diseased antrum.

### Demographics

Stomach cancer was the most common form of cancer in the world in the 1970s and early 1980s. The incidence rates show substantial variations worldwide. Rates are currently highest in Japan and eastern Asia, but other areas of the world have high incidence rates, including eastern European countries and parts of Latin America. Incidence rates are generally lower in western European countries and the United States. Stomach cancer incidence and mortality rates have been declining for several decades in most areas of the world.

### Description

After removing a piece of the stomach, the surgeon reattaches the remainder to the rest of the bowel. The Billroth I gastroduodenostomy specifically joins the upper stomach back to the duodenum.

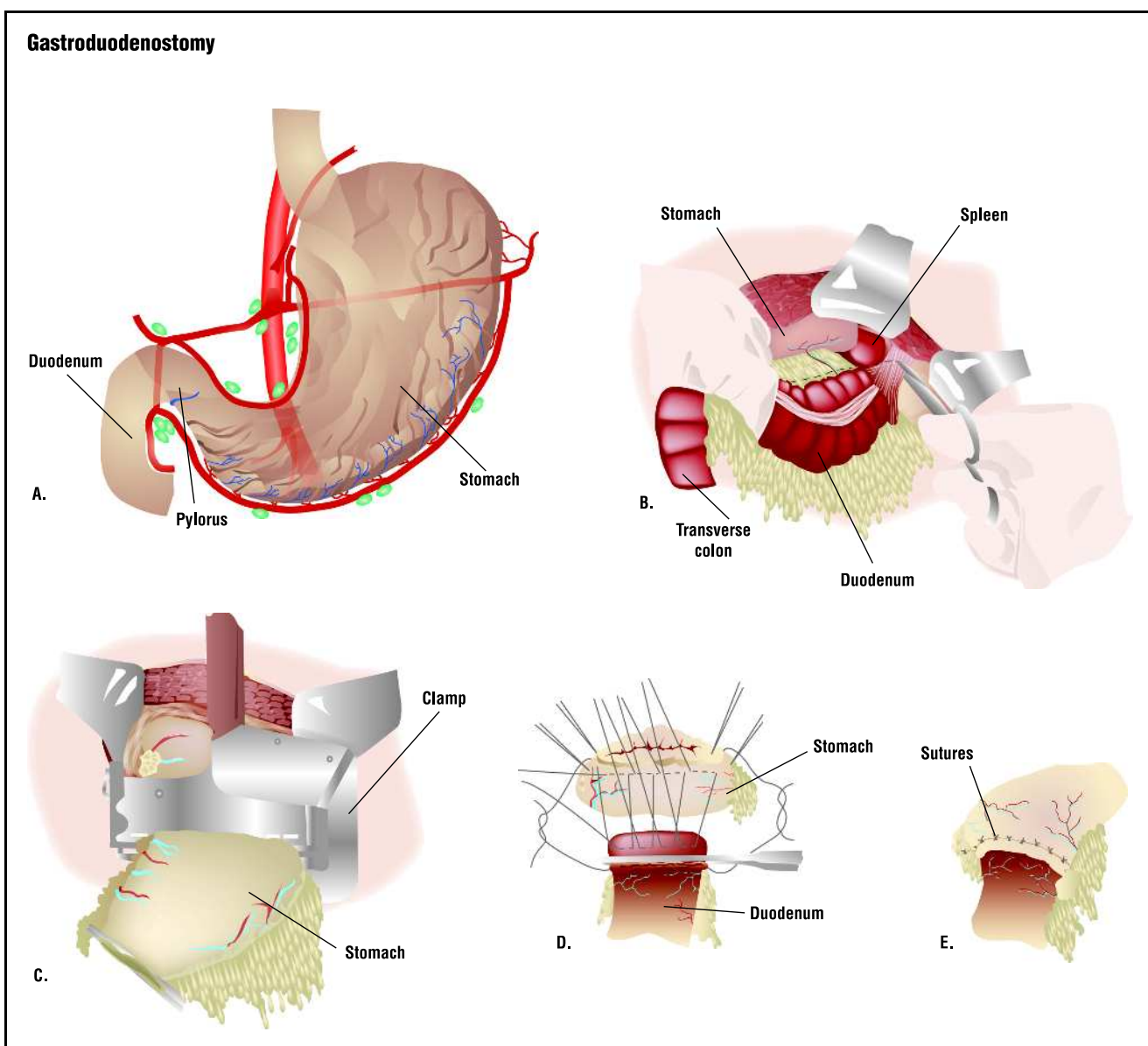
Typically, the procedure requires ligation (tying) of the right gastric veins and arteries as well as of the blood supply to the duodenum (pancreatico-duodenal vein and artery). The lumen of the duodenum and stomach is occluded at the proposed site of resection (removal). After resection of the diseased tissues, the stomach is closed in two layers, starting at the level of the lesser curvature, leaving an opening close to the diameter of the duodenum. The gastroduodenostomy is performed in a similar fashion as small intestinal end-to-end anastomosis, meaning an opening created between two normally separate spaces or organs. Alternatively, the Billroth I procedure may be performed with stapling equipment (ligation and thoraco-abdominal staplers).

### Diagnosis/Preparation

If a gastroduodenostomy is performed for gastric cancer, diagnosis is usually established using the following tests:

- Endoscopy and barium x rays. The advantage of endoscopy is that it allows for direct visualization





An abdominal incision exposes the stomach and duodenum (small intestine) (A). The duodenum is freed from connecting materials (B), and is clamped and severed. The stomach is also clamped and severed (C). The remaining stomach is then connected to the duodenum with sutures (D and E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

of abnormalities and directed biopsies. Barium x rays do not facilitate biopsies, but are less invasive and may give information regarding motility.

- **Computed tomography (CT) scan.** A CT scan of the chest, abdomen, and pelvis is usually obtained to help assess tumor extent, nodal involvement, and metastatic disease.
- **Endoscopic ultrasound (EUS).** EUS complements information gained by CT. Specifically, the depth of tumor invasion, including invasion of nearby organs, can be assessed more accurately by EUS than by CT.

- **Laparoscopy.** This technique allows examination of the inside of the abdomen through a lighted tube.

The diagnosis of gastric ulcer is usually made based on a characteristic clinical history. Routine laboratory tests such as a complete blood cell count and iron studies can help detect anemia, which is indicative of the condition. By performing high-precision endoscopy and by obtaining multiple mucosal biopsy specimens, the diagnosis of gastric ulcer can be confirmed. Additionally, upper gastrointestinal tract radiography tests are usually performed.

## KEY TERMS

**Adenocarcinoma**—The most common form of gastric cancer.

**Anastomosis**—An opening created by surgical, traumatic, or pathological means between two normally separate spaces or organs.

**Barium swallow**—An upper gastrointestinal series (barium swallow) is an x-ray test used to define the anatomy of the upper digestive tract; the test involves filling the esophagus, stomach, and small intestines with a white liquid material (barium).

**Computed tomography (CT) scan**—An imaging technique that creates a series of pictures of areas inside the body, taken from different angles. The pictures are created by a computer linked to an x-ray machine.

**Duodenum**—The first part of the small intestine that connects the stomach above and the jejunum below.

**Endoscopy**—The visual inspection of any cavity of the body by means of an endoscope.

**Gastrectomy**—A surgical procedure in which all or a portion of the stomach is removed.

**Gastroduodenostomy**—A surgical procedure in which the doctor creates a new connection between the stomach and the duodenum.

**Gastrointestinal**—Pertaining to or communicating with the stomach and intestine.

**Gastrojejunostomy**—A surgical procedure where the stomach is surgically connected to the jejunum.

**Laparoscopy**—The examination of the inside of the abdomen through a lighted tube, sometimes accompanied by surgery.

**Lumen**—The cavity or channel within a tube or tubular organ.

**Small intestine**—The small intestine consists of three sections: duodenum, jejunum, and ileum. All are involved in the absorption of nutrients.

Preparations for the surgery include nasogastric decompression prior to the administration of anesthesia, intravenous or intramuscular administration of **antibiotics**, insertion of intravenous lines for administration of electrolytes, and a supply of compatible blood. Suction provided by placement of a nasogastric tube is necessary if there is any evidence of obstruction. Thorough medical evaluation, including hematological studies, may indicate the need for preoperative transfusions. All

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A gastroduodenostomy is performed by a surgeon trained in gastroenterology, the branch of medicine that deals with the diseases of the digestive tract. An anesthesiologist is responsible for administering anesthesia, and the operation is performed in a hospital setting.

patients should be prepared with systemic antibiotics, and there may be some advantage in washing out the abdominal cavity with tetracycline prior to surgery.

## Aftercare

After surgery, the patient is brought to the **recovery room** where **vital signs** are monitored. Intravenous fluid and electrolyte therapy is continued until oral intake resumes. Small meals of a highly digestible diet are offered every six hours, starting 24 hours after surgery. After a few days, the usual diet is gradually introduced. Medical treatment of associated gastritis may be continued in the immediate postoperative period.

## Risks

A gastroduodenostomy has many of the same risks associated with any other major abdominal operation performed under **general anesthesia**, such as wound problems, difficulty swallowing, infections, nausea, and blood clotting.

More specific risks are also associated with a gastroduodenostomy, including:

- Duodenogastric reflux, resulting in persistent vomiting.
- Dumping syndrome, occurring after a meal and characterized by sweating, abdominal pain, vomiting, lightheadedness, and diarrhea.
- Low blood sugar levels (hypoglycemia) after a meal.
- Alkaline reflux gastritis marked by abdominal pain, vomiting of bile, diminished appetite, and iron-deficiency anemia.
- Malabsorption of necessary nutrients, especially iron, in patients who have had all or part of the stomach removed.

## QUESTIONS TO ASK THE DOCTOR

- What happens on the day of surgery?
- What type of anesthesia will be used?
- How long will it take to recover from the surgery?
- When can I expect to return to work and/or resume normal activities?
- What are the risks associated with a gastroduodenostomy?
- How many gastroduodenostomies do you perform in a year?
- Will there be a scar?

### Normal results

Results of a gastroduodenostomy are considered normal when the continuity of the gastrointestinal tract is reestablished.

### Morbidity and mortality rates

For gastric obstruction, a gastroduodenostomy is considered the most radical procedure. It is recommended in the most severe cases and has been shown to provide good results in relieving gastric obstruction in most patients. Overall, good to excellent gastroduodenostomy results are reported in 85% of cases of gastric obstruction. In cases of cancer, a median survival time of 72 days has been reported after gastroduodenostomy following the removal of gastric carcinoma, although a few patients had extended survival times of three to four years.

### Alternatives

In the case of ulcer treatment, the need for a gastroduodenostomy procedure has diminished greatly over the past 20–30 years due to the discovery of two new classes of drugs and the presence of the responsible germ (*Helicobacter pylori*) in the stomach. The drugs are the H<sub>2</sub> blockers such as cimetidine and ranitidine and the **proton pump inhibitors** such as omeprazole; these effectively stop acid production. *H. pylori* can be eliminated from most patients with combination therapy that includes antibiotics and bismuth.

If an individual requires gastrointestinal reconstruction, there is no alternative to a gastroduodenostomy.

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- American College of Gastroenterology. 4900 B South 31st St., Arlington, VA 22206. (703) 820 7400. [www.acg.gi.org](http://www.acg.gi.org).
- American Gastroenterological Association (AGA). 4930 Del Ray Avenue, Bethesda, MD 20814. (301) 654 2055. [www.gastro.org](http://www.gastro.org).
- United Ostomy Association, Inc. (UOA). 19772 MacArthur Blvd., Suite 200, Irvine, CA 92612 2405. (800) 826 0826. <http://www.uoa.org>.

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Monique Laberge, PhD

## Gastroenterologic surgery

### Definition

Gastroenterologic surgery includes a variety of surgical procedures performed on the organs and conduits of the digestive system. These procedures include

the repair, removal, or resection of the esophagus, liver, stomach, spleen, pancreas, gallbladder, colon, anus, and rectum. Gastroenterologic surgery is performed for diseases ranging from appendicitis, gastroesophageal reflux disease (GERD), and gastric ulcers; to the life-threatening cancers of the stomach, colon, liver, and pancreas; and ulcerative conditions like ulcerative colitis and Crohn's disease.

### Purpose

Scientific understanding, treatment, and diagnostic advances, combined with an aging population, have made this century the golden age of gastroenterology. Modern gastroenterologic surgery's success in treating conditions of the digestive system by removing obstructions, diseased or malignant tissue, or by enlarging and augmenting conduits for digestion is largely due to the ability to view and work on the various critical organs through video representation and by biopsy. The word abdomen is derived from the Latin *abdere*, meaning concealed or un-seeable. The use of gastrointestinal endoscopy, **laparoscopy**, computer tomography (**CT scan**), and **ultrasound** has made the inspection of inaccessible organs possible without surgery, and sometimes treatable with only minor surgery. Advances in other diagnostics, such as the fecal occult blood test known as the Guaiac test, have made it possible to quickly determine the need for bowel surgery without expensive tests. This is especially important for colon cancer, which is the leading cause of cancer mortality in the United States, with about 56,000 Americans **dying** from it each year.

Some prominent surgical procedures included in gastroenterologic surgery are:

- Fundoplication to prevent reflux acids in the stomach from damaging the esophagus.
- Appendectomy for removal of an inflamed or infected appendix.
- Cholecystectomy for removal of an inflamed gallbladder and the crystallized salts called gallstones.
- Vagotomy, antrectomy, pyloroplasty are surgeries for gastric and peptic ulcers and are very rare in the twenty-first century. In the last 10 years, medical research has confirmed that gastric and peptic ulcers are due primarily to *Helicobacter pylori*, which causes more than 90% of duodenal ulcers and up to 80% of gastric ulcers. The most frequent surgeries today for ulcers of the stomach and duodenum are for complications of ulcerative conditions, largely perforation.
- Colostomy, ileostomy, and ileoanal reservoir surgery are done to remove part of the colon by colostomy, part of the colon as it enters the small intestine by

ileostomy, and removal of part of the colon as it enters the rectal reservoir by ileoanal reservoir surgery. These surgeries are required to relieve diseased tissue and allow for the continuation of waste to be removed from the body. Inflammatory bowel disease includes two severe conditions: ulcerative colitis and Crohn's disease. In both cases, portions of the bowel must be resected. Crohn's disease affects the small intestine and ulcerative colitis affects the lining of the colon. Cancers in the area of the colon and rectum can also necessitate the resection of the colon, intestine, and/or rectum.

### Demographics

Gastroenterologic diseases disproportionately affect the elderly, with prominent disorders including diverticulosis and other diseases of the bowel, and fecal and urinary incontinence. Many diseases, like gastrointestinal malignancies and liver diseases, occur more frequently as people age. The number of Americans age 65 and above is expected to rise from 35 million in 2000 to 78 million by 2050, with those over 85 rising from four million in 2000 to almost 18 million by 2050, therefore gastroenterologic surgeries are greatly in need, not only to prolong life but to relieve suffering. It is not surprising that the elderly account for approximately 60% of health care expenditures, 35% of hospital discharges, and 47% of hospital days.

Sixty to 70 million Americans are affected by digestive diseases, according to the National Digestive Diseases Clearinghouse. Digestive diseases accounted for 13% of all hospitalizations in the United States in 1985 and 16% of all diagnostic procedures. The most costly digestive diseases are gastrointestinal disorders such as diarrhea infections (\$4.7 billion); gallbladder disease (\$4.5 billion); colorectal cancer (\$4.5 billion); liver disease (\$3.2 billion); and peptic ulcer disease (\$2.5 billion). **Appendectomy** is the fourth most frequent intra-abdominal operation performed in the United States. Appendicitis is one of the most common causes of emergency abdominal surgery in children. Appendectomies are more common in males than females, with incidence peaking in the late teens and early twenties. Each year in the United States, four appendectomies are performed per 1,000 children younger than 18 years of age. Gallstones are responsible for about half of the cases of acute pancreatitis in the United States. More than 500,000 Americans have gallbladder surgery annually. The most common procedure is the laparoscopic **cholecystectomy**. Women 20–60 years of age have twice the rate of gallstones as men, and individuals over 60 develop gallstones at higher rates than those who are younger. Those at



## KEY TERMS

**Colonoscopy**—Video study of the colon by use of a tube with a video camera on the end, placed up the rectum into the colon.

**Endoscopy**—A procedure used on the stomach and duodenum to picture abnormalities with a video camera on the end of a long tube placed down the esophagus.

**Gastrointestinal diseases**—Diseases that affect the digestive system.

**Laparoscopy**—Use of a small instrument for viewing a surgical area through small incisions, often used in gastroenterologic surgery.

highest risk for gallstones are individuals who are obese and those with elevated estrogen levels, such as women who take birth control pills or hormone replacement therapy.

According to the U.S. Centers for Disease Control and Prevention, 25 million Americans suffer from peptic ulcer disease some time in their life. Between 500,000 and 850,000 new cases of peptic ulcer disease and more than one million ulcer-related hospitalizations occur each year. Ulcers cause an estimated one million hospitalizations and 6,500 deaths per year. According to the American College of Gastroenterology Bleeding Registry, patients tend to be elderly; male; and users of alcohol, tobacco, **aspirin**, nonsteroidal anti-inflammatory drugs (NSAIDs), and anticoagulants. According to the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), about 25–40% of ulcerative colitis patients must eventually have their colons removed because of massive bleeding, disease, rupture, or the risk of cancer. The use of **corticosteroids** to control inflammation can destroy tissue and require removal of the colon. According to the Society of American Gastrointestinal Endoscopic Surgeons, 600,000 surgical procedures alone are performed in the United States each year to treat a colon disease.

The incidence of gastroenterologic diseases differs among ethnic groups. For instance, while gastroesophageal reflux disease (GERD) is common in Caucasians, its incidence is lower among African Americans. This is true for the incidence of esophageal and gastric-cardio adenocarcinoma. On the other hand, African Americans, Hispanics, and Asians have a different form of cancer of the esophagus called squamous cell carcinoma, seen also in new immigrants

from northern China, India, and northern Iran. While gastric and peptic ulcerative incidence due to *Helicobacter pylori* ranges in rates from 70–80% for African Americans and Hispanics, the rate for Caucasians is only 34%. Caucasians, on the other hand, have higher rates of intestinal gastric cancer. Finally, there are differences in colon cancer mortality between African Americans and Caucasians. African Americans with colon cancer have a 50% higher mortality risk than Caucasians. Advanced cancer stage at presentation accounts for half of this increased risk. Restricted access to health care, especially screening innovations, may account for much of this disparity.

## Description

Advances in laparoscopy allow the direct study of large portions of the liver, gallbladder, spleen, lining of the stomach, and pelvic organs. Many biopsies of these organs can be performed by laparoscopy. Increasingly, laparoscopic surgery is replacing open abdomen surgery for many diseases, with some procedures performed on an outpatient basis. Gastrointestinal applications have resulted in startling changes in surgeries for appendectomy, gallbladder, and adenocarcinoma of the esophagus, the fastest increasing cancer in North America. Significant other diseases include liver, colon, stomach, and pancreatic cancers; ulcerative conditions in the stomach and colon; and inflammations and/or irritations of the stomach, liver, bowel, and pancreas that cannot be treated with medications or other therapies. Research has shown that laparoscopy is useful in detecting small ( $<0.8$  in [ $<2$  cm]) cancers not seen by imaging techniques and can be used to stage pancreatic or esophageal cancers, averting surgical removal of the organ wall in a high percentage of cases. There are also indications, however, that some laparoscopic procedures may not have the long-lasting efficacy of open surgeries and may involve more complications. This drawback has proven true for laparoscopic fundoplication for GERD disease.

Advances in gastrointestinal fiber-optic endoscopic technology have made endoscopy mandatory for gastrointestinal diagnosis, therapy, and surgery. Especially promising is the use of endoscopic techniques in the diagnosis and treatment of bowel diseases, **colonoscopy**, and **sigmoidoscopy**, particularly with acute and chronic bleeding. Combined with laparoscopic techniques, endoscopy has substantially reduced the need for open surgical techniques for the management of bleeding.

For most gastroenterologic surgeries, whether laparoscopic or open, preoperative medications are

given as well as **general anesthesia**. Food and drink are not allowed after midnight before the surgery the next morning. Surgery proceeds with the patient under general anesthetics for open surgery and local or regional anesthetics for laparoscopic surgery. Specific diseases require specific procedures, with resection and repair of abdomen, colon and intestines, liver, and pancreas considered more serious than other organs. The level of complication of the procedure dictates whether laparoscopic procedures may be used.

### Diagnosis/Preparation

The need for surgery of the esophagus, duodenum, stomach, colon, and intestines is assessed by medical history, general physical, and X-ray after the patient swallows barium for maximum visibility. Diagnosis and preparation for gastroenterological surgery involve some very advanced techniques. Upper and lower gastrointestinal endoscopies are more accurate in spotting abnormalities than X-ray and can be used in treatment. Endoscopy utilizes a long, flexible plastic tube with a camera to look at the stomach and bowel. Quite often, physicians will also use a CT scan for procedures like appendectomy. Upper esophagogastroduodenal endoscopy is considered the reference method of diagnosis for ulcers of the stomach and duodenum. Colonoscopy and sigmoidoscopy are mandatory for diseases and cancers of the colon and large intestine.

### Aftercare

For simple procedures like appendectomy and gallbladder surgery, patients stay in the hospital the night of surgery and may require extra days in the hospital, but they usually go home the next day. Postoperative pain is mild, with liquids strongly recommended in the diet, followed gradually with solid foods. Return to normal activities usually occurs in a short period. For more involved procedures on organs like the stomach, bowel, pancreas, and liver, open surgery usually dictates a few days of hospitalization with a slow recovery period.

### Risks

The risks in gastroenterologic surgery are largely confined to wound or injuries to adjacent organs, infection, and the general risks of open surgery that involve thrombosis and heart difficulties. With some laparoscopic procedures such as fundoplication with injury or laceration of other organs, the return of symptoms within two to three years may occur. With appendectomy, the rates of infection and wound

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Gastroenterologic surgery is performed by urologists, internists, and other specialists in digestive diseases and disorders. Surgery is performed in a general hospital. Some less complicated surgeries done by laparoscopy may be used in an outpatient setting.

complications range between 10% and 18% in patients. The institution of new clinical practice guidelines that include wound guidelines and directed management of postoperative infectious complications are substantially reducing patient mortality. Gallbladder surgery, especially laparoscopic cholecystectomy, is one of the most common surgical procedures in the United States; however, injuries to adjacent organs or structures may occur, requiring a second surgery to repair it. Stomach surgical procedures carry risks, generally in proportion to their benefits. In the 2000s, surgery for peptic ulcer disease is largely restricted to the treatment of complications such as bleeding for ulcer perforation. Research indicates that surgery for bleeding is 90% effective using endoscopic techniques. Laparoscopic surgery for ulcer complications has not been found to be better than regular surgery. Stomach and intestinal surgery risks include diarrhea, reflux gastritis, malabsorption of nutrients, especially iron, as well as the general surgical risks associated with abdominal surgery. The risks of colon surgery are tied to both the general risks of surgical procedures—thrombosis and heart problems—and to the specific disease being treated. For instance, in Crohn's disease, resection of the colon may not be effective in the long run and may require repeated surgeries. Colon surgery in general has risks for bowel obstruction and bleeding.

### Morbidity and mortality rates

According to a study published by the *British Journal of Surgery*, a small minority of patients undergoing gastroenterologic surgery are at high risk for postoperative complications that may lead to prolonged hospital stays. In a study of 235 patients, 47% had at least one postoperative complication, with the **length of hospital stay** at 11 days compared to those without complications with length of stay at six days.

## QUESTIONS TO ASK THE DOCTOR

- How often do you perform this surgery?
- Is this surgery one that can be done laparoscopically?
- How long will it take for me to heal postoperatively?
- What are the risks involved for this type of procedure?
- How long have you been performing this surgery laparoscopically?

### Resources

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American Society for Gastrointestinal Endoscopy, 1520 Kensington Road, Suite 202, Oak Brook, IL, 60523, (630) 573 0600, <http://www.asge.org>.

Crohn's & Colitis Foundation of America, 386 Park Avenue South, 17th Floor, New York, NY, 10016 8804, (800) 932 2423, <[info@ccfa.org](mailto:info@ccfa.org)>, <http://www.ccfa.org>.

International Foundation for Functional Gastrointestinal Disorders, P.O. Box 170864, Milwaukee, WI, 53217, (414) 964 1799, (888) 964 2001, <http://www.iffgd.org>.

National Institute of Diabetes and Digestive and Kidney Diseases, 31 Center Drive, MSC 2560, Bethesda, MD, 20892 2560, (301) 496 3583, <http://www.niddk.nih.gov>.  
Society for Gastroenterology Nurses and Associates, 401 North Michigan Avenue, Chicago, IL, 60611 4267, (800) 245 7462, <http://www.sgna.org>.

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## Gastroesophageal reflux scan

### Definition

Gastrointestinal reflux imaging refers to several methods of diagnostic imaging used to visualize and diagnose gastroesophageal reflux disease (GERD). GERD is one of the most common gastrointestinal problems among children or adults. It is defined as the movement of solid or liquid contents from the stomach backward into the esophagus.

### Purpose

The purpose of gastroesophageal reflux scanning is to allow the doctor to visualize the interior of the patient's upper stomach and lower esophagus. This type of visual inspection helps the doctor make an accurate diagnosis and plan appropriate treatment.

### Description

A brief description of gastroesophageal reflux disease is helpful in understanding the scanning methods used to diagnose it. Gastroesophageal reflux disease is the term used to describe the symptoms and damage caused by the backflow (reflux) of the contents of the stomach into the esophagus. The contents of the human stomach are usually acidic. Because of their acidity, they have the potential to cause chemical burns in such unprotected tissues as the lining of the esophagus.

Gastrointestinal reflux is common in the general American population. Approximately one adult in three reports experiencing some occasional reflux, commonly referred to as heartburn. About 10% of these persons experience reflux on a daily basis. Most persons, however, have only very mild symptoms. Occasionally, someone may experience a burning sensation as a result of gastrointestinal reflux. This symptom is described as reflux esophagitis when it occurs in association with inflammation.

## KEY TERMS

**Barrett's esophagus**—An abnormal condition of the esophagus in which normal mucous cells are replaced by changed cells. This condition is often a prelude to cancer.

**Clearance**—The process of removing a substance or obstruction from the body.

**Dysphagia**—Difficulty in swallowing.

**Endoscope**—An instrument with a light source attached that allows the doctor to examine the inside of the digestive tract or other hollow organ.

**Erosion**—A gradual breakdown or ulceration of the uppermost layer of tissue lining the esophagus or stomach.

**Erythema**—Redness.

**Esophageal varices** —Varicose veins at the lowermost portion of the esophagus. Esophageal varices are easily injured, and bleeding from them is often difficult to stop.

**Esophagus**—The muscular tube that connects the mouth to the stomach.

**Heartburn**—A sensation of warmth or burning behind the breastbone, rising upward toward the

neck. It is often caused by stomach acid flowing upward from the stomach into the esophagus.

**Hematemesis**—Vomit that contains blood, usually seen as black specks in the vomitus.

**Incompetent**—In a medical context, insufficient. An incompetent sphincter is one that is not closing properly.

**pH**—A measure of acidity; technically, a measure of hydrogen ion concentration. The stomach contents are more acidic than the tissues of the esophagus.

**Raynaud's disease**—A disease of the arteries in hands or feet.

**Reflux**—Backflow, also called regurgitation.

**Sjögren's syndrome**—An autoimmune disorder characterized by dryness of the eyes, nose, mouth, and other areas covered by mucous membranes.

**Sphincter**—A circular band of muscle fibers that constricts or closes a passageway in the body. The esophagus has sphincters at its upper and lower ends.

**Visualize**—To achieve a complete view of a body structure or area.

Gastroesophageal reflux has several possible causes:

- An incompetent lower esophageal sphincter. Acid reflux can occur when the ring of muscular tissue at the boundary of the esophagus and stomach is weak and relaxes too far. Sphincter incompetence is the most common cause of gastroesophageal reflux. The acid juices from the stomach are most likely to flow backward through a weak sphincter when a person bends, lifts a weight, or strains. People with esophageal strictures or Barrett's esophagus are more likely to experience gastroesophageal reflux than are others.
- Acid irritation. Gastric contents are acidic, with a pH lower than 3.9. This degree of acidity is very caustic to the lining of the esophagus; repeated exposures may lead to scarring. If the exposure is sufficiently severe or prolonged, strictures can develop. Occasionally, pancreatic enzymes or bile may also flow backward into the stomach and lower esophagus. These fluids are extremely acidic, with a pH lower than 2.0.
- Abnormal esophageal clearance. Clearance refers to the process of removing a substance from a part of the body, in this case the removal of stomach acid

from the esophagus. Acid reflux is ordinarily washed out of the esophagus by the saliva that a person swallows over the course of a day. Saliva also contains some bicarbonate, which helps to neutralize the acidity of the stomach juices. During sleep, however, people swallow less frequently, which results in a longer period of contact between the acid contents of the stomach and the tissues that line the esophagus. The net result is a chemical injury. Sjögren's syndrome, radiation to the oral cavity, and some medications (anticholinergics) also decrease the flow of saliva and can result in chemical injury. Such other medical conditions as Raynaud's disease and scleroderma are often associated with abnormal esophageal clearance. Hiatal hernia is present in more than 90% of persons with erosive disease.

- Delayed gastric emptying. When outflow from the stomach is blocked or the stomach's contractions are weakened, the partially digested food does not leave the stomach in a timely manner. This delay makes gastric reflux more likely to occur.

Heartburn associated with gastroesophageal reflux occurs 30–60 minutes after eating. It also occurs when a person is lying down. Most people who



experience gastroesophageal reflux can obtain relief from heartburn with baking soda, bismuth subsalicylate (Pepto-Bismol), or antacid tablets. A pattern of symptom relief following a dose of one of these non-prescription remedies is usually enough to make the diagnosis of gastroesophageal reflux. Under these conditions, the results of a **physical examination** and laboratory tests are usually within normal limits.

Persons with complicated GERD, or those who do not respond to nonprescription heartburn remedies, require special examinations. There are several imaging methods used in the diagnosis of GERD:

### *Upper endoscopy*

Upper endoscopy is the standard procedure for diagnosing GERD, determining the degree of tissue damage, and documenting the findings. A barium esophagography may be performed in addition to an upper endoscopy. Between 50% and 75% of all patients diagnosed with GERD will have abnormalities in the mucous lining of the esophagus, usually erosion, tissue fragility, and erythema. Upper endoscopy is also used to document esophageal strictures and Barrett's esophagus. Patients with such symptoms as hematemesis (vomiting blood), iron deficiency anemia, guaiac-positive stools, or dysphagia should have an upper endoscopy.

To perform this study, the doctor passes an endoscope, which is a thin instrument with a light source attached, through the patient's mouth into the esophagus. The endoscope allows the doctor to visualize the mucosal lining of the esophagus, the junction between the esophagus and the stomach, and the lining of the upper portion of the stomach. He or she can take biopsy specimens at the same time.

### *Ambulatory esophageal pH monitoring*

This test provides information concerning the frequency and duration of episodes of acid reflux. It can also provide information related to the timing of these episodes. Ambulatory esophageal monitoring is the standard procedure for documenting abnormal acid reflux; however, it is not necessary for most persons with GERD as they can be adequately diagnosed on the basis of their history or by performing an upper endoscopy.

To perform this test, the doctor passes a tiny catheter (about 2 mm wide) with two electrodes through the patient's nose and throat. One electrode is positioned about 2 in (5 cm) above the esophageal sphincter. The other electrode is positioned just below the esophageal sphincter. Data related to pH level are

obtained every four seconds for 24 hours. The patient is instructed to keep a diary of his or her symptoms, and to record coughing episodes, meal times, bedtime, and time of rising. The electrodes are removed after 24 hours and the patients' diary is reviewed.

### *Barium esophagography*

In a barium esophagograph, the patient is given a solution of water and barium sulfate to drink slowly. X rays are taken at intervals as the patient swallows the mixture; the images are analyzed for signs of reflux, inflammation, dysmotility, strictures, and other abnormalities. Barium esophagography provides important information about a number of disorders involving esophageal function, including cricopharyngeal achalasia (a swallowing disorder of the throat); decreased or reverse peristalsis; and **hiatal hernia**.

### *Esophageal manometry*

Esophageal manometry is a useful test for patients who may need surgery because it provides data about esophageal peristalsis and the minimum closing pressure of the esophageal sphincter by measuring the pressure within the esophagus. To perform this test, the doctor passes a thin soft tube through the patient's nose or mouth. When the patient swallows, the tip of the tube enters the esophagus and is positioned at the desired location. The patient then swallows air or water while a technician records the pressure at the tip of the tube.

## **Preparation**

### *Upper endoscopy*

Persons are instructed not to eat or drink for 6 hours before an upper endoscopy. A mild sedative may be given to patients who are unusually nervous.

### *Ambulatory esophageal pH monitoring*

No special preparations are needed for this test. A short-acting anesthetic spray is sometimes used to relieve any discomfort associated with placing the electrodes.

### *Barium esophagography*

The patient should not eat or drink for 6 hours before a barium test.

### *Esophageal manometry*

The patient should take nothing by mouth for 8 hours prior to the test. The doctor may use an anesthetic spray to reduce the throat irritation caused by the manometry tube.

## Aftercare

### Upper endoscopy

After an upper endoscopy, a friend or relative should drive the patient home because of the lingering effects of the sedative.

### Other esophageal scans

There are no special aftercare instructions for patients who have had ambulatory esophageal **pH monitoring**, barium esophagography, or esophageal manometry.

## Risks

### Upper endoscopy

Patients sometimes feel as if they are choking as the doctor passes the endoscope down the throat. This feeling is uncommon, however, if the patient has been given a sedative.

### Ambulatory esophageal pH monitoring

There are no common complications following this test.

### Barium esophagography

Constipation after the test is an infrequent side effect that is treated by giving the patient a laxative.

### Esophageal manometry

Complications following this test are very rare.

## Normal results

### Upper endoscopy

An upper endoscopy documents the condition of the mucous lining of the lower esophagus and upper stomach, thus allowing the doctor to evaluate the progression of GERD.

### Ambulatory esophageal pH monitoring

Measurements of pH are used to evaluate the degree of GERD.

### Barium esophagography

Barium esophagography can detect many structural and functional abnormalities, including the presence of acid reflux, inflammation, tissue masses, or strictures in the esophagus.

### Esophageal manometry

This test documents the ability of the esophageal sphincter to close adequately and keep the contents of

the stomach from flowing backward into the esophagus.

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- American College of Radiology. 1891 Preston White Drive, Reston, VA, 20191. (703) 648-8900. www.acr.org.
- American Osteopathic College of Radiology. 119 East Second St., Milan, MO 63556. (660) 265-4011. www.aocr.org.

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## Gastroesophageal reflux surgery

### Definition

Gastroesophageal reflux surgery is typically performed in patients with serious gastroesophageal reflux disease that does not respond to drug therapy.

Gastroesophageal reflux is classified as the symptoms produced by the inappropriate movement of stomach contents back up into the esophagus. Nissen fundoplication is the most common surgical approach in the correction of gastroesophageal reflux. The laparoscopic method of Nissen fundoplication is becoming the standard form of surgical correction.

### Purpose

Gastroesophageal reflux surgery, including Nissen fundoplication and laparoscopic fundoplication, has two essential purposes: heartburn symptom relief and reduced backflow of stomach contents into the esophagus.

### Heartburn symptom relief

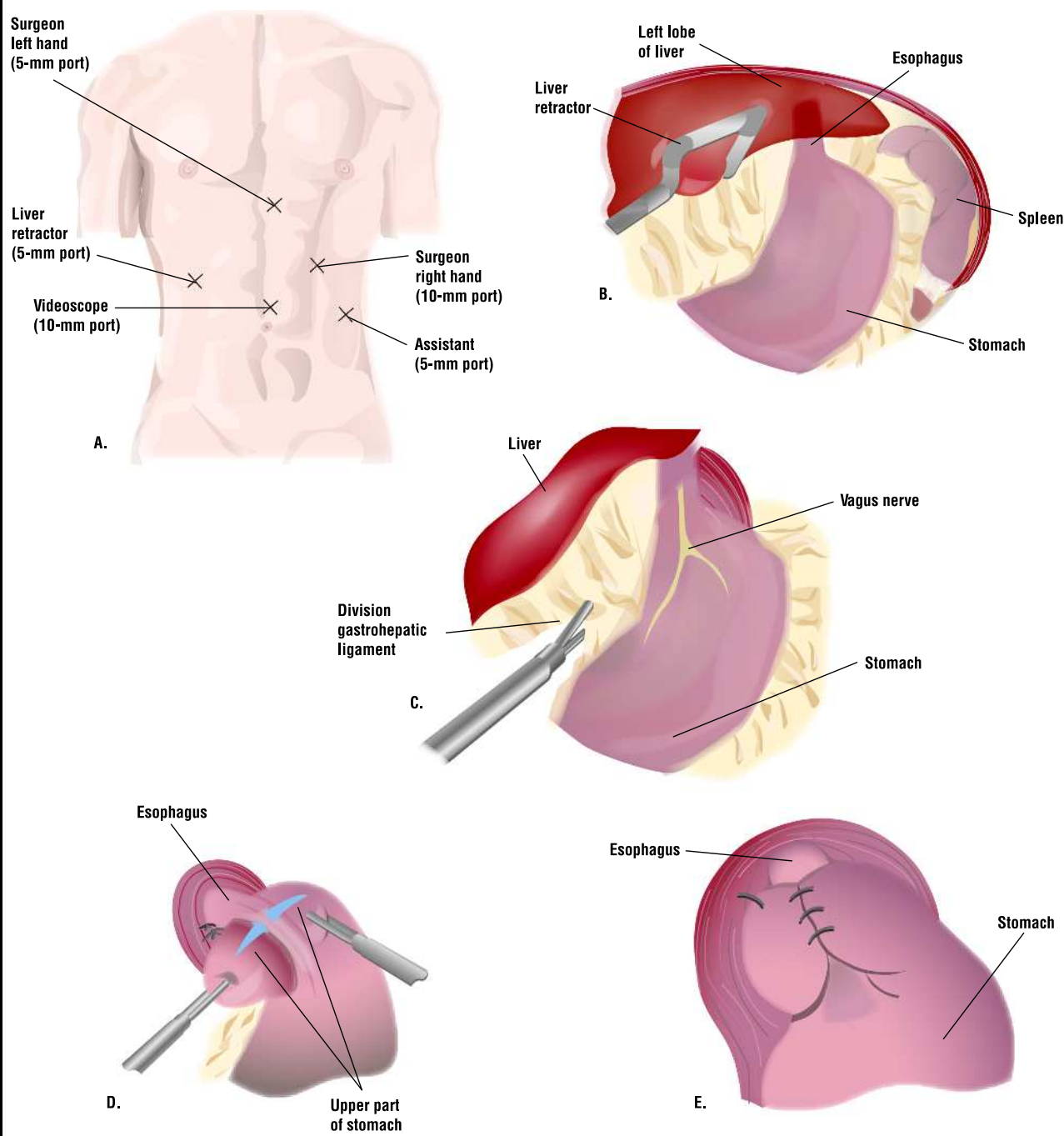
Because Nissen fundoplication is considered surgery, it is usually considered as a treatment option only when drug treatment is only partially effective or ineffective. Nissen fundoplication is often used in patients with a particular anatomic abnormality called



A pediatric surgeon performing gastroesophageal reflux surgery (stomach stapling) on an 8-year-old with GERD. (Barry Slaven, MD, PhD / Phototake. Reproduced by permission.)



# Gastroesophageal reflux surgery (Fundoplication)



In a laparoscopic surgery to alleviate gastroesophageal reflux, the surgeon makes several incisions to gain access to the stomach and esophagus (A). Using the videoscope, the stomach is visualized (B), and the ligament connecting the stomach to the liver is divided (C). The upper part of the stomach is brought up around the base of the esophagus (D), and stitched to place (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

**hiatal hernia** that causes significant gastroesophageal reflux. In some cases, Nissen fundoplication is also used when the patient cannot or does not want to

take reflux medication. Surgery is also more likely to be considered when it is obvious that the patient will need to take reflux drugs on a permanent basis. Reflux



## KEY TERMS

**Barrett's esophagus**—Changes in the cells lining the esophagus that result from constant exposure to refluxed stomach acid.

**Esophagitis**—Inflammation of the esophagus.

**Hiatal hernia**—Protrusion of the stomach upward into the mediastinal cavity through the esophageal hiatus of the diaphragm.

**Motility**—Gastrointestinal movement.

drugs, like virtually all drugs, may produce side effects, especially when taken over a period of years.

One of the biggest problems in diagnosing and controlling gastroesophageal reflux disease is that the severity of disease is not directly related to the presence or intensity of symptoms. There is also no consistent relationship between the severity of disease and the degree of tissue damage in the esophagus. When reflux occurs, stomach acid comes into contact with the cells lining the esophagus. This contact can produce a feeling of burning in the esophagus and is commonly called heartburn. Some of the other symptoms associated with this condition include:

- chest pain
- swallowing problems
- changes in vocal qualities

### *Reduced reflux*

The reduction or elimination of reflux is as important, and sometimes more important, than the elimination of symptoms. This leads to one of the most important points in gastroesophageal reflux disease. Long-term exposure to acid in the esophagus tends to produce changes in the cells of the esophagus. These changes are usually harmful and can result in very serious conditions, such as Barrett's esophagus and cancer of the esophagus. Because of this, all persons with gastroesophageal reflux disease symptoms need to be evaluated with a diagnostic instrument called an endoscope. An endoscope is a long, flexible tube with a camera on the end that is inserted down the throat and passed all the way down to the esophageal/stomach region.

All gastroesophageal reflux surgery, including Nissen fundoplication, attempts to restore the normal function of the lower esophageal sphincter (LES). Malfunction of the LES is the most common cause of gastroesophageal reflux disease. Typically, the LES opens during swallowing but closes quickly thereafter

to prevent the reflux of acid back into the esophagus. Some patients have sufficient strength in the sphincter to prevent reflux, but the sphincter opens and closes at the wrong times. However, this is not the case in most individuals with gastroesophageal reflux disease. These individuals usually have insufficient sphincter strength. In a small number of cases, the muscles of the upper esophagus region are too weak and are not appropriately coordinated with the process of swallowing.

The development of heartburn does not necessarily suggest the presence of gastroesophageal reflux disease, which is a more serious condition. Gastroesophageal reflux disease is often defined as the occurrence of heartburn more than twice per week on a long-term basis. Gastroesophageal reflux disease can lead to more serious health consequences if left untreated. The primary symptoms of gastroesophageal reflux disease are chronic heartburn and acid regurgitation, or reflux. It is important to note that not all patients with gastroesophageal reflux disease have heartburn. Gastroesophageal reflux disease is most common in adults, but it can also occur in children.

The precise mechanism that causes gastroesophageal reflux disease is not entirely known. It is known that the presence of a hiatal hernia increases the likelihood that gastroesophageal reflux disease will develop. Other factors that are known to contribute to gastroesophageal reflux disease include:

- smoking
- alcohol ingestion
- obesity
- pregnancy

The following foods and drinks are known to increase the production of stomach acid and the resulting reflux into the esophagus:

- caffeinated drinks
- high-fat foods
- garlic
- onions
- citrus fruits
- chocolate
- fried foods
- foods that contain tomatoes
- foods that contain mint
- spicy foods

Most patients take over-the-counter antacids initially to relieve the symptoms of acid reflux. If antacids do not help, the physician may prescribe drugs called H<sub>2</sub> blockers, which can help those with mild-to-moderate disease. If these drugs are not effective, more powerful

acid-inhibiting drugs called **proton-pump inhibitors** may be prescribed. If these drugs are not effective in controlling gastroesophageal reflux disease, then the patient may require surgery.

## Demographics

It has been estimated that heartburn occurs in more than 60% of adults. About 20% of the population take antacids or over-the-counter H<sub>2</sub> blockers at least once per week to relieve heartburn. In addition, about 80% of pregnant women have significant heartburn. Hiatal hernia is believed to develop in more than half of all persons over the age of 50 years. Hiatal hernia is present in about 70% of patients with gastroesophageal reflux disease, but the majority of patients with hiatal hernia do not have symptoms of gastroesophageal reflux disease. In addition, about 7-10% of the population has daily episodes of heartburn. It is these individuals who are likely to be classified as having gastroesophageal reflux disease.

## Description

The most common type of gastroesophageal reflux surgery to correct gastroesophageal reflux disease is Nissen fundoplication. Nissen fundoplication is a specific technique that is used to help prevent the reflux of stomach contents back into the esophagus. When Nissen fundoplication is successful, symptoms and further damage to tissue in the esophagus are significantly reduced. Prior to Nissen fundoplication, open surgery was required to access to the lower esophageal region. This approach required a large external incision in the abdomen of the patient.

Fundoplication involves wrapping the upper region of the stomach around the lower esophageal sphincter to increase pressure on the LES. This procedure can be understood by visualizing a bun being wrapped around a hot dog. The wrapped portion is then sewn into place so that the lower part of the esophagus passes through a small hole in the stomach muscle. When the surgeon performs the fundoplication wrap, a large rubber dilator is usually placed inside the esophagus to reduce the likelihood of an overly tight wrap. The goal of this approach is to strengthen the sphincter; to repair a hiatal hernia, if present; and to prevent or significantly reduce acid reflux.

Fundoplication was greatly improved with the development of the laparoscope. The laparoscope is a long, thin, flexible instrument with a camera and tiny surgical tools on the end. Laparoscopic fundoplication (sometimes called “telescopic” or “keyhole” surgery) is

performed under **general anesthesia** and usually includes the following steps:

- Several small incisions are created in the abdomen.
- The laparoscope is passed into the abdomen through one of the incisions. The other incisions are used to admit instruments to manipulate structures within the abdomen.
- The abdomen is inflated with carbon dioxide. The contents of the abdomen can now be viewed on a video monitor that receives its picture from the laparoscopic camera.
- The stomach is freed from its attachment to the spleen.
- An esophageal dilator is passed through the mouth into the esophagus. This dilator keeps the stomach from being wrapped too tightly around the esophagus.
- The portion of the esophagus in the abdomen is freed of its attachments.
- The top portion of the stomach (the fundus) is passed behind the esophagus, wrapped around it 360°, and sutured in place.
- If a hiatal hernia is present, the hiatus (the hole in the diaphragm through which the esophagus passes) is made smaller with one to three sutures so that it fits around the esophagus snugly. The sutures keep the fundoplication from protruding into the chest cavity.
- The laparoscope and instruments are removed and the incisions are closed.

## Diagnosis/Preparation

The diagnosis of gastroesophageal reflux disease can be straightforward in cases where the patient has the classic symptoms of regurgitation, heartburn, and/or swallowing difficulties. Gastroesophageal reflux disease can be more difficult to diagnose when these classic symptoms are not present. Some of the less common symptoms associated with reflux disease include asthma, nausea, cough, hoarseness, and chest pain. Symptoms such as severe chest pain and weight loss may be an indication of disease more serious than gastroesophageal reflux disease.

The most accurate test for diagnosing gastroesophageal reflux disease is ambulatory **pH monitoring**. This is a test of the pH (a measurement of acids and bases) above the lower esophageal sphincter over a 24-hour period. Endoscopies can be used to diagnose the complications of gastroesophageal reflux disease, such as esophagitis, Barrett’s esophagus, and esophageal cancer, but only about 50% of patients with gastroesophageal reflux disease have changes that are

evident using this diagnostic tool. Some physicians prescribe omeprazole, a proton-pump inhibiting drug, to persons suspected of having gastroesophageal reflux disease to see if the person improves over a period of several weeks.

### Aftercare

Patients should be able to participate in light physical activity at home in the days following **discharge from the hospital**. In the days and weeks following surgery, anti-reflux medication should not be necessary. Pain following this surgery is usually mild, but some patients may need pain medication. Some patients are instructed to limit food intake to a liquid diet in the days following surgery. Over a period of days, they are advised to gradually add solid foods to their diet. Patients should ask the surgeon about the post-operative diet. Normal activities, such as lifting, work, driving, showering, and sexual intercourse, can usually be resumed within a short period of time. If pain is more than mild and pain medication is not effective, then the surgeon should be consulted in a follow-up appointment.

The patient should call the doctor if any of the following symptoms develop:

- drainage from the incision region
- swallowing difficulties
- persistent cough
- shortness of breath
- chills
- persistent fever
- bleeding
- significant abdominal pain or swelling
- persistent nausea or vomiting

### Risks

Risks or complications that have been associated with fundoplication include:

- heartburn recurrence
- swallowing difficulties caused by an overly tight wrap of the stomach on the esophagus
- failure of the wrap to stay in place so that the LES is no longer supported
- normal risks associated with major surgical procedures and the use of general anesthesia
- increased bloating and discomfort due to a decreased ability to expel excess gas

Complications, though rare, can occur during fundoplication. These complications can include injury to

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Fundoplication, including the laparoscopic approach, is generally performed by a specialist known as a gastroenterologist. A gastroenterologist is a medical doctor (M.D.) who has received additional training in the diseases of the gastrointestinal system. Gastroenterologists who perform laparoscopic fundoplications receive extensive training in general surgery and in the proper techniques involving the use of the laparoscope. If surgery is being considered, it is a good idea to find out how many laparoscopic fundoplications the surgeon performs on a yearly basis. Laparoscopic fundoplications are often performed in the specialized department of a general hospital, but they are also performed in specialized clinics or institutes for gastrointestinal disorders.

surrounding tissues and organs, such as the liver, esophagus, spleen, and stomach. One of the major drawbacks to fundoplication surgery, whether it is open or laparoscopic, is that the procedure is not reversible. In addition, some of the symptoms associated with complications are not always treatable. One study showed that about 10% to 20% of patients who receive fundoplication have a recurrence of gastroesophageal reflux disease symptoms or develop other problems, such as bloating, intestinal gas, vomiting, or swallowing problems, following the surgery. In addition, some patients may develop altered bowel habits following the surgery.

### Normal results

One research study found that fundoplication is successful in 50–90% of cases. This study found that successful surgery typically relieves the symptoms of gastroesophageal reflux disease and esophagus inflammation (esophagitis). However, the researchers in this study provided no information on the long-term stability of the procedure. Fundoplication does not always eliminate the need for medication to control gastroesophageal reflux disease symptoms. A different study found that 62% of patients who received fundoplication continued to need medication to control reflux symptoms. However, these patients required less medication than before fundoplication.

## QUESTIONS TO ASK THE DOCTOR

Questions to ask the primary care physician:

- What are my alternatives?
- Is surgery the answer for me?
- Can you recommend a surgeon who performs the laparoscopic procedure?
- If surgery is appropriate for me, what are the next steps?

Two studies demonstrated that laparoscopic fundoplication improved reflux symptoms in 76% and 98% of the treated populations, respectively. In an additional study, researchers evaluated 74 patients with reflux disease who received Nissen fundoplication after failure of medical therapy. The researchers concluded that 93.8% of the patients had complete resolution of symptoms and did not require anti-reflux medications approximately 14 months after fundoplication. Researchers have found that when fundoplication is successful, the resting pressure in the LES increases. This reflects a return to more normal LES functioning where the LES keeps stomach acid in the stomach through increased pressure.

Overall, studies have suggested that the vast majority of patients who receive laparoscopic reflux surgery have positive results. These patients are either symptom-free or have significant improvements in reflux symptoms. The laparoscopic approach has a few advantages over other forms of fundoplication. These advantages include:

- decreased postoperative pain
- more rapid return to work
- decreased hospital stay
- better cosmetic results

### Morbidity and mortality rates

Mortality is extremely rare during or following fundoplication. Complications and side effects are not common following fundoplication, especially using the laparoscopic approach, and are usually mild. A review of 621 laparoscopic fundoplication procedures performed in Italy found no cases of mortality and complications in 7.3% of cases. The most serious complication was acute dysphagia (difficulty swallowing) that required a re-operation in 10 patients. In general, long-term complications resulting from this procedure are uncommon.

## QUESTIONS TO ASK THE SURGEON:

- How many times have you performed Nissen or laparoscopic fundoplication?
- Are you a board-certified surgeon?
- What types of outcomes have you had?
- What are the most common side effects or complications?
- What should I do to prepare for surgery?
- What should I expect following the surgery?
- Can you refer me to one of your patients who has had this procedure?
- What type of diagnostic procedures are performed to determine if patients require surgery?
- Will I need to see another specialist for the diagnostic procedures?
- Do you use endoscopy, motility studies, and/or pH studies for your pre-operative evaluation?

### Alternatives

There are several variations of fundoplication that may be performed. In addition, laparoscopic fundoplication may require conversion to an open, or traditional, surgical fundoplication in a small percentage of cases. The most common alternative to fundoplication is simply a continuation of medical therapy. Typically, patients receive medication for a period prior to being evaluated for surgery. A review of nine studies found that omeprazole, a proton-pump inhibitor, was as effective as surgery. However, this same review found that the other commonly used anti-reflux drugs, histamine H<sub>2</sub>-antagonists, were not as effective as surgery.

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## Gastrostomy

### Definition

Gastrostomy is a surgical procedure for inserting a tube through the abdomen wall and into the stomach. The tube, called a "g-tube," is used for feeding or drainage.

### Purpose

Gastrostomy is performed because a patient temporarily or permanently needs to be fed directly through a tube in the stomach. Reasons for feeding by gastrostomy include birth defects of the mouth, esophagus, or stomach, and neuromuscular conditions that cause people to eat very slowly due to the shape of their mouth or a weakness affecting their chewing and swallowing muscles.

Gastrostomy is also performed to provide drainage for the stomach when it is necessary to bypass a longstanding obstruction of the stomach outlet into the small intestine. Obstructions may be caused by peptic ulcer scarring or a tumor.

### Demographics

In the United States, gastrostomies are more frequently performed on older individuals.

### Description

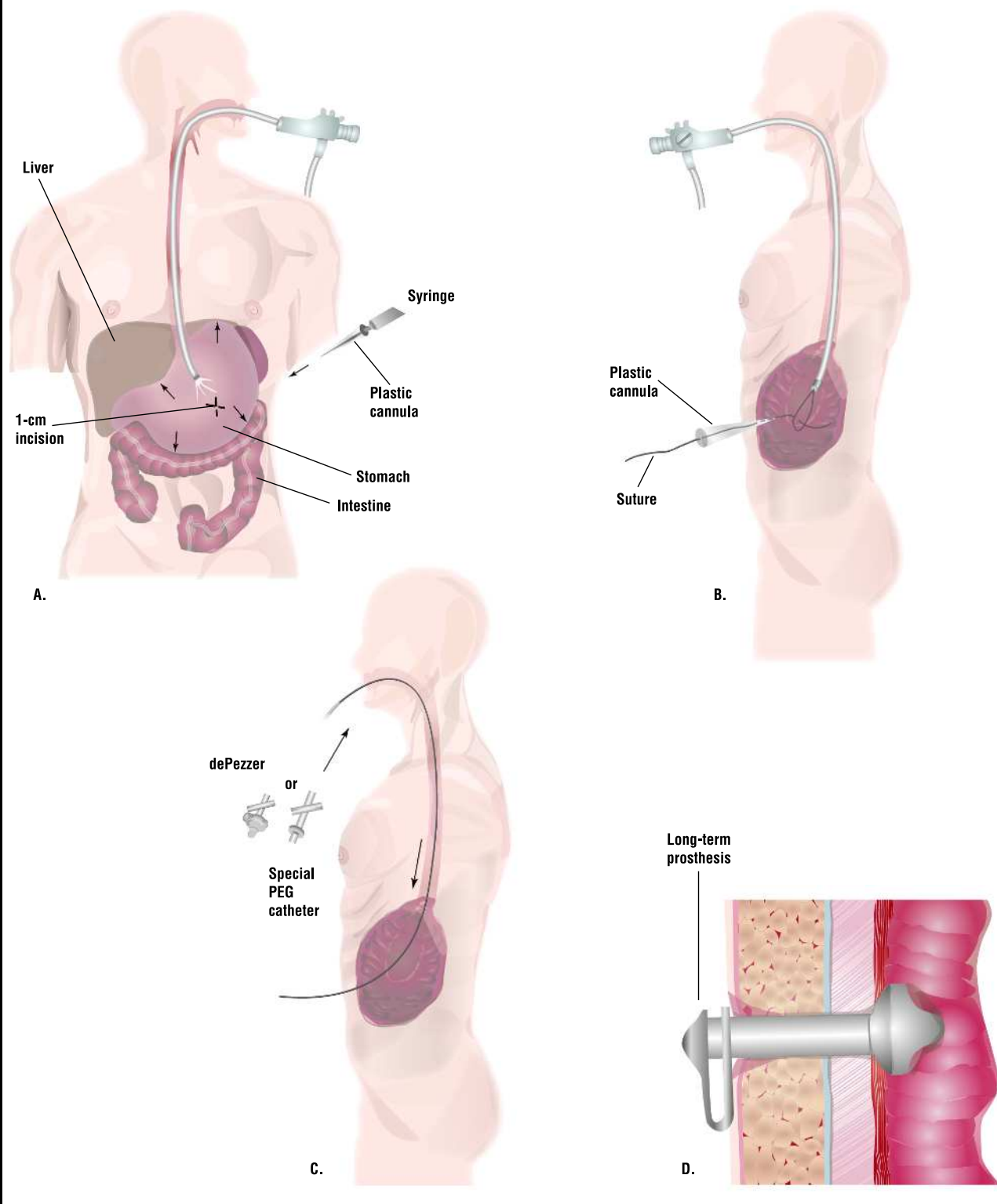
Gastrostomy, also called gastrostomy tube (g-tube) insertion, is surgery performed to give an external opening into the stomach. Surgery is performed either when the patient is under **general anesthesia** or under **local anesthesia**.

Fitting the g-tube usually requires a short surgical operation that lasts about 30 minutes. During the surgery, an opening (stoma) about the diameter of a small pencil is cut in the skin and into the stomach; the stomach is then carefully attached to the abdominal wall. The g-tube is then fitted into the stoma. It is a special tube held in place by a disc or a water-filled balloon that has a valve inside allowing food to enter, but nothing to come out. The hole can be made using two different methods. The first uses a tube called an endoscope that has a light at the end, which is inserted into the mouth and fed down the esophagus and into the stomach. The light shines through the skin, showing the surgeon where to perform the incision. The other procedure does not use an endoscope. Instead, a small incision is made on the left side of the abdomen; an incision is then made through the stomach. A small, flexible, hollow tube, usually made of polyvinyl chloride or rubber, is inserted into the stomach. The stomach is stitched tightly around the tube, and the incision is closed.

The length of time the patient needs to remain in the hospital depends on the age of the patient and the patient's general health. In some cases, the hospital stay can be as short as one day, but often is longer. Normally, the stomach and abdomen heal in five to seven days.

The cost of the surgery varies, depending on the age and health of the patient. Younger patients are usually sicker and require more intensive, and thus more expensive, care. The procedure is normally covered by medical insurance.

## Gastrostomy



For a percutaneous endoscopic gastrostomy procedure, the stomach is inflated with air (A). An incision is made into the abdomen and the stomach, and a plastic cannula is inserted (B). A catheter is inserted into the patient's mouth, pulled down the esophagus, and into the stomach (C). When the catheter is in place, access to the stomach is maintained (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Anesthesia**—A combination of drugs administered by a variety of techniques by trained professionals that provide sedation, amnesia, analgesia, and immobility adequate for the accomplishment of a surgical procedure with minimal discomfort, and without injury to the patient.

**Endoscopy**—A procedure in which an instrument containing a camera is inserted into the gastrointestinal tract so that the doctor can visually inspect the gastrointestinal system.

## Preparation

Before the operation, the doctor will perform an endoscopy and take x rays of the gastrointestinal tract. Blood and urine tests will also be performed, and the patient will meet with the anesthesiologist to evaluate any special conditions that might affect the administration of anesthesia.

## Aftercare

Immediately after the operation, the patient is fed intravenously (through a vein) for at least 24 hours. Once bowel sounds are heard, indicating that the gastrointestinal system is working, the patient can begin clear liquid feedings through the tube. The volume of the feedings is gradually increased.

Patient education concerning use and care of the gastrostomy tube is very important. Patients and their families are taught how to recognize and prevent infection around the tube, how to insert food through the tube, how to handle tube blockage, what to do if the tube pulls out, and what normal activities can be resumed.

## Risks

There are few risks associated with this surgery. The main complications are infection, bleeding, dislodgment of the tube, stomach bloating, nausea, and diarrhea.

Gastrostomy is a relatively simple procedure. As with any surgery, however, patients are more likely to experience complications if they are smokers, obese, use alcohol heavily, or use illicit drugs. In addition,

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The procedure is performed at a hospital or surgical clinic by a surgeon or gastroenterologist trained in endoscopy and placement of these tubes.

some prescription medications may increase risks associated with anesthesia.

## Normal results

The patient is able to eat through the gastrostomy tube, or the stomach can be drained through the tube.

## Morbidity and mortality rates

The mortality rate of people who have had a gastrostomy is relatively high, however, the cause of **death** is almost always related to the illness or conditions that necessitated the insertion of the tube rather than to the actual surgical procedure.

## Alternatives

There are no alternatives to a gastrostomy because the decision to perform it is made when a person is unable to take in enough calories to meet the demands of the body.

## Resources

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### ORGANIZATIONS

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American Gastroenterological Association (AGA). 4930 Del Ray Avenue, Bethesda, MD 20814. (301) 654 2055. <http://www.gastro.org> (accessed March 31, 2008).

United Ostomy Association of America. (UOAA). P. O. Box 66, Fairview, TN 37062 0066 (800) 826 0826. <http://www.uoaa.org> (accessed March 31, 2008).

## QUESTIONS TO ASK THE DOCTOR

- What happens on the day of surgery?
- What type of anesthesia will be used?
- What happens after g-tube insertion?
- What are the risks associated with the procedure?
- How is the g-tube insertion done?
- Will there be a scar?
- Will I be able to eat normal food?
- Will people notice that I have a g-tube?
- Will it be there forever?

### OTHER

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GE surgery see **Gastroenterologic surgery**  
General anesthesia see **Anesthesia, general**

## General surgery

### Definition

General surgery is the treatment of injury, deformity, and disease using operative procedures.

### Purpose

General surgery is frequently performed to alleviate suffering when a cure is unlikely through medication alone. It can be used for routine procedures performed in a physician's office, such as **vasectomy**, or for more complicated operations requiring a medical team in a hospital setting, such as laparoscopic **cholecystectomy** (removal of the gallbladder). Areas of the body treated by general surgery include the stomach, liver, intestines, appendix, breasts, thyroid gland, salivary glands, some arteries and veins, and the skin. The brain, heart, lungs, eyes, feet, kidneys, bladder, and reproductive organs—to name only a few—are areas that require specialized surgical repair.

## KEY TERMS

**Appendectomy**—Removal of the appendix.

**Endoscope**—Instrument for visual examination of the inside of a body canal or a hollow organ such as the stomach, colon, or bladder.

**Hysterectomy**—Surgical removal of part or all of the uterus.

**Laparoscopic cholecystectomy**—Removal of the gallbladder using a laparoscope, a fiber-optic instrument inserted through the abdomen.

**Microsurgery**—Surgery on small body structures or cells performed with the aid of a microscope and other specialized instruments.

**Portal**—An entrance or a means of entrance.

New methods and techniques are less invasive than older practices, permitting procedures that were considered impossible in the past. For example, **microsurgery** has been used in reattaching severed body parts by successfully reconnecting small blood vessels and nerves. Laparoscopic techniques are more efficient, promote more rapid healing, leave smaller scars, and have lower postoperative infection rates.

### Demographics

All surgeons receive similar training in the first two years of their residency (post-medical school) training. General surgeons are the surgical equivalent of family practitioners. General surgeons typically differ from other surgical specialties in the operations that they perform. This difference is most easily understood by exclusion. For example, procedures involving nerves or the brain are usually performed by neurosurgeons. Surgeons having specialized training during the final three years of their residency period similarly focus on other regions of the body. General surgeons may perform such procedures in the absence of other surgeons with specialized training; however, these situations are the exception rather than the rule.

In the United States, there are approximately 850,000 physicians licensed to practice medicine and surgery. Experts estimate that fewer than 5% of these physicians (approximately 42,000) restrict their practices to general surgery.

### Description

In earlier times, surgery was a dangerous and dirty practice. Through the middle of the nineteenth



century, the number of people who died from surgery approximately equaled the number of those who were cured. With the discovery and development of **general anesthesia** in the mid-nineteenth century, surgery became more humane. As knowledge about infections grew and sterile practices were introduced into the **operating room**, surgery became more successful. The last 50 years have brought continued advancements.

General surgery experienced major advances with the introduction of the endoscope. This is an instrument for visualizing the interior of a body canal or a hollow organ. Endoscopic surgery relies on this pencil-thin instrument, equipped with its own lighting system and small video camera. The endoscope is inserted through tiny incisions called portals. While viewing the procedure on a video screen, the surgeon then operates with various other small, precise instruments inserted through one or more of the portals. The specific area of the body to be treated determines the type of endoscopic surgery performed. For example, **colonoscopy** uses an endoscope, which can be equipped with a device for obtaining tissue samples for visual examination of the colon. Gastrosocopy uses an endoscope inserted through the mouth to examine the interior of the stomach. Arthroscopy refers to joint surgery. Abdominal procedures are called laparoscopies.

Endoscopy is frequently used in both treatment and diagnosis involving the digestive and female reproductive systems. Endoscopy has advantages over many other surgical procedures, resulting in a quicker recovery and shorter hospital stays. This non-invasive technique is used for appendectomies, gall-bladder surgery, hysterectomies, and the repair of shoulder and knee ligaments; however, endoscopy has limitations such as complications and operating expense. Endoscopy does not offer advantages over conventional surgery in all procedures. Some literature states that, as general surgeons become more experienced in their prospective fields, additional non-invasive surgical procedures will become more common options.

One-day surgery is also termed same-day or **out-patient surgery**. Surgical procedures in this category usually require two hours or less and involve minimal blood loss and a short recovery time. In the majority of surgical cases, oral medications control postoperative pain. Cataract removal, **laparoscopy**, **tonsillectomy**, repair of broken bones, hernia repair, and a wide range of cosmetic procedures are common same-day surgical procedures. Many individuals prefer the convenience and atmosphere of one-day surgery centers, as there is less competition for attention with more serious surgical cases. These centers are accredited by

the Joint Commission on Accreditation of Healthcare Organizations or the Accreditation Association for Ambulatory Health Care.

## Diagnosis/Preparation

The preparation of persons for surgery has advanced significantly with improved diagnostic techniques and procedures. Before surgery, a candidate may be asked to undergo a series of tests, including blood and urine studies, X-rays, and specific heart studies if the person's past medical history or **physical examination** warrants this testing. Before any surgical procedure, the physician will explain the nature of the surgery needed, the reason for the procedure, and the anticipated outcome. The risks involved will be discussed, along with the types of anesthesia to be utilized. The expected length of recovery and limitations imposed during the recovery period are also explained in detail before any surgical procedure.

Surgical procedures most often require some type of anesthetic. Some procedures require only **local anesthesia**, produced by injecting the anesthetic agent into the skin near the site of the operation. The person remains awake with this form of medication. Injecting anesthetic agents near a primary nerve located adjacent to the surgical site produces block anesthesia (also known as regional anesthesia), which is a more extensive local anesthesia. The person remains conscious, but is usually sedated. General anesthesia involves injecting anesthetic agents into the blood stream or inhaling medicines through a mask placed over the person's face. During general anesthesia, an individual is asleep and an airway tube is usually placed into the windpipe (trachea) to help keep the airway open.

As part of the preoperative preparation, surgical patients will receive printed educational material and may be asked to review audio or videotapes. They will be instructed to shower or bathe the evening before or morning of surgery and may be asked to scrub the operative site with a special antibacterial soap. Instructions will also be given to eat or drink nothing by mouth for a determined period of time prior to the surgical procedure.

## Precautions

Persons who are obese, smoke, have bleeding tendencies, or are over 60 must follow special precautions, as do persons who have recently experienced illnesses, including pneumonia or a heart attack. People taking medications such as heart and blood pressure medicine, blood thinners, **muscle relaxants**, tranquilizers,

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

General surgery is performed by a physician with specialized training in surgery. It is most commonly performed in an outpatient facility adjacent to a hospital or in an operating room of a hospital. Very minor procedures such as abscess incision and drainage or the removal of a small or superficial foreign body may be performed in a professional office.

anticonvulsants, insulin, or sedatives may require special laboratory tests prior to surgery and special monitoring during surgery. Extra precautions may be necessary for persons using mind-altering drugs such as narcotics, psychedelics, hallucinogens, marijuana, sedatives, or cocaine since these drugs may interact with the anesthetic agents used during surgery.

### Risks

A risk associated with general surgery is the potential for postoperative complications. These complications include, but are not limited to, pneumonia, internal bleeding, and wound infection as well as adverse reactions to anesthesia.

### Normal results

Advances in diagnostic and surgical techniques have greatly increased the success rate of general surgery. Contemporary procedures are less invasive than those practiced a decade or more ago. The results include reduced length of hospital stays, shortened recovery times, decreased postoperative pain, and decreases in the size and extent of surgical incisions. The length of time required for a full recovery varies with the procedure.

### Morbidity and mortality rates

Mortality from general surgical procedures is uncommon. The most common causes of mortality are adverse reactions to anesthetic agents or drugs used to control pain, postsurgical clot formation in the veins, and postsurgical heart attacks or strokes.

Abnormal results from general surgery include persistent pain, swelling, redness, drainage, or bleeding in the surgical area and surgical wound infection, resulting in slow healing.

## QUESTIONS TO ASK THE DOCTOR

- What tests will be performed prior to surgery?
- Which body parts will be affected?
- How will the procedure affect daily activities after recovery?
- Where will the surgery be performed?
- What form of anesthesia will be used?
- What will the area look like after surgery?
- Is the surgeon board certified?
- How many similar procedures has the surgeon performed?
- What is the surgeon's complication rate?

### Alternatives

For the removal of diseased or nonvital tissue, there is no alternative to surgery. Alternatives to general surgery depend on the condition being treated. Medications, acupuncture, or hypnosis are used to relieve pain. Radiation is an occasional alternative for shrinking growths. Chemotherapy may be used to treat cancer. Some foreign bodies may remain in the body without harm.

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#### ORGANIZATIONS

American Board of Surgery, 1617 John F. Kennedy Boulevard, Suite 860, Philadelphia, PA, 19103, (215) 568 4000, (215) 563 5718, <http://www.absurgery.org>.

American College of Surgeons, 633 North Saint Claire Street, Chicago, IL, 60611, (312) 202 5000, <http://www.facs.org/>.

American Medical Association, 515 N. State Street, Chicago, IL, 60610, (800) 621 8335, <http://www.ama-assn.org>.

American Society for Aesthetic Plastic Surgery, 11081 Winers Circle, Los Alamitos, CA, 90720, (888) 272 7711, <http://www.surgery.org/>.

American Society for Dermatologic Surgery, 5550 Meadowbrook Drive, Suite 120, Rolling Meadows, IL, 60008, (847) 956 0900, <http://www.asds.net>.

American Society of Plastic and Reconstructive Surgeons, 444 E. Algonquin Road, Arlington Heights, IL, 60005, (847) 228 9900, <http://www.plasticsurgery.org>.

L. Fleming Fallon, Jr., M.D., Dr.P.H.

GERD scan see **Gastroesophageal reflux scan**

GERD surgery see **Gastroesophageal reflux surgery**

## Gingivectomy

### Definition

Gingivectomy is periodontal surgery that removes and reforms diseased gum tissue or other gingival buildup related to serious underlying conditions. For more chronic gingival conditions, gingivectomy is utilized after other nonsurgical methods have been tried,

and before gum disease has advanced enough to jeopardize the ligaments and bone supporting the teeth. Performed in a dentist's office, the surgery is primarily done one quadrant of the mouth at a time under local anesthetic. Clinical attachment levels of the gum to teeth and supporting structures determine the success of the surgery. Surgery required beyond gingivectomy involves the regeneration of attachment structures through tissue and bone grafts.

### Purpose

Periodontal surgery is primarily performed to alter or eliminate the microbial factors that create periodontitis, and thereby stop the progression of the disease. Periodontal diseases comprise a number of conditions that affect the health of periodontium. The factors include a variety of microorganisms and host conditions, such as the immune system, that combine to affect the gums and, ultimately, the support of the teeth. The primary invasive factor creating disease is plaque-producing bacteria. Once the gingiva are infected by plaque-making bacteria unabated due to immunosuppression or by oral hygiene, the bacterial conditions for periodontitis or gum infections are present. Unless the microorganisms and the pathological changes they produce on the gum are removed, the disease progresses. In the most severe cases, graft surgery may be necessary to restore tissue ligament and bone tissue destroyed by pathogens.

In healthy gums, there is very little space between the gum and tooth, usually less than 0.15 in (4 mm). With regular brushing and flossing, most gums stay healthy and firm unless there are underlying hereditary or immunosuppressive conditions that affect the gums. The continuum of progressive bacterial infection of the gums leads to two main conditions in the periodontium: gingivitis and periodontitis. External factors such as smoking and certain illnesses such as diabetes are associated with periodontal disease and increase the severity of disease in the gum tissue, support, and bone structures. Two types of procedures are necessitated by the severity of gum retreat from the teeth, represented by periodontal pockets. Both non-surgical and surgical procedures are designed to eliminate these pockets and restore gum to the teeth, thereby ensuring the retention of teeth.

### Gingivitis

Gingivitis occurs when gum tissue is invaded by bacteria that change into plaque in the mouth due to disease-fighting secretions. This plaque resides on the gums and hardens, becoming tartar, or crystallized plaque, known also as calculus. Brushing and flossing

## KEY TERMS

**Calculus**—A term for plaque buildup on the teeth that has crystallized.

**Gingivitis**—Inflammation of the gingiva or gums caused by bacterial buildup in plaque on the teeth.

**Periodontitis**—Generalized disease of the gums in which unremoved calculus has separated the gingiva or gum tissue from the teeth and threatens support ligaments of the teeth and bone.

**Scaling and root planing**—A dental procedure to treat gingivitis in which the teeth are scraped inside the gum area and the root of the tooth is planed to dislodge bacterial deposits.

cannot remove calculus. The gum harboring calculus becomes irritated, causing inflammation and a loss of a snug fit to the teeth. As the pockets between the gum and the teeth become more pronounced, more residue is developed, and the calculus becomes resistant to the cleaning ability of brushing and flossing. Gums become swollen and begin to bleed. A dentist or periodontist can reverse this form of gum disease through the mechanical removal of calculus and plaque. This cleaning is called curettage, which is a deep cleaning process that includes scraping the tartar off the teeth above and below the gum line and planing or smoothing the tooth at the root. Also known as dental **debridement**, this procedure is often accompanied by antibiotic treatment to stave off further microbe proliferation.

### *Periodontitis*

Periodontitis is the generalized condition of the periodontium in which gums are so inflamed by bacteria-produced calculus that they separate from the teeth, creating large pockets (more than 0.23 in [6 mm] from the teeth), with increased destruction of periodontal structures and noticeable tooth mobility. Periodontitis is the stage of the disease that threatens significant ligament damage and tooth loss. If earlier procedures like scaling and root planing cannot restore the gum tissue to a healthy, firm state and pocket depth is still sufficient to warrant treatment, a gingivectomy is indicated. The comparative success of this surgery over nonsurgical treatments such as more debridement and more frequent use of **antibiotics** has not been demonstrated by research.

## Demographics

According to a report by the U.S. Surgeon General in 2000, half of adults living in the United States have gingivitis, and about one in five have periodontitis. According to the same report, smokers are four times more likely than nonsmokers to have periodontitis, and three to four times more likely to lose some or all of their teeth. By region, individuals living in the Southern states have a higher rate of periodontal disease and tooth loss than other regions of the country. Severe gum disease affects about 14% of adults aged 45–54 years. One of the main risk factors for gum disease is lack of dental care. Initiatives by the Centers for Disease Control and Prevention have begun to study the relation between periodontal disease and general health. There is growing acknowledgment of the public health issues related to chronic periodontal disease.

The delivery of oral surgery, or even dental care, to individuals in the United States is difficult to determine. Race, ethnicity, and poverty level stratified individuals making dental visits in a year. While 70% of white individuals made visits, only 56% of non-Hispanic black individuals and only 50% of Mexican-American individuals made visits. Seventy-two percent of individuals at or above the federal poverty level made visits, while only 50% of those below the poverty level made visits. Since it is also estimated that more than 100 million Americans lack dental insurance, it is likely that periodontal surgery among the people most likely to have periodontal disease (low-income individuals with nutritional issues, with little or no preventive dental care, and who smoke) are the least likely to have periodontal surgery.

## Description

Periodontal procedures for gingivitis involve gingival curettage, in which the surgeon cuts away some of the most hygienically unhealthy tissue, reducing the depth of the pocket. This surgery is usually done under a local anesthetic and is done on one quadrant of the mouth at a time.

Gingival or periodontal flap surgery (gingivectomy) is indicated in advanced periodontal disease, in which the stability of the teeth are compromised by infection, which displaces ligament and bone. In gingivectomy, the gingival flap is resected or separated from the bone, exposing the root. The calculus buildup on the tooth, down to the root, is removed. The surgery is performed under local anesthetic.

Small incisions are made in the gum to allow the dentist to see both tooth and bone. The surrounding



alveolar, or exposed bone, may require reforming to ensure proper healing. Gum tissue is returned to the tooth and sutured. A putty-like coating spread over the teeth and gums protects the sutures. This coating serves as a kind of bandage and allows the eating of soft foods and drinking of liquids after surgery. The typical procedure takes between one and two hours and usually involves only one or two quadrants per visit. The sutures remain in place for approximately one week. Pain medication is prescribed and antibiotics treatment is begun.

### Diagnosis/Preparation

Many factors contribute to periodontal disease, and the process that leads to the need for surgery may occur early or take many months or years to develop. Early primary tooth mobility or early primary tooth loss in children may be due to very serious underlying diseases, including hereditary gingival fibromatosis, a fibrous enlargement of the gingiva; conditions induced by drugs for liver disease; or gum conditions related to leukemia. Patient-related factors for chronic periodontal disease include systemic health, age, oral hygiene, various presurgical therapeutic options, and the patient's ability to control plaque formation and smoking. Another factor includes the extent and frequency of periodontal procedures to remove subgingival deposits. Gum inflammation can be secondary to many conditions, including diabetes, genetic predisposition, stress, immunosuppression, pregnancy, medications, and nutrition.

The most telling signs of early gum disease are swollen gums and bleeding. If gingivectomy is considered, consultation with the patient's physician is important, as are instruction and reinforcement with the patient to control plaque. Gingiva scaling and root planing should be performed to remove plaque and calculus to see if gum health improves.

The protective responses of the body and the use of dental practices to overcome the pathology of periodontal disease may be thwarted and the concentration of pathogens may be such that plaque below the gum line leads to tissue destruction. Refractory periodontitis, or the form of periodontal disease characterized by its resistance to repeated gingival treatments, and often also associated with diabetes mellitus and other systematic diseases, may require surgery to remove deep pockets and to offer regenerative procedures like tissue and bone grafts.

The level of damage is determined by signs of inflammation and by measuring the pocket depth.

Healthy pockets around the teeth are usually between 0.04–0.11 in (1–3 mm). The dentist measures each tooth and notes the findings. If the pockets are more than 0.19–0.23 in (5–6 mm), x rays may be taken to look at bone loss. After conferring with the patient, a decision will be made to have periodontal surgery or to try medications and/or more gingival scaling.

Risks for infection must be assessed prior to surgery. Certain conditions, including damaged heart valves, congenital heart defects, immunosuppression, liver disease, and artificial joints such as hip or **knee replacement**, put the oral surgery patient at higher risk for infection. Ultimately, the decision for surgery should be based upon the health of the patient, the quality of life with or without surgery, their willingness to change lifestyle factors such as smoking and bad nutrition, and the ability to incorporate oral hygiene into a daily regimen. Expense is also a factor since periodontal surgery is relatively expensive. Long-term studies are still needed to determine if medications such as antibiotic treatments are superior to surgery for severe chronic periodontal disease.

### Aftercare

Surgery will take place in the periodontist's office and usually takes a few hours from the time of surgery until the anesthetic wears off. After that, normal activities are encouraged. It takes a few days or weeks for the gums to completely heal. Ibuprofen (Advil) or **acetaminophen** (Tylenol) is very effective for pain. Dental management after surgery that includes deep cleaning by a dental hygienist will be put in force to maintain the health of the gums. Visits to the dentist for the first year are scheduled every three months to remove plaque and tartar buildup. After a year, periodontal cleaning is required every six months.

### Risks

Periodontal surgery has few risks. However, there is the risk of introducing infection into the bloodstream. Some surgeons require antibiotic treatment before and after surgery.

### Normal results

The gold standard of periodontal treatment is the decrease of attachment loss, which is the decrease in tooth loss due to gingival conditions. Normal immediate results of surgery are short-term pain; some gum shrinkage due to the surgery, which over time takes on a more normal shape; and easier success with oral

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Periodontal surgery involving gingivectomy and regenerative grafts are performed by a dentist specializing in diseases and surgery of the gums; the specialist is known as a periodontist. This is usually through a referral from the patient's general dentist. The procedure is performed in a dentist's office.

hygiene. Long-term results are equivocal. One study followed 600 patients in a private periodontal practice for more than 15 years. The study found tooth retention was more closely related to the individual case of disease than to the type of surgery performed. In another study, a retrospective chart review of 335 patients who had received non-surgical treatment was conducted. All patients were active cases for 10 years, and 44.8% also had periodontal surgery. The results of the study showed that those who received surgical therapy lost more teeth than those who received nonsurgical treatment. The factor that predicted tooth loss was neither procedure: it was earlier or initial attachment loss.

### Morbidity and mortality rates

The most common complications of oral surgery include bleeding, pain, and swelling. Less common complications are infections of the gums from the surgery. Rarer still is a bloodstream infection from the surgery, which can have serious consequences.

### Alternatives

Alternatives to periodontal surgery include other dental procedures concomitant with medication treatment as well as changes in lifestyle. Lifestyle changes included quitting smoking, nutritional changes, **exercise**, and better oral hygiene. There have been some medication advances for the gum infections that lead to inflammation and disease. Medication, combined with scaling and root planing, can be very effective. New treatments include antimicrobial mouthwashes to control bacteria; a gelatin-filled antibiotic "chip" inserted into periodontal pockets; and low doses of an antibiotic medication to keep destructive enzymes from combining with the bacteria to create plaque.

## QUESTIONS TO ASK THE DOCTOR

- How many quadrants for surgery will be performed at each visit?
- Can the gum scaling and root planing be repeated with antibiotic treatment as an alternative to gingivectomy?
- How effective have you found antibacterial, antibiotic, or anti-microbial treatment in slowing down disease progression?
- How often must I return to have periodontal cleaning after the surgery? Can my regular dentist do that?
- Besides dental care and home hygiene, what can I do to keep the disease from reoccurring after surgery?

### Resources

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Periodontal (Gum) Diseases. National Institute of Dental and Craniofacial Research, National Institutes of Health. Bethesda, MD 20892-2190. (301) 496-4261. <http://www.nidcrinfo.nih.gov>.

#### OTHER

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Nancy McKenzie, PhD

Glaucoma cryotherapy see  
**Cyclocryotherapy**

## Glossectomy

### Definition

A glossectomy is the surgical removal of all or part of the tongue.

## Purpose

A glossectomy is performed to treat cancer of the tongue. Removing the tongue is indicated if the patient has a cancer that does not respond to other forms of treatment. In most cases, however, only part of the tongue is removed (partial glossectomy). Cancer of the tongue is considered very dangerous due to the fact that it can easily spread to nearby lymph glands. Most cancer specialists recommend surgical removal of the cancerous tissue.

## Demographics

According to the Oral Cancer Foundation, 30,000 Americans will be diagnosed with oral or pharyngeal cancer in 2003, or about 1.1 persons per 100,000. Of these 30,000 newly diagnosed individuals, only half will be alive in five years. This percentage has shown little improvement for decades. The problem is much greater in the rest of the world, with over 350,000 to 400,000 new cases of oral cancer appearing each year.

The most important risk factors for cancer of the tongue are alcohol consumption and smoking. The risk is significantly higher in patients who use both alcohol and tobacco than in those who consume only one.

## Description

Glossectomies are always performed under **general anesthesia**. A partial glossectomy is a relatively simple operation. If the “hole” left by the excision of the cancer is small, it is commonly repaired by sewing up the tongue immediately or by using a small graft of skin. If the glossectomy is more extensive, care is taken to repair the tongue so as to maintain its mobility. A common approach is to use a piece of skin taken from the wrist together with the blood vessels that supply it. This type of graft is called a radial forearm free flap. The flap is inserted into the hole in the tongue. This procedure requires a highly skilled surgeon who is able to connect very small arteries. Complete removal of the tongue, called a total glossectomy, is rarely performed.

## Diagnosis/Preparation

If an area of abnormal tissue has been found in the mouth, either by the patient or by a dentist or doctor, a biopsy is the only way to confirm a diagnosis of cancer. A pathologist, who is a physician who specializes in the study of disease, examines the tissue sample under a microscope to check for cancer cells.

## KEY TERMS

**Biopsy**—A diagnostic procedure that involves obtaining a tissue specimen for microscopic analysis to establish a precise diagnosis.

**Fistula (plural, fistulae)**—An abnormal passage that develops either between two organs inside the body or between an organ and the surface of the body. Fistula formation is one of the possible complications of a glossectomy.

**Flap**—A piece of tissue for grafting that has kept its own blood supply.

**Lymph**—The almost colorless fluid that bathes body tissues. Lymph is found in the lymphatic vessels and carries lymphocytes that have entered the lymph glands from the blood.

**Lymph gland**—A small bean-shaped organ consisting of a loose meshwork of tissue in which large numbers of white blood cells are embedded.

**Lymphatic system**—The tissues and organs (including the bone marrow, spleen, thymus and lymph nodes) that produce and store cells that fight infection, together with the network of vessels that carry lymph throughout the body.

**Oncology**—The branch of medicine that deals with the diagnosis and treatment of cancer.

If the biopsy indicates that cancer is present, a comprehensive **physical examination** of the patient's head and neck is performed prior to surgery. The patient will meet with the treatment team before **admission to the hospital** so that they can answer questions and explain the treatment plan.

## Aftercare

Patients usually remain in the hospital for seven to 10 days after a glossectomy. They often require oxygen in the first 24–48 hours after the operation. Oxygen is administered through a face mask or through two small tubes placed in the nostrils. The patient is given fluids through a tube that goes from the nose to the stomach until he or she can tolerate taking food by mouth. Radiation treatment is often scheduled after the surgery to destroy any remaining cancer cells. As patients regain the ability to eat and swallow, they also begin speech therapy.

## Risks

Risks associated with a glossectomy include:

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A glossectomy is performed in a hospital by a treatment team specializing in head and neck oncology surgery. The treatment team usually includes an ear, nose & throat (ENT) surgeon, an oral-maxillofacial (OMF) surgeon, a plastic surgeon, a clinical oncologist, a nurse, a speech therapist, and a dietician.

- Bleeding from the tongue. This is an early complication of surgery; it can result in severe swelling leading to blockage of the airway.
- Poor speech and difficulty swallowing. This complication depends on how much of the tongue is removed.
- Fistula formation. Incomplete healing may result in the formation of a passage between the skin and the mouth cavity within the first two weeks following a glossectomy. This complication often occurs after feeding has resumed. Patients who have had radiotherapy are at greater risk of developing a fistula.
- Flap failure. This complication is often due to problems with the flap's blood supply.

### Normal results

A successful glossectomy results in complete removal of the cancer, improved ability to swallow food, and restored speech. The quality of the patient's speech is usually very good if at least one-third of the tongue remains and an experienced surgeon has performed the repair.

Total glossectomy results in severe disability because the "new tongue" (a prosthesis) is incapable of movement. This lack of mobility creates enormous difficulty in eating and talking.

### Morbidity and mortality rates

Even in the case of a successful glossectomy, the long-term outcome depends on the stage of the cancer and the involvement of lymph glands in the neck. Five-year survival data reveal overall survival rates of less than 60%, although the patients who do survive often endure major functional, cosmetic, and psychological burdens as a result of their difficulties in speaking and eating.

## QUESTIONS TO ASK THE DOCTOR

- Will the glossectomy prevent the cancer from coming back?
- What are the possible complications of this procedure?
- How long will it take to recover from the surgery?
- How will the glossectomy affect my speech?
- What specific techniques do you use?
- How many new cancers of the head and neck do you treat every year?

### Alternatives

An alternative to glossectomy is the insertion of radioactive wires into the cancerous tissue. This is an effective treatment but requires specialized surgical skills and facilities.

### Resources

#### BOOKS

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**ORGANIZATIONS**

American Academy of Otolaryngology Head and Neck Surgery. One Prince Street, Alexandria, VA 22314. (703) 806 4444. [www.entnet.org](http://www.entnet.org).

American Cancer Society. National Headquarters, 1599 Clifton Road NE, Atlanta, GA 30329. (800) ACS 2345. [www.cancer.org](http://www.cancer.org)

Oral Cancer Foundation. 3419 Via Lido, #205, Newport Beach, CA 92663. (949) 646 8000. [www.oralcancer.org](http://www.oralcancer.org)

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Monique Laberge, Ph. D.

**Blood glucose test (blood sugar, fasting blood sugar [FBS])**

	Normal findings	Possible critical values
Cord	45–96 mg/dl (2.5–5.3 mmol/L)	
Premature infant	20–60 mg/dl (1.1–3.3 mmol/L)	
Newborn	30–60 mg/dl (1.7–3.3 mmol/L)	.30 and .300 mg/dl
Infant	40–90 mg/dl (2.2–5.0 mmol/L)	.40 mg/dl
Child ,2 years	60–100 mg/dl (3.3–5.5 mmol/L)	
Child ,2 years to adult	70–105 mg/dl (3.9–5.8 mmol/L)	Male: .50 and .400 mg/dl Female: .40 and .400 mg/dl
Elderly	increase in normal range after age 50 years	

SOURCE: Pagana, K.D. and T.J. Pagana. *Mosby's Diagnostic and Laboratory Test Reference*. 3rd ed. St. Louis: Mosby, 1997.

**Glucose tests****Definition**

Glucose tests are used to determine the concentration of glucose in blood, urine, cerebrospinal fluid (CSF), and other body fluids. These tests are used to detect increased blood glucose (hyperglycemia), decreased blood glucose (hypoglycemia), increased glucose in the urine (glycosuria), and decreased glucose in CSF, serous, and synovial fluid glucose.

**Purpose**

The results of glucose tests are used in a variety of situations, including:

- Screening persons for diabetes mellitus. The American Diabetes Association (ADA) recommends that a



Testing blood sugar level. (moodboard / Alamy)

(Cengage Learning, Gale.)

fasting plasma glucose (fasting blood sugar) be used to diagnose diabetes. People without symptoms of diabetes should be tested when they reach the age of 45 years, and again every three years. People in high-risk groups should be tested before the age of 45, and then more frequently. If a person already has symptoms of diabetes, a blood glucose test without fasting (a casual plasma glucose test), may be performed. In difficult diagnostic cases, a glucose challenge test called a two-hour oral glucose tolerance test (OGTT) is recommended. If the result of any of these three tests is abnormal, it must be confirmed with a second test—performed on another day. The same test or a different test can be used. However, the result of the second test must be abnormal as well to establish a diagnosis of diabetes.

- Screening for gestational diabetes. Diabetes that occurs during pregnancy is called gestational diabetes. This condition is associated with hypertension, increased birth weight of the fetus, and a higher risk for preeclampsia. Women who are at risk are screened when they are 24–28 weeks pregnant. A woman is considered at risk if she is older than 25 years, is not at her normal body weight, has a parent or sibling with diabetes, or is in an ethnic group that has a high rate of diabetes (such as Hispanic, Native American, or African-American).
- Blood glucose monitoring. Daily measurement of whole blood glucose identifies persons with diabetes who require intervention to maintain their blood glucose within an acceptable range as determined

**Normal findings for glucose tolerance test (GTT, oral glucose tolerance test [OGTT])****Blood test**

Fasting	70–115 mg/dl (.6.4 mmol/L)
30 minutes	,200 mg/dl (.11.1 mmol/L)
1 hour	,200 mg/dl (.11.1 mmol/L)
2 hours	,140 mg/dl (.7.8 mmol/L)
3 hours	70–115 mg/dl (.6.4 mmol/L)
4 hours	70–115 mg/dl (.6.4 mmol/L)
Urine test	Negative

SOURCE: Pagana, K.D. and T.J. Pagana. *Mosby's Diagnostic and Laboratory Test Reference*. 3rd ed. St. Louis: Mosby, 1997.

(Cengage Learning, Gale.)

by their doctors. The Diabetes Control and Complications Trial (DCCT) demonstrated that persons with diabetes who maintained blood glucose and glycated hemoglobin (hemoglobin with glucose bound to it) at or near normal decreased their risk of complications by 50–75%. Based on results of this study, the ADA recommends routine glycated hemoglobin testing to measure long-term control of blood sugar. The most common glycated hemoglobin test, is the HbA<sub>1c</sub>, which provides the average, overall blood glucose levels over the prior two to three month period. A DCCT randomized study found that the knowledge alone that their glycated hemoglobin results were good improved blood glucose control in some patients.

- **Diagnosis and differentiation of hypoglycemia.** Low blood glucose may be associated with symptoms such as confusion, memory loss, and seizures. Demonstration that such symptoms are the result of hypoglycemia requires evidence of low blood glucose at the time of symptoms and reversal of the symptoms by glucose. In documented hypoglycemia, blood glucose tests are used along with measurements of insulin and C-peptide (a fragment of proinsulin) to differentiate between fasting and postprandial (after a meal) causes.
- **Analysis of glucose in body fluids.** High levels of glucose in body fluids reflect a hyperglycemic state and are not otherwise clinically significant. However, low body fluid glucose levels indicate increased glucose utilization, often caused by infection (meningitis causes a low CSF glucose); inflammatory disease (rheumatoid arthritis causes a low pleural fluid glucose); or malignancy (a leukemia or lymphoma, such as Hodgkin's disease infiltrating the CNS or serous cavity).

**KEY TERMS**

**Diabetes mellitus**—A disease in which a person can't effectively use glucose to meet the needs of the body. It is caused by a lack of the hormone insulin.

**Glucose**—The main form of sugar (chemical formula C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>) used by the body for energy.

**Glycated hemoglobin**—A test that measures the amount of hemoglobin bound to glucose. It is a measure of how much glucose has been in the blood during a two to three month period beginning approximately one month prior to sample collection.

**Hyperglycemia**—Abnormally increased amount of sugar in the blood.

**Hypoglycemia**—Abnormally decreased amount of sugar in the blood.

**Ketones**—Waste products in the blood that build up in uncontrolled diabetes.

**Ketosis**—Abnormally elevated concentration of ketones in body tissues. A complication of diabetes.

**Precautions**

Diabetes must be diagnosed as early as possible so that treatment can begin. If left untreated, it will result in progressive vascular disease that may damage the blood vessels, nerves, kidneys, heart, and other organs. Brain damage can occur from glucose levels below 40 mg/dL and coma from levels above 450 mg/dL. For this reason, plasma glucose levels below 40 mg/dL or above 450 mg/dL are commonly used as alert values. Point-of-care and home glucose monitors measure glucose in whole blood rather than plasma. They are accurate, for the most part, within a range of glucose concentration between 40 mg/dL and 450 mg/dL. In addition, whole blood glucose measurements are generally 10% lower than those of serum or plasma glucose.

Other endocrine disorders and a number of medications can cause both hyperglycemia and hypoglycemia. For this reason, abnormal glucose test results must be interpreted by a doctor.

Glucose is affected by heat; therefore, plasma or serum must be separated from the blood cells and refrigerated as soon as possible. **Splenectomy**, for example, can result in an increase in glycated hemoglobin, but hemolytic anemia can produce a decrease in it.

There are other factors that can also affect the OGTT, such as **exercise**, diet, anorexia, and smoking.

Drugs that decrease tolerance to glucose and affect the test include steroids, oral contraceptives, estrogens, and thiazide **diuretics**.

### Description

The body uses glucose to produce most of the energy it needs to function. Glucose is absorbed from the gastrointestinal tract directly and is also derived from digestion of other dietary carbohydrates. It is also produced inside cells by the processes of glycogen breakdown (glycogenolysis) and reverse glycolysis (gluconeogenesis). Insulin is made by the pancreas and facilitates the movement of glucose from the blood and extracellular fluids into the cells. Insulin also increases the formation of glucose by cells.

Diabetes may result from a lack of insulin or a subnormal (below normal) response to insulin. There are three forms of diabetes: Type I or insulin-dependent (IDDM); type II or noninsulin dependent (NIDDM); and gestational diabetes (GDM). Type I diabetes usually occurs in childhood and is associated with low or absent blood insulin and production of ketones. It is caused by autoantibodies to the islet cells in the pancreas that produce insulin, and persons must be given insulin to control blood glucose and prevent ketosis. Type II accounts for 85% or more of persons with diabetes. It usually occurs after age 40, and is usually associated with obesity. Persons who have a deficiency of insulin may require insulin to maintain glucose, but those who have a poor response to insulin may not. Gestational diabetes is a form of glucose intolerance that first appears during pregnancy. It usually ends after delivery, but over a 10-year span approximately 30–40% of females with gestational diabetes go on to develop NIDDM.

There are a variety of ways to measure a person's blood glucose level.

#### *Whole blood glucose tests*

Whole blood glucose testing can be performed by a person at home, or by a member of the health care team outside the laboratory. The test is usually performed using a drop of whole blood obtained by finger puncture. Care must be taken to wipe away the first drop of blood because it is diluted with tissue fluid. The second drop is applied to the dry reagent test strip or device.

#### *Fasting plasma glucose test*

The fasting plasma glucose test requires an eight-hour fast. The person must have nothing to eat or drink except water. The person's blood is usually

collected by a nurse or phlebotomist (person trained to draw blood) by insertion of a needle into a vein in the patient's arm. Either serum, the liquid portion of the blood after it clots, or plasma may be used. Plasma is the liquid portion of unclotted blood that is collected. The ADA recommends a normal range for fasting plasma glucose of 55–109 mg/dL. A glucose level equal to greater than 126 mg/dL is indicative of diabetes. A fasting plasma glucose level of 110–125 gm/dL is referred to as "impaired fasting glucose."

#### *Oral glucose tolerance test (OGTT)*

The OGTT is done to see how well the body handles a standard amount of glucose. There are many variations of this test. A two-hour OGTT as recommended by the ADA is described below. The person must have at least 150 grams of carbohydrate each day for at least three days before this test. The person must take nothing but water and abstain from exercise for 12 hours before the glucose is given. At 12 hours after the start of the fast, the person is given 75 grams of glucose to ingest in the form of a drink or standardized jelly beans. A health care provider draws a sample of venous blood two hours following the dose of glucose. A glucose concentration equal to or greater than 200 mg/dL is indicative of diabetes. A level below 140 mg/dL is considered normal. A level of 140–199 mg/dL is termed "impaired glucose tolerance."

#### *Testing for gestational diabetes*

The screening test for gestational diabetes is performed between 24 and 28 weeks of pregnancy. No special preparation or fasting is required. The patient is given an oral dose of 50 grams of glucose and blood is drawn one hour later. A plasma or **serum glucose level** less than 140 mg/dL is normal and requires no follow-up. If the glucose level is 140 mg/dL or higher, a three-hour OGTT is performed. The same pretest preparation is followed for the two-hour OGTT described previously, except that 100 grams of glucose are given orally. Blood is drawn at the end of the fast and at one-, two-, and three-hour intervals after the glucose is ingested. Gestational diabetes is diagnosed if two or more of the following results are obtained:

- fasting plasma glucose is greater than 105 mg/dL
- one-hour plasma glucose is greater than 190 mg/dL
- two-hour plasma glucose is greater than 165 mg/dL
- three-hour plasma glucose is greater than 145 mg/dL

### ***Glycated hemoglobin blood glucose test (G-Hgb)***

The glycated (glycosylated) **hemoglobin test** is used to diagnose diabetes and monitor the effectiveness of treatment. Glycated hemoglobin is a test that indicates how much glucose was in a person's blood during a two- to three-month window beginning about four weeks prior to sampling. The test is a measure of the time-averaged blood glucose over the 120-day lifespan of the red blood cells (RBCs). The normal range for glycated hemoglobin measured as HbA<sub>1c</sub> is 3–6%. Values above 8% indicate that a hyperglycemic episode occurred sometime during the window monitored by the test (two to three months beginning four weeks prior to the time of blood collection).

The ADA recommends that glycated hemoglobin testing be performed during a person's first diabetes evaluation, again after treatment begins and glucose levels are stabilized, then repeated semiannually. If the person does not meet treatment goals, the test should be repeated quarterly.

A related blood test, fructosamine assay, measures the amount of albumin in the plasma that is bound to glucose. Albumin has a shorter half-life than RBCs, and this test reflects the time-averaged blood glucose level over a period of two to three weeks prior to sample collection.

### **Preparation**

Blood glucose tests require either whole blood, serum, or plasma collected by vein puncture or finger puncture. No special preparation is required for a casual blood glucose test. An eight-hour fast is required for the fasting plasma or whole-blood glucose test. A 12-hour fast is required for the two-hour OGTT and three-hour OGTT tests. In addition, the person must abstain from exercise in the 12-hour fasting period. Medications known to affect carbohydrate metabolism should be discontinued three days prior to an OGTT test if possible (the doctor should provide guidance on this), and the patient must maintain a diet of at least 150 grams of carbohydrate per day for at least three days prior to the fast.

### **Aftercare**

After the test or series of tests is completed (and with the approval of the doctor), the person should eat and drink as normal, and take any medications that were stopped for the test.

The patient may feel discomfort when blood is drawn from a vein. Pressure should be applied to the

puncture site until the bleeding stops; this will help to reduce bruising. Warm packs can also be placed over the puncture site to relieve discomfort.

### **Risks**

The patient may experience weakness, fainting, sweating, or other reactions while fasting or during the test. If any of these reactions occur, the patient should immediately inform the doctor or nurse.

### **Normal results**

Normal values listed below are for children and adults. Results may vary slightly from one laboratory to another depending on the method of analysis used.

- fasting plasma glucose test: 55–109 mg/dL
- OGTT at two hours: less than 140 mg/dL
- glycated hemoglobin: 3%–6%
- fructosamine: 1.6–2.7 mmol/L for adults (5% lower for children)
- gestational diabetes screening test: less than 140 mg/dL
- cerebrospinal glucose: 40–80 mg/dL
- serous fluid glucose: equal to plasma glucose
- synovial fluid glucose: within 10 mg/dL of the plasma glucose
- urine glucose (random semiquantitative): negative

For the person with diabetes, the ADA recommends an ongoing blood glucose level of less than or equal to 120 mg/dL.

The following results are suggestive of diabetes mellitus, and must be confirmed with repeat testing:

- fasting plasma glucose test: greater than or equal to 126 mg/dL
- OGTT at two hours: equal to or greater than 200 mg/dL
- casual plasma glucose test (nonfasting, with symptoms): equal to or greater than 200 mg/dL
- gestational diabetes three-hour oral glucose tolerance test: two or more of the limits following are exceeded: fasting plasma glucose greater than 105 mg/dL; one-hour plasma glucose greater than 190 mg/dL; two-hour plasma glucose greater than 165 mg/dL; three-hour plasma glucose: greater than 145 mg/dL

### **Resources**

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#### ORGANIZATIONS

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- Centers for Disease Control and Prevention (CDC). Division of Diabetes Translation, National Center for Chronic Disease Prevention and Health Promotion. TISB Mail Stop K 13, 4770 Buford Highway NE, Atlanta, GA 30341 3724. (770) 488 5080. <http://www.cdc.gov/diabetes>.
- National Diabetes Information Clearinghouse (NDIC). 1 Information Way, Bethesda, MD 20892 3560. (301) 907 8906. <http://www.niddk.nih.gov/health/diabetes/ndic.htm>.
- National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). National Institutes of Health, Building 31, Room 9A04, 31 Center Drive, MSC 2560, Bethesda, MD 20879 2560. (301) 496 3583. <http://www.niddk.nih.gov>.

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## Goniotomy

### Definition

A goniotomy is a surgical procedure primarily used to treat congenital glaucoma, first described in 1938. It is caused by a developmental arrest of some of the structures within the anterior (front) segment of the eye. These structures include the iris and the ciliary body, which produces the aqueous fluid needed to maintain the integrity of the eye. These structures do not develop normally in the eyes of patients with isolated congenital glaucoma. Instead, they overlap and block the trabecular meshwork, which is the primary drainage system for the aqueous fluid. As a result of this blockage, the trabecular meshwork itself becomes thicker and the drainage holes within the meshwork are narrowed. These

changes lead to an excess of fluid in the eye, which can cause pressure that can damage the internal structures of the eye and cause glaucoma.

All types of congenital glaucoma are caused by a decrease in or even a complete obstruction of the outflow of intraocular fluid. The ocular syndromes and anomalies that predispose a child to congenital glaucoma include the following: Reiger's anomaly; Peter's anomaly; Axenfeld's syndrome; and Axenfeld-Rieger's syndrome. Systemic disorders that affect the eyes in ways that may lead to glaucoma include Marfan's syndrome; rubella (German measles); and the phacomatoses, which include neurofibromatosis and Sturge-Weber syndrome. Since these disorders affect the entire body as well as the eyes, the child's pediatrician or family doctor will help to diagnose and treat these diseases.

### Purpose

The purpose of a goniotomy is to clear the obstruction to aqueous outflow from the eye, which in turn lowers the intraocular pressure (IOP). Lowering the IOP helps to stabilize the enlargement of the cornea and the distension and stretching of the eye that often occur in congenital glaucoma. The size of the eye, however, will not return to normal. Most importantly, once the aqueous outflow improves, damage to the optic nerve is halted or reversed. The patient's visual acuity may improve after surgery.

Goniotomies are commonly performed to treat the following eye disorders:

- congenital glaucomas
- aniridia (Aniridia is a condition in which the patient lacks a visible iris. A goniotomy is performed as a preventive measure, as 50–75% of patients with aniridia will develop glaucoma.)
- uveitic glaucoma associated with juvenile rheumatoid arthritis
- maternal rubella syndrome
- juvenile-onset open angle glaucoma (JOAG)

### Demographics

The congenital glaucomas affect one in 10,000 infants, with boys affected twice as often as girls. Both eyes are affected in 75% of patients. These glaucomas are differentiated from the secondary glaucomas caused by such medical conditions as juvenile rheumatoid arthritis (JRA), Marfan's syndrome, or diabetes; or caused by intraocular tumors, cataract surgery, or trauma. Many of the secondary glaucomas respond

## KEY TERMS

**Anomaly**—A marked deviation from normal structure or function, particularly as the result of congenital defects.

**Anterior chamber**—The anterior part of the eye, bound by the cornea in front and the iris in the back, filled with aqueous fluid. The trabecular meshwork is located in a channel of the anterior chamber referred to as the angle.

**Ciliary body**—The structure of the eye, located behind the iris, that produces the aqueous fluid.

**Congenital**—Present at birth.

**Cornea**—The clear structure on the front of the eye that allows light to enter the eye.

**Intraocular pressure (IOP)**—A measurement of the degree of pressure exerted by the aqueous fluid in the eye. Elevated IOP is usually 21 mm/Hg or higher, but glaucoma can be present when the pressure is lower.

**Miotics**—Medications that cause the pupil of the eye to contract.

**Optic nerve**—A large nerve found in the posterior part of the eye, through which all the visual nerve fibers leave the eye on their way to the brain.

**Schlemm's canal**—A reservoir deep in the front part of the eye where the fluid drained from the trabecular meshwork collects prior to being sent out to systemic or general circulation.

**Trabecular meshwork**—Canals of the eye through which the aqueous fluid is drained before it collects in Schlemm's canal.

better to medical treatment than to surgical treatment. Ninety-five percent of developmental or congenital glaucoma appears before age three. Another type of pediatric glaucoma is usually diagnosed between ages 10 and 35 and resembles the type of glaucoma seen in adults more closely than the congenital glaucomas, although some developmental anomalies may be present. This type of glaucoma is referred to as juvenile-onset open angle glaucoma (JOAG).

Congenital glaucoma is a polygenic disorder; that is, it involves more than one gene. Since this type of glaucoma is inherited and the genes for JOAG and congenital glaucoma have been mapped, genetic testing is available to determine whether a specific child is at risk for these disorders.

## Description

Before the surgeon begins the procedure, the patient is given miotics, which are drugs that cause the pupil to contract. This partial closure improves the surgeon's view of and access to the trabecular meshwork; it also protects the lens of the eye from trauma during surgery. Other drugs are administered to lower the intraocular pressure.

Once the necessary drugs have been given and the patient is anesthetized, the surgeon uses a forceps or sutures to stabilize the eye in the correct position. The patient's head is rotated away from the surgeon so that the interior structures of the eye are more easily seen. Next, with either a knife-needle or a goniotomy knife, the surgeon punctures the cornea while looking at the interior of the eye through a microscope or a loupe. An assistant uses a syringe to introduce fluid into the eye's anterior chamber through a viscoelastic tube as the surgeon performs the goniotomy.

A gonioscopy lens is then placed on the eye. As the eye is rotated by an assistant, the surgeon sweeps the knife blade or needle through 90–120 degrees of arc in the eye, making incisions in the anterior trabecular meshwork, avoiding the posterior part of the trabecular meshwork in order to decrease the risk of damage to the iris and lens.

Once the knife and tubing are removed, saline solution is introduced through the hole to maintain the integrity of the eye and the hole is closed with sutures. The surgeon then applies **antibiotics** and **corticosteroids** to the eye to prevent infection and reduce inflammation. The head is then rotated away from the incision site so that blood cannot accumulate. The second eye may be operated on at the same time. If the procedure needs to be repeated, another area of the eye is treated.

## Diagnosis/Preparation

### Diagnosis

The clinical signs of congenital and infantile glaucoma may be detected within a few months after birth. They include an enlarged eye, called buphthalmos; corneal swelling; decreased vision; tearing; sensitivity to light; and blepharospasm, or uncontrolled twitching of the eyes. These signs, however, are usually absent in JOAG. As a result, glaucoma in the older child may go undetected until the child loses vision.

The examiner must take some measurements in order to confirm a diagnosis of glaucoma, including measurement of the corneal diameter and the axial length of the eye. The corneal diameter is usually less

then 10 mm in an infant and only 11–12 mm in a one-year-old, but can be as large as 14 mm in a child with advanced glaucoma. The axial length is measured with an A-scan, which is a type of **ultrasound**. The doctor will also determine the intraocular pressure. An elevated intraocular pressure is not always present in congenital glaucoma; unless it is extremely high, it is only one factor in the diagnosis of glaucoma. Gonioscopy, a technique used to examine the interior structures of the eye, is performed by placing a special contact lens on the eye. This lens, used in combination with a biomicroscope, allows the surgeon to evaluate the structures of the anterior part of the eye. The condition of the optic nerve is also evaluated; photos or drawings may be taken for future comparison.

Since cooperation is difficult for infants and young children, these assessments may be done either under anesthesia or with the use of a sedative. Older children are examined in a manner similar to adults.

### *Preparation*

Once the diagnosis of glaucoma is confirmed, goniotomy is often the first line of treatment. If goniotomy is determined to be the best procedure and there is a lot of corneal haze, the surgeon may treat the patient for several days pre-operatively with acetazolamide to lower the IOP and increase the clarity of the cornea. Or, he may elect to perform another procedure called a trabeculotomy, which is the preferred surgery if the corneal diameter is greater than 14 mm. The patient is given antibiotics for several days before surgery.

Obtaining the family's **informed consent** is another important part of preparing for a goniotomy. The surgeon tells the family that the child will need **general anesthesia**, and that several postoperative visits with anesthesia or sedation will be necessary after the goniotomy.

### *Aftercare*

The patient will continue to be given antibiotics, corticosteroids, and miotics for one to two weeks after surgery. If the surgeon believes that the procedure was not successful, then he or she may give the patient acetazolamide by mouth in addition to these medications for up to 10 days to lower the IOP.

The patient will be anesthetized again three to six weeks after surgery for a reevaluation of the anterior chamber of the eye. This examination is repeated every three months for the first year; every six months during the second year; and once a year thereafter. Once the child is older, usually three to four years old, the physician can perform the follow-up examination in

his or her office without anesthesia or sedation. Since a visual field test is difficult or impossible to do on an infant or young child, the doctor measures the cornea to assess progression of the disease. An increase in corneal diameter indicates that the glaucoma is getting worse. Visual field testing will be performed when the child is old enough to understand it. A visual field test can establish the extent of vision loss that has occurred because of glaucoma.

An important aspect of managing glaucoma patients after surgery is assessing the degree of nearsightedness and astigmatism, both of which result from the stretching of the eye caused by increased intraocular pressure. If the child needs eyeglasses, they should be given as early in life as possible to decrease the probability of amblyopia. Amblyopia is a condition in which the vision cannot be corrected completely, even with glasses, and is common for pediatric glaucoma patients. Although almost 80% of children with congenital glaucoma can have their vision corrected to 20/50 or better, patching of an eye and vision therapy is often required to achieve this level of correction.

About 10% of goniotomy patients will experience a recurrence of the glaucoma or have it develop in the unaffected eye. As a result, the patient will need periodic eye examinations for the rest of his/her life. If glaucoma does recur later in life, then either medical or surgical treatment is instituted depending on the cause.

### *Risks*

Since goniotomy is performed under general anesthesia, there is some risk of a reaction to the anesthetic. The most common risk of general anesthesia in infants is cardiorespiratory arrest. This complication is not life-threatening, however, and occurs in fewer than 2% of goniotomies.

A hyphema (bleeding and formation of a blood clot in the anterior chamber) is the most common complication of a goniotomy. In most cases, however, the blood clots resolve within a few days.

If the cornea is not clear during surgery, the surgeon may accidentally sever the iris from the ciliary body or separate the ciliary body from the sclera of the eye. Both of these complications can lead to hypotony, a condition in which the integrity of the eye is compromised because of insufficient intraocular fluid.

Other complications of goniotomy are cataract formation; inflammation in the anterior chamber; scarring of the cornea; subluxation or dislocation of the lens; and retinal detachment. The risk of damage to the lens is greater when the patient is aniridic.

The intraocular pressure may increase in spite of, or due to complications of the procedure, and the goniotomy may have to be repeated. If the goniotomy is not successful after two or three attempts, the surgeon will perform a trabeculotomy.

### Normal results

Goniotomy is considered to be successful when the measured IOP is below 21 mm/Hg, or below 16 mm/Hg if the patient is under anesthesia; when there is no increase in corneal diameter; and when damage to the optic nerve is stabilized or even reversed. Goniotomy is successful in about 94% of patients with primary congenital glaucoma in decreasing IOP, corneal haze, and corneal diameter. Tearing, sensitivity to light, and blepharospasm all decrease over time.

If a goniotomy is successful it will be apparent within three to six weeks. A repeat goniotomy is required for 50% of patients. Goniotomy is most successful when the child is between one month and three years of age; it is successful only a quarter of the time in patients younger than one month. It is also more successful when the corneal diameter is less than 14 mm and when the IOP is not extremely high. Even if the IOP has been lowered, anti-glaucoma medication or drops may still be needed after the goniotomy.

When a goniotomy is performed on patients with uveitic glaucoma, the success rate is 75–83%, although most of these patients need ongoing medication for glaucoma, and 30% require a repeat procedure.

### Morbidity and mortality rates

Fifteen years after a goniotomy, one in seven patients will have such serious complications as corneal decompensation or detachment of the retina. Vision loss occurs in 50% of children with congenital glaucoma in spite of surgical and medical intervention. This is particularly true of infants diagnosed with glaucoma before two months of age. About 50% of children who undergo goniotomy require a repeat procedure. Complications are more common for patients treated as young infants and as older children.

### Alternatives

Congenital glaucoma does not respond well to medical treatment, so the first line of treatment is usually surgical. Medical therapy is often initiated as adjunct therapy after surgery.

One alternative to goniotomy is trabeculotomy. Goniotomy has been the preferred procedure for treatment of congenital glaucoma, but trabeculotomy has been favored in recent years because of the surgeon's

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A goniotomy is performed in a hospital by an ophthalmologist, or eye specialist, while the patient is under general anesthesia. Preoperative and postoperative evaluations are also done in a hospital setting if anesthesia is required. These evaluations can be done for older children in an office setting. An ophthalmologist qualified to perform a goniotomy has usually had advanced fellowship training in glaucoma surgery after completing a three-year residency in ophthalmology.

difficulty in seeing the structures in the eye when the cornea is hazy. A clear view of the cornea is required for goniotomy. In a trabeculotomy, the surgeon inserts a probe into the eye, passes it through Schlemm's canal, and rotates it inside the anterior chamber in order to tear a hole in the trabecular meshwork. This maneuver creates an alternative passageway for the aqueous fluid to leave the anterior chamber of the eye. In some cases the surgeon will perform a **trabeculectomy**, a procedure in which part of the trabecular meshwork is removed by cutting, at the same time as the trabeculotomy.

Another alternative procedure involves placement of a filtering shunt to direct the intraocular fluid out of the eye. A shunt is often placed if Schlemm's canal cannot easily be located, as in the case with infants. The safety profile for trabeculotomy and filtering surgery are comparable to goniotomy, but there is a higher rate of long-term success with goniotomies and trabeculotomies.

A newer variation of surgical goniotomy is laser goniotomy, in which the surgeon uses a Yag:Nd laser to cut into the trabecular meshwork. Laser goniotomies appear to be less effective than surgical goniotomies, but if a patient responds well to a laser procedure, then surgical goniotomy may be considered.

Other alternative treatments for pediatric glaucoma are the cyclodestructive techniques, which include cyclophotocoagulation, and the more commonly performed **cyclocryotherapy**. These procedures involve destruction of the ciliary body by using either freezing temperatures or lasers. These procedures have lower success rates and a higher risk of complications; they are usually performed as a last resort when other techniques have failed.



## QUESTIONS TO ASK THE DOCTOR

- How many goniotomies have you performed?
- Have you had advanced training in glaucoma surgery?
- What are the chances that the procedure will need to be repeated?
- Is a goniotomy the best surgical procedure for my child?

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#### ORGANIZATIONS

- American Academy of Ophthalmology. P.O. Box 7424, San Francisco, CA 94120 7424. (415) 561 8500. [www.aao.org](http://www.aao.org).
- Canadian Ophthalmological Society (COS). 610 1525 Carling Avenue, Ottawa ON K1Z 8R9. [www.eyesite.ca](http://www.eyesite.ca).
- National Eye Institute. 2020 Vision Place, Bethesda, MD 20892 3655. (301) 496 5248. [www.nei.nih.gov](http://www.nei.nih.gov).

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Martha Reilly, OD

Grafts and grafting see **Bone grafting;**  
**Coronary artery bypass graft surgery;**  
**Skin grafting**

Gum disease surgery see **Gingivectomy**

Gynecologic sonogram see **Pelvic ultrasound**

Gynecologic surgery see **Obstetric and gynecologic surgery**

# H

H<sub>2</sub> reception blockers see **Gastric acid inhibitors**

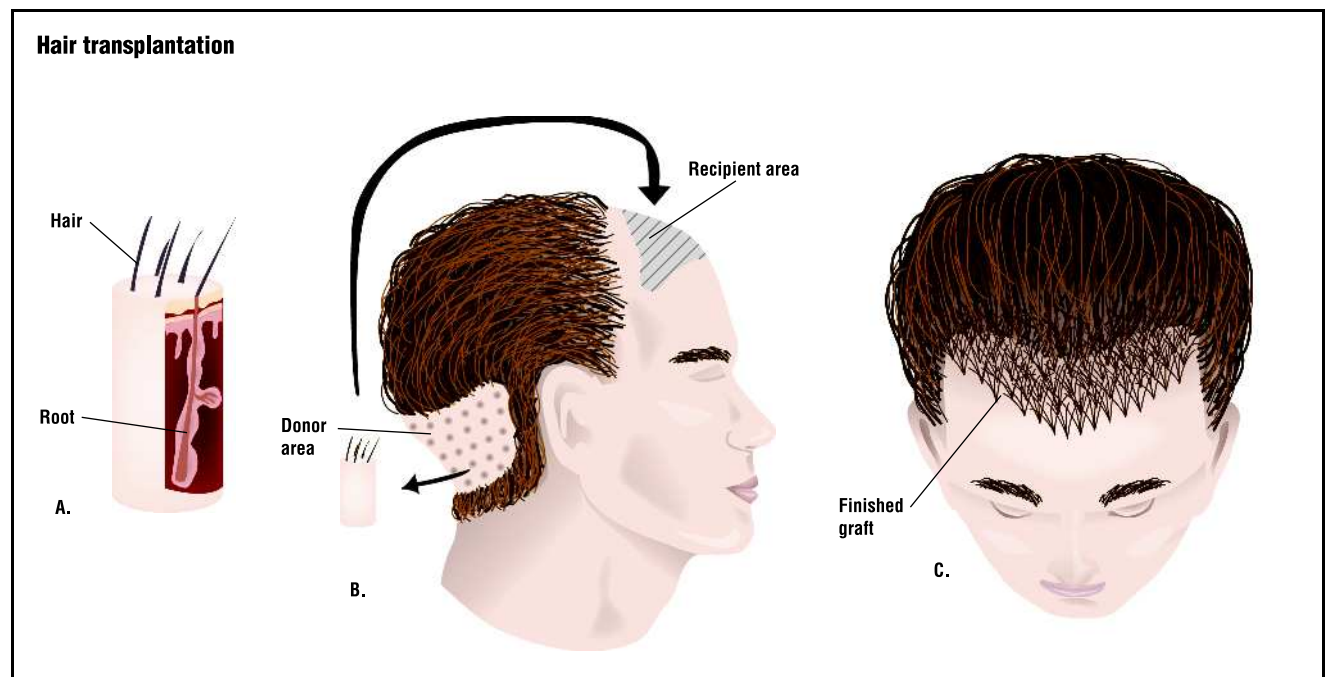
## Hair transplantation

### Definition

Hair transplantation is a surgical procedure used to treat baldness or hair loss (alopecia). Typically, tiny patches of scalp are removed from the back and sides of the head and implanted in the bald spots in the front and top of the head.

### Purpose

Hair transplantation is a cosmetic procedure performed on men and occasionally on women who have significant hair loss, thinning hair, or bald spots where hair no longer grows. In men, hair loss and baldness are most commonly due to genetic factors and age. Male pattern baldness, in which the hairline gradually recedes to expose more and more of the forehead, is the most common form. Men may also experience a gradual thinning of hair at the crown, or very top of the skull. For women, hair loss is more commonly due to hormonal changes and is more likely to be a thinning of hair from the entire head. Transplants can also be performed



In a hair transplant, plugs of hair and supporting tissues are removed from a donor area at the back of the head (A and B). Pieces of skin are removed at the front of the head, and grafts are placed (C). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Alopecia**—Hair loss or baldness.

**Hair follicle**—A tube-like indentation in the skin from which a single hair grows.

**Minigraft or micrograft**—Transplantation of a small number of hair follicles, as few as one to three hairs, into a transplant site.

**Transplantation**—Surgically cutting out hair follicles and replanting them in a different spot on the head.

to replace hair lost due to burns, injury, or diseases of the scalp.

### Demographics

An estimated 50,000 men receive hair transplants each year.

### Description

Hair transplantation surgery is performed by a physician with specialty training in **plastic surgery** or, less commonly, dermatology. Each surgery lasts two to three hours during which approximately 250 grafts will be transplanted. A moderately balding man may require up to 1,000 grafts to get good coverage of a bald area; consequently, a series of surgeries scheduled three to four months apart is usually required. Individuals may be completely awake during the procedure with just a local anesthetic drug applied to numb the areas of the scalp. Some persons may be given a drug to help them relax or may be given an anesthetic drug that puts them to sleep.

The most common transplant procedure uses a thin strip of hair and scalp from the back of the head. This strip is cut into smaller clumps of five or six hairs. Tiny slits are made in the balding area of the scalp, and a clump is implanted into each slit. The doctor performing the surgery will attempt to recreate a natural-looking hairline along the forehead. Minigrafts, micrografts, or implants of single hair follicles can be used to fill in between larger implant sites and can provide a more natural-looking hairline. The implants will also be arranged so that thick and thin hairs are interspersed and the hair will grow in the same direction.

Another type of hair replacement surgery is called scalp reduction. This involves removing some of the skin from the hairless area and “stretching” some of the nearby hair-covered scalp over the cut-away area.

Health insurance will not pay for hair transplants that are performed for cosmetic reasons. Insurance plans may pay for hair replacement surgery to correct hair loss due to accidents, burns, or disease.

It is important to be realistic about what the final result of a hair transplant will look like. This procedure does not create new hair. Rather, it simply redistributes the hair that an individual still has. Chest hair has been experimentally transplanted onto the scalp. As of 2003, this procedure has not been widely used.

### Diagnosis/Preparation

Although hair transplantation is a fairly simple procedure, some risks are associated with any surgery. It is important to inform the physician about any medications being used and about previous allergic reactions to drugs or anesthetic agents. People with blood-clotting disorders also need to inform their physician before the procedure is performed.

It is important to find a respected, well-established, experienced surgeon and discuss the expected results prior to the surgery. The candidate may need blood tests to check for bleeding or clotting problems and is usually asked not to take **aspirin** products before the surgery. The type of anesthesia used will depend on how extensive the surgery will be and the setting in which it will be performed. The candidate may be awake during the procedure, but is usually given medication to cause relaxation. A local anesthetic drug that numbs the area will be applied or injected into the skin at the surgery sites.

### Aftercare

The areas involved in transplantation may need to be bandaged overnight. People can return to normal activities within a day. Strenuous activities should be avoided in the first few days after the surgery. On rare occasions, the implants can be ejected from the scalp during vigorous **exercise**. There may be some swelling, bruising, headache, and discomfort around the graft areas and around the eyes. These symptoms can usually be controlled with a mild pain reliever such as aspirin. Scabs may form at the graft sites and should not be scraped off. There may be some numbness at the sites, but it will diminish within two to three months.

### Risks

Although there are rare cases of infection or scarring, the major risk is that the grafted area might not look the way the patient expects it to look.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Hair transplantation is performed by a physician with specialty training in plastic and cosmetic surgery or dermatology. It may be performed in a professional office, outpatient, or hospital setting.

### Normal results

The transplanted hair will fall out within a few weeks; however, new hair will start to grow in the graft sites within about three months. A normal rate of hair growth is about 0.25–0.5 in (6–13 mm) per month.

### Morbidity and mortality rates

Major complications as a result of hair transplantation are extremely rare. Occasionally, a person may have problems with delayed healing, infection, scarring, or rejection of the graft, but these are uncommon.

### Alternatives

There are several alternatives to hair transplantation. The two most common include use of a lotion that contains a drug preparation, or the use of a wig.

As of 2003, only lotions containing minoxidil or finasteride actually grow any new hair. This does not occur for all users. The new hair minoxidil grows is usually only a light fuzz on the crown of the head. When minoxidil treatment is discontinued, the fuzz disappears, in addition to any hairs that were supposed to die during treatment. In some cases, finasteride does grow thick, strong, long-growing hair on the crown.

Wigs and hairpieces have been used for centuries. They are available in a wide price range, the more expensive ones providing a more realistic appearance than less expensive models.

### Resources

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- Man, Daniel, and L. C. Faye. *The New Art of Man: Faces of Plastic Surgery*, 3rd ed. New York: BeautyArt Press, 2003.

## QUESTIONS TO ASK THE DOCTOR

Candidates for hair transplantation surgery should ask the following questions:

- What will be the resulting appearance?
- Is the doctor board certified in plastic and reconstructive surgery or dermatology?
- How many hair transplantation procedures has the doctor performed?
- What is the doctor's complication rate?

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- "Locate a Hair Loss Doctor in Your State with DocShop." DocShop.com [http://www.docshop.com/hair\\_loss\\_specialists/states.html](http://www.docshop.com/hair_loss_specialists/states.html) (April 13, 2008).
- "UW Dermatologic Surgery: Hair Transplantation." University of Washington School of Medicine, Division of Dermatology. May 1, 2006. <http://faculty.washington.edu/danberg/bergweb/page3.htm> (April 13, 2008).

### ORGANIZATIONS

- American Academy of Cosmetic Surgery, 737 North Michigan Avenue, Suite 820, Chicago, IL, 60611 5405, (312) 981 6760, <http://www.cosmeticsurgery.org>.
- American Academy of Dermatology, P.O. Box 4014, Schaumburg, IL, 60618 4014, (847) 330 0230, (866) 503 7546, (847) 240 1859, [MRC@aad.org](mailto:MRC@aad.org), <http://www.aad.org/>.



American Academy of Facial Plastic and Reconstructive Surgery, 310 S. Henry Street, Alexandria, VA, 22314, (703) 229 9291, <http://www.aafprs.org/>.

American Board of Plastic Surgery, Seven Penn Center, Suite 4001635 Market Street, Philadelphia, PA, 19103 2204, (215) 587 9322, <http://www.abplsurg.org/>.

American College of Surgeons, 633 North Saint Claire Street, Chicago, IL, 60611, (312) 202 5000, <http://www.facs.org/>.

American Society for Aesthetic Plastic Surgery, 11081 Winers Circle, Los Alamitos, CA, 90720, (888) 272 7711, <http://www.surgery.org/>.

American Society for Dermatologic Surgery, 5550 Meadowbrook Drive, Suite 120, Rolling Meadows, IL, 60008, (847) 956 0900, <http://www.asds.net>.

American Society of Plastic Surgeons, 444 E. Algonquin Road, Arlington Heights, IL, 60005, (847) 228 9900, <http://www.plasticsurgery.org>.

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## Hammer, claw, and mallet toe surgery

### Definition

Hammer, claw, and mallet toe surgery refers to a series of surgical procedures performed to correct deformed toes.

### Purpose

There are three main forms of toe abnormalities in the human foot: hammer toes, claw toes, and mallet toes. A hammer toe, also called contracted toe, bone spur, rotated toe, or deformed toe, is a toe curled as the result of a bend in the middle joint. It may be either flexible or rigid, and may affect any of the four smaller toes. The joints in the toe buckle due to tightening of the ligaments and tendons, which points the toe upward at an angle. The patient's shoes then put pressure on the prominent portion of the toe, leading to inflammation, bursitis, corns, and calluses. Mallet toes and claw toes are similar to hammer toes, except that different joints on the toe are affected. The joint at the end of the toe buckles in a mallet toe, while a claw toe involves abnormal positions of all three joints in the toe.

Toe deformities are caused by a variety of factors:

- Genetic. All three toe deformities may be hereditary.
- Poorly fitted shoes. Claw toes are usually the result of wearing shoes that are too short. Many people

have second toes that are longer than their big toes; if they wear shoes sized to fit the big toe, the second toe has to bend to fit into the shoe. High-heeled shoes with pointed toes are also a major cause of claw toes.

- Bunions. A bunion is an abnormal prominence of the first joint of the big toe that pushes the toe sideways toward the smaller toes. Hammer toes often develop together with bunion deformities, and they are often treated together.
- Flat feet. This condition is due to poor biomechanics of the foot and may lead to hammer toes.
- Highly arched feet.
- Rheumatoid arthritis.
- Tendon imbalance. When the foot cannot function normally, the tendons may stretch or tighten to compensate and lead to toe deformities.
- Traumatic injuries of the toes.

When the toe deformity is painful or permanent, surgical repair is performed to relieve pain, correct the problem, and provide a stable, functional toe.

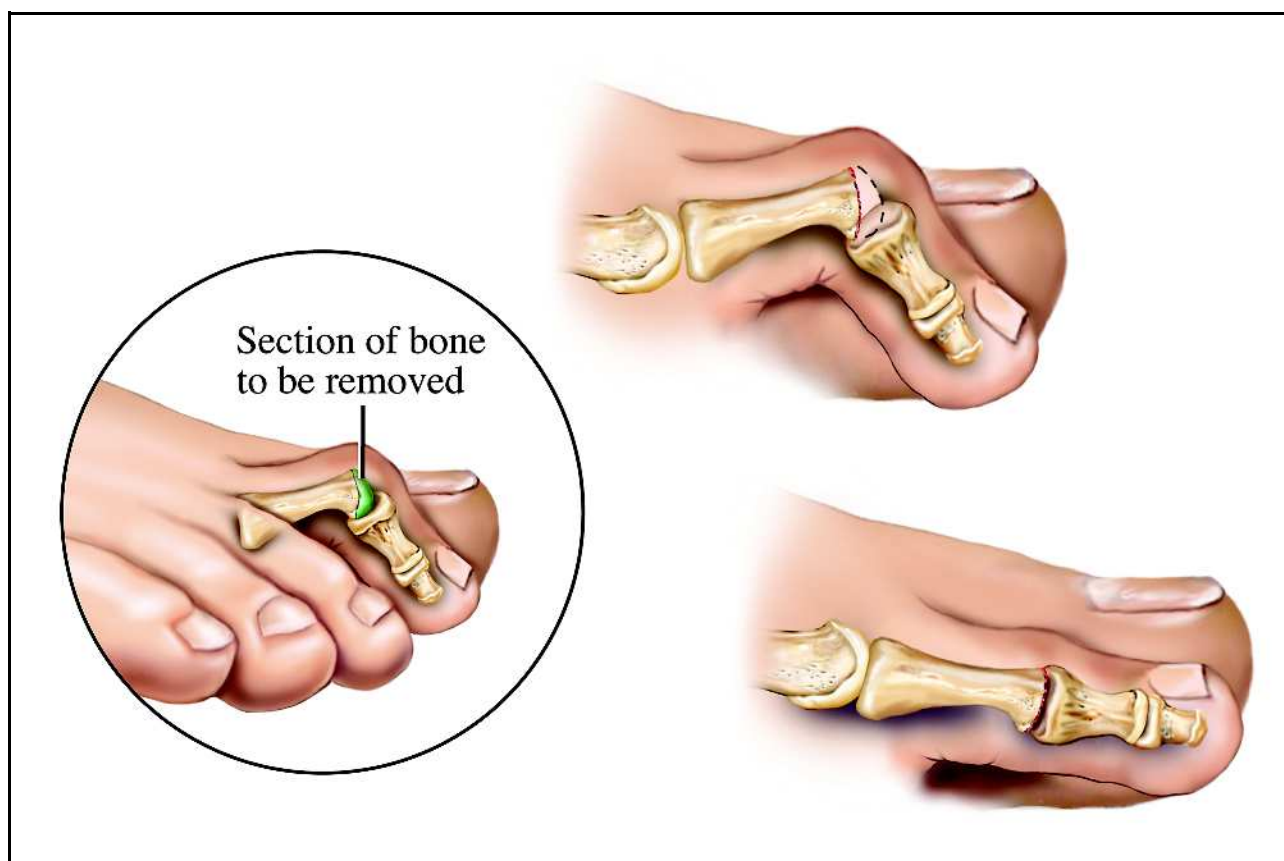
### Demographics

As of 2002, the incidence of claw and hammer toe deformities ranges from 2–20% of the population in the United States, with the frequency gradually increasing in the older age groups. Claw and hammer toes are most often seen in patients in the seventh and eighth decades of life. Women are affected four to five times more often than men. Little is known about the incidence of these deformities among people who usually wear sandals or go barefoot.

### Description

Some of the most common surgical procedures used to repair hammer, claw, and mallet toes include:

- Tenoplasty and capsulotomy. These procedures release or lengthen tightened tendons and ligaments that have caused the toe joints to contract. In some patients with flexible hammer toes, the toe straightens out after these soft tissue structures are lengthened or relaxed.
- Tendon transfer. This procedure is used to correct a flexible hammer toe deformity. It involves the repositioning of a tendon to straighten the toe.
- Bone arthroplasty. In this procedure, the surgeon removes some bone and cartilage to correct the toe deformity. A small segment of bone is removed at the joint to eliminate pressure on the toe, relieve pain, and straighten the toe. The tendons and ligaments surrounding the joint may also be reconstructed.



**Surgical repair of hammertoe.** (Nucleus Medical Art, Inc/Phototake. Reproduced by permission.)

- **Derotation arthroplasty.** In this technique, the surgeon removes a small wedge of skin and realigns the deformed toe. The surgeon may also remove a small section of bone, and repair tendons and ligaments if necessary.
- **Implant arthroplasty.** In this procedure, the surgeon inserts a silicone rubber or metal implant specially designed for the toe to replace the gliding surfaces of the joint and act as a joint spacer.

### Diagnosis/Preparation

Patients usually consult a doctor about toe deformities because of pain or discomfort in the foot when walking or running. The physician takes several factors into consideration when examining a patient who may require surgery to correct a toe deformity. Some surgical procedures require only small amounts of cutting or tissue removal while others require extensive dissection. The blood supply in the affected toe is an important factor in planning surgery. It determines not only whether the toe will heal fully but also whether the surgeon can perform more than one procedure on the toe. In addition to a visual examination of the patient's

foot, the doctor will ask the patient to walk back and forth in the office or hallway in order to evaluate the patient's gait (habitual pattern of walking). This part of the office examination allows the doctor to identify static or dynamic forces that may be causing the toe deformity. Imaging tests are also performed, usually x-ray studies.

If the doctor considers it necessary to rule out systemic disorders, he or she may order the following laboratory tests: a fasting glucose test to evaluate or rule out diabetes, and a **sedimentation rate** test to evaluate the possibility of an underlying infection in the foot.

Before surgery, the patient receives an appropriate local anesthetic, and the foot is cleansed and draped.

### Aftercare

The patient can expect moderate swelling, stiffness and limited mobility in the operated foot following toe surgery, sometimes for as long as eight to 12 weeks. Patients are advised to keep the operated foot elevated above heart level and apply ice packs to

## KEY TERMS

**Arthroplasty**—The surgical repair of a joint.

**Bunion**—A swelling or deformity of the big toe, characterized by the formation of a bursa and a sideways displacement of the toe.

**Bursa (plural, bursae)**—A pouch lined with joint tissue that contains a small quantity of synovial fluid. Bursae are located between tendons and bone, or between bones and muscle tissue.

**Bursitis**—Inflammation of a bursa.

**Callus**—A localized thickening of the outer layer of skin cells, caused by friction or pressure from shoes or other articles of clothing.

**Corn**—A horny thickening of the skin on a toe, caused by friction and pressure from poorly fitted shoes or stockings.

**Gait**—A person's habitual manner or style of walking.

**Orthopedics**—The branch of medicine that deals with bones and joints.

**Orthotics**—Shoe inserts that are intended to correct an abnormal or irregular gait or walking pattern. They are sometimes prescribed to relieve gait-related foot pain.

**Podiatrist**—A physician who specializes in the care and treatment of the foot.

reduce swelling during the first few days after surgery. Many patients are able to walk immediately after the operation, although the podiatric surgeon may restrict any such activity for at least 24 hours. Crutches or walkers are not usually needed. There is no cast on the foot, but only a soft gauze dressing. Wearing a splint for the first two to four weeks after surgery is usually recommended. Special surgical shoes are also available to protect the foot and help to redistribute the patient's body weight. If the surgeon has used sutures, they must be kept dry until they are removed, usually seven to 10 days after the operation.

The patient's physician may also suggest exercises to be done at home or at work to strengthen the toe muscles. These exercises may include picking up marbles with the toes and stretching the toe muscles.

### Risks

Risks associated with hammer, claw, and mallet toe surgery include:

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Corrective toe surgery is performed by experienced podiatric surgeons, who are physicians who specialize in foot and ankle surgery. Patients who are otherwise healthy usually have toe surgery on an outpatient basis at the surgeon's office or in an ambulatory surgery center. The procedures are usually performed under local anesthesia or with intravenous sedatives administered by trained staff.

- swelling of the toes for one to six months following surgery;
- recurrence of the deformity;
- infection;
- persistent pain and discomfort; and
- nerve injury.

### Normal results

All corrective toe procedures usually have good outcomes in relieving pain and improving toe mobility. They restore appropriate toe length and anatomy while realigning and stabilizing the joints in the foot.

### Morbidity and mortality rates

There are no reported cases of **death** following corrective surgery on the toes.

### Alternatives

Conservative treatments may be tried by patients with minor discomfort or less serious toe deformities. These treatments include:

- trimming or wearing protective padding on corns and calluses;
- wearing supportive custom-made plastic or leather shoe inserts (orthotics) to help relieve pressure on toe deformities. Orthotics allow the toes and major joints of the foot to function more efficiently;
- using splints or small straps to realign the affected toe;
- wearing shoes with a wider toe box; and
- injecting anti-inflammatory medications to relieve pain and inflammation.

## QUESTIONS TO ASK THE DOCTOR

- What can I do to prevent the deformity from recurring after surgery?
- What are the chances that the toe will be completely corrected?
- How long will it take to recover from the surgery?
- What specific techniques do you use?
- How many corrective toe procedures do you perform each year?

### Resources

#### BOOKS

- Adelaar, R. S., ed. *Disorders of the Great Toe*. Rosemont, IL: American Academy of Orthopaedic Surgeons, 1997.
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- "Hammertoe Deformity." Foot Pain and Podiatry Online. 1999. <http://www.footpain.org/Hammertoes.html> (April 14, 2008).

### ORGANIZATIONS

- American Academy of Orthopaedic Surgeons, 6300 N. River Road, Rosemont, IL, 60018 4262, (847) 823 7186, (800) 346 AAOS, (847) 823 8125, <http://www.aaos.org>.
- American College of Foot and Ankle Surgeons, 8725 West Higgins Road, Suite 555, Chicago, IL, 60631 2724, (773) 693 9300, (800) 421 2237, (773) 693 9304, [info@acfas.org](mailto:info@acfas.org), <http://www.acfas.org>.
- American Podiatric Medical Association, 9312 Old Georgetown Road, Bethesda, MD, 20814, (301) 581 9200, <http://www.apma.org>.

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## Hand surgery

### Definition

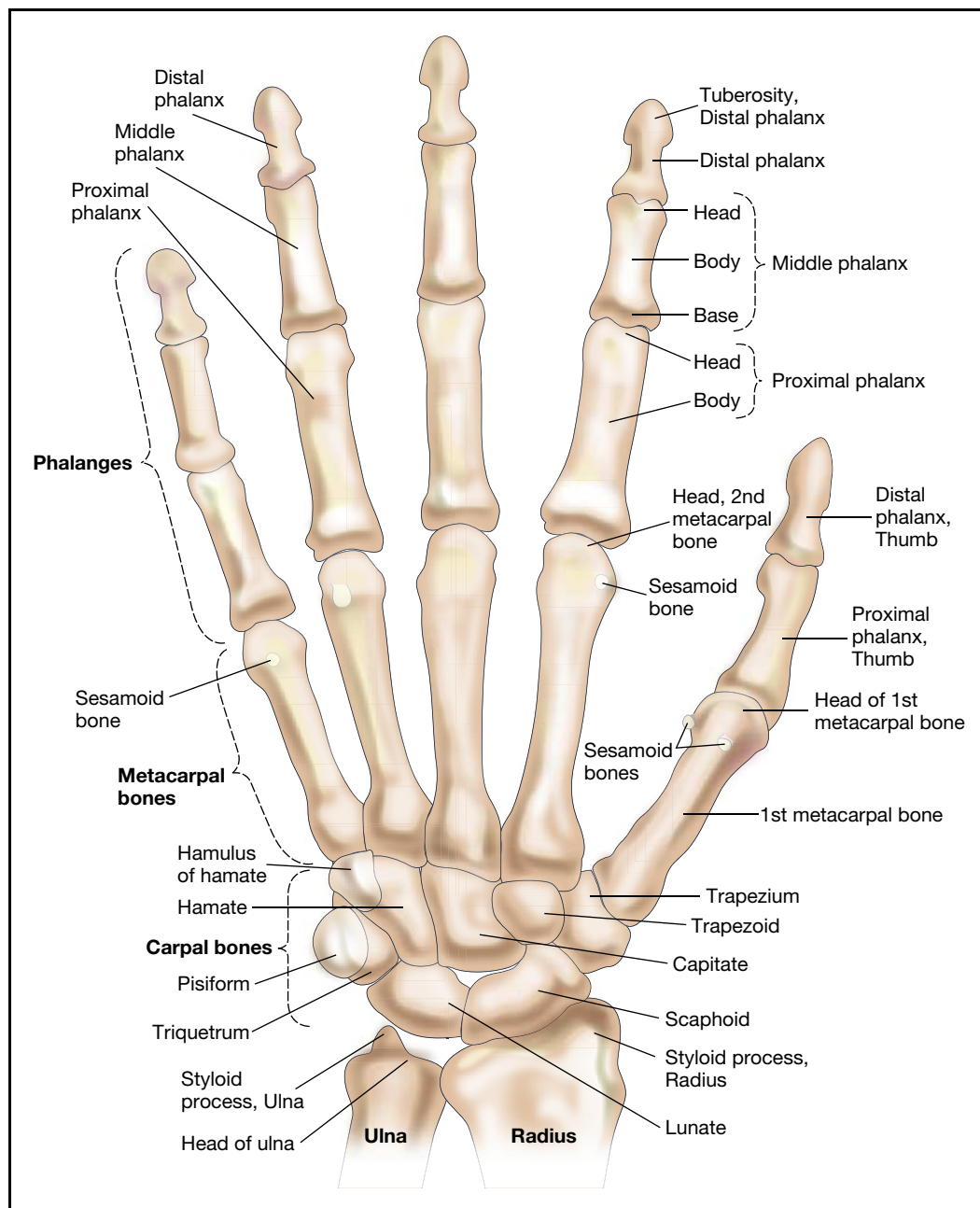
Hand surgery refers to procedures performed to treat traumatic injuries or loss of function resulting from such diseases as advanced arthritis of the hand.

### Purpose

The purpose of hand surgery is the treatment of a broad range of problems that affect the hand, whether they result from cuts, burns, crushing injuries, or disease processes. Hand surgery includes procedures that treat traumatic injuries of the hands, including closed-fist injuries; congenital deformities; repetitive stress injuries; deformities caused by arthritis and similar disorders affecting the joints; nail problems; and **tendon repair**.

The central priority of the hand surgeon is adequate reconstruction of the skin, bone, nerve, tendon, and joint(s) in the hand. Proper repair of any cuts, tears, or burns in the skin will help to ensure a wound free of infection and will provide cover for the anatomical structures beneath the skin. Early repair and grafting is an essential component of hand surgery. Nerve repair is important because a delay in reconnecting the nerve fibers may affect the recovery of sensation in the hand. Restoration of sensation in the hand is necessary if the patient is to recover a reasonable level of functionality. Next, the bones in the hand must be stabilized in a fixed position before the surgeon can repair joints or tendons. Joint mobility may be restored by specific tendon repairs or grafts. In some cases, the patient's hand may require several operations over a period of time to complete the repair.





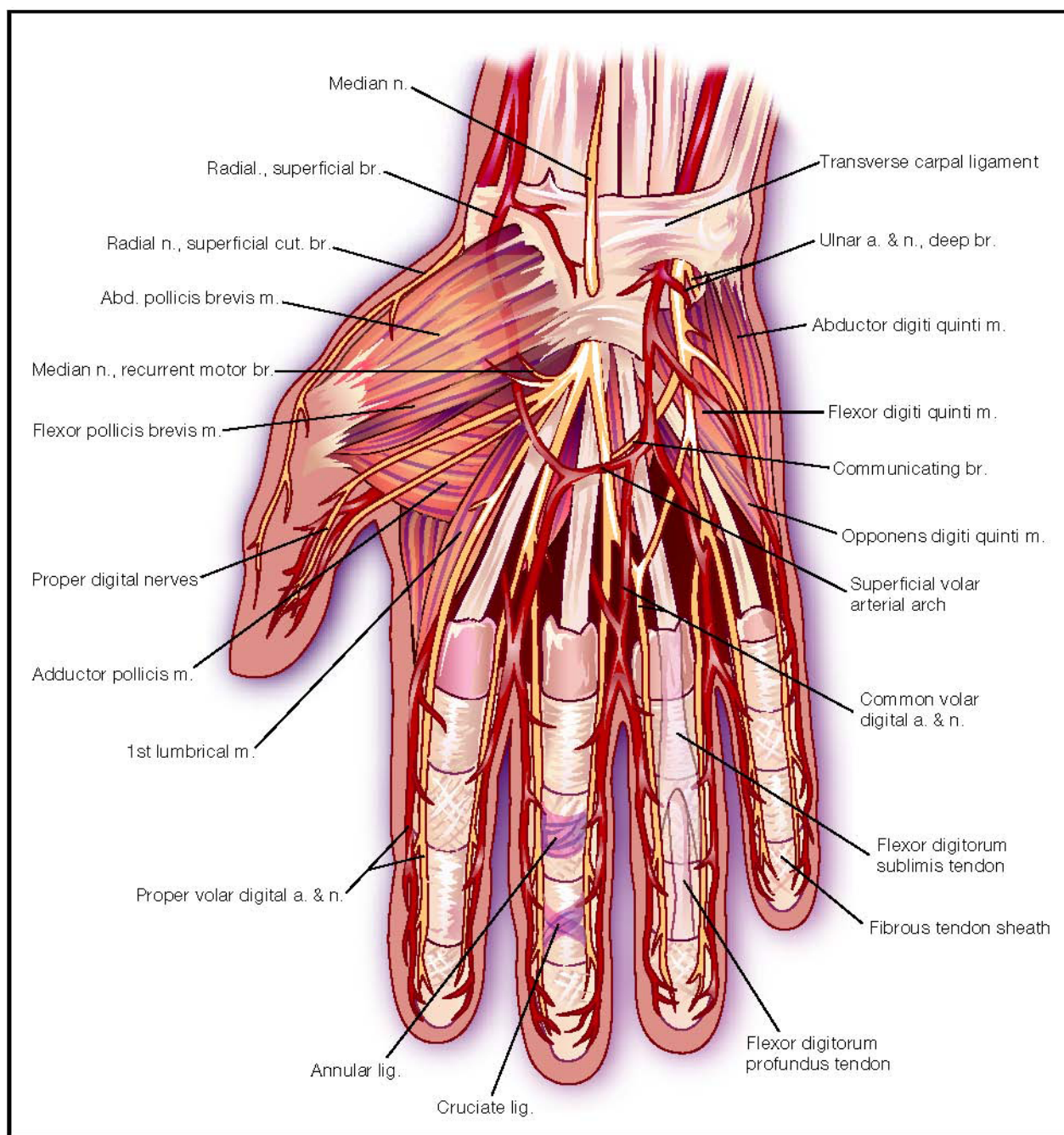
The bones of the hand. (Illustration by Electronic Illustrators Group.)

## Demographics

The demographics of hand injuries and disorders depend on the specific injury or disorder in question. Repetitive stress injuries (RSIs) of the hands are often related to occupation; for example, nurse anesthetists, dental hygienists, keyboard instrumentalists, word processors, violinists, and some assembly-line workers are at relatively high risk of developing carpal tunnel syndrome or tendinitis of the fingers related to their

work. Nearly 17% of all disabling work injuries in the United States involve the fingers, most often when the finger strikes or is jammed against a hard surface. Over 25% of athletic injuries involve the hand or wrist.

In terms of age groups, children under the age of six are the most likely to be affected by crushing or burning injuries of the hand. Closed-fist injuries, which frequently involve infection of the hand resulting from a human bite, are almost entirely found in



**Some major muscles, tendons, ligaments, and nerves of the hand.** (Illustration by Electronic Illustrators Group.)

males between the ages of 15 and 35. Pain or loss of function in the hands resulting from osteoarthritis, however, is found most often in middle-aged or older adults, and affects women as often as men.

Some specific categories of conditions that may require hand surgery include:

- **Congenital malformations.** The most common congenital hand deformity is syndactyly, in which two or

more fingers are fused together or joined by webbing; and polydactyly, in which the person is born with an extra finger, often a duplication of the thumb.

- **Infections.** Hand surgeons treat many different types of infections, including paronychia, an infection resulting from a penetrating injury to the nail; felon, an inflammation of the deeper tissue under the fingertip resulting in an abscess; suppurative tenosynovitis,

## KEY TERMS

**Congenital**—Present at birth.

**Felon**—A very painful abscess on the lower surface of the fingertip, resulting from infection in the closed space surrounding the bone in the fingertip. It is also known as whitlow.

**Hemostat**—A small surgical clamp used to hold a blood vessel closed.

**Lipoma**—A type of benign tumor that develops within adipose or fatty tissue.

**Loupe**—A convex lens used to magnify small objects at very close range. It may be held on the hand, mounted on eyeglasses, or attached to a headband.

**Paresthesia**—An abnormal touch sensation, such as a prickling or burning feeling, often in the absence of an external cause.

**Paronychia**—Inflammation of the folds of tissue surrounding the nail.

**Polydactyly**—A developmental abnormality characterized by an extra digit on the hand or foot.

**Skin flap**—A piece of skin with underlying tissue that is used in grafting to cover a defect and that receives its blood supply from a source other than the tissue on which it is laid.

**Syndactyly**—A developmental abnormality in which two or more fingers or toes are joined by webbing between the digits.

an infection of the flexor tendon sheath of the fingers or thumb; and deeper infections that often result from human or animal bites.

- **Tumors.** The most common tumor of the hand is the ganglion cyst, which is a mass of tissue fluid arising from a joint or tendon space. Giant cell tumors are the second most common hand tumor. These tumors usually arise from joints or tendon sheaths and are yellow-brown in color. The third type of hand tumor is a lipoma, which is a benign tumor that occurs in fatty tissue.
- **Nerve compression syndromes.** These syndromes occur when a peripheral nerve is compressed, usually because of an anatomic or developmental problem, infection or trauma. For example, carpal tunnel syndrome develops when a large nerve in the arm called the median nerve is subjected to pressure building up inside the carpal tunnel, which is a passageway through the wrist. This pressure on the nerve may result from injury, overuse of the hand and wrist,

fluid retention during pregnancy, or rheumatoid arthritis. The patient may experience tingling or aching sensations, numbness, and a loss of function in the hand. The ulnar nerve is another large nerve in the arm that runs along the little finger. Compression of the ulnar nerve at the elbow can cause symptoms that typically include aching pain, numbness, and paresthesias.

- **Amputation.** Some traumatic injuries result in the loss of a finger or the entire hand, requiring reattachment or replantation. Crushing injuries of the hand have the lowest chance of a successful outcome. Children and young adults have the best chances for recovery following surgery to repair an accidental amputation.
- **Fractures and dislocations.** Distal phalangeal fractures (breaking the bone of a finger above the first joint towards the tip of the finger) are the most commonly encountered fractures of the hand. They often occur while playing sports.
- **Fingertip injury.** Fingertip injuries are extremely dangerous since they comprise the most common hand injuries and can lead to significant disability. Fingertip injuries can cause damage to the tendons, nerves, or veins in the hands.

## Description

There are a number of different procedures that may be involved in hand surgery, with a few general principles that are applicable to all cases: operative planning; preparing and draping the patient; hair removal; tourniquet usage; the use of special **surgical instruments**; magnification (special visualization attachments); and **postoperative care**. The operative preplanning stage is vitally important since it allows for the best operative technique. The hand to be operated on is shaved and washed with an antiseptic for five minutes. A tourniquet will be placed on the patient's arm to minimize blood loss; special inflation cuffs are available for this purpose.

The four basic instruments used in hand surgery include a knife, small forceps, dissecting scissors, and mosquito hemostats. A standard drill with small steel points is used to drill holes in bone during reconstructive bone surgery. Additionally, visualization of small anatomical structures is essential during hand surgery. Frequently, the hand surgeon may use wire loupes (a special instrument held in place on top of the surgeon's head) or a double-headed binocular microscope in order to see the tendons, blood vessels, muscles, and other structures in the hand.



In most cases, the anesthesiologist will administer a regional nerve block to keep the patient comfortable during the procedure. The patient is usually positioned lying on the back with the affected arm extended on a hand platform. If the surgeon is performing a bone reconstruction, he or she may require such special instruments as a drill, metal plates and/or screws, and steel wires (K-wires). Arteries and veins should be reconnected without tension. If this cannot be done, the hand surgeon must take out a piece of vein from another place in the patient's body and use it to reconstruct the vein in the hand. This process is called a venous graft. Nerves damaged as a result of traumatic finger injuries can usually be reconnected without tension, since bone reconstruction prior to nerve surgery shortens the length of the bones in the hand. The surgeon may also perform skin grafts or skin flaps. After all the bones, nerves, and blood vessels have been repaired or reconstructed, the surgeon closes the wound and covers it with a dressing.

### Diagnosis/Preparation

With the exception of emergencies requiring immediate treatment, the diagnosis of hand injuries and disorders begins with a detailed history and **physical examination** of the patient's hand. During the physical examination, the doctor evaluates the range of motion (ROM) in the patient's wrist and fingers. Swollen or tender areas can be felt (palpated) by the clinician. The doctor can assess sensation in the hand by very light pinpricks with a fine sterile needle. In cases of trauma to the hand, the doctor will inspect the hand for bite marks, burns, foreign objects that may be embedded, or damage to deeper anatomical structures within the hand. The tendons will be evaluated for evidence of tearing or cutting. Broken bones or joint injuries will be tender to the touch and are easily visible on x-ray imaging.

The doctor may order special tests, including radiographic imaging (x rays), **wound culture**, and special diagnostic tests. X rays are the most common and most useful diagnostic tools available to the hand surgeon for evaluating traumatic injuries. Wound cultures are important for assessing injuries involving bites (human or animal) as well as wounds that have been badly contaminated by foreign matter. Such other special tests as a Doppler flowmeter examination can be used to evaluate the patterns of blood flow in the hand.

Before a scheduled operation on the hand, the patient will be given standard blood tests and a physical examination to make sure that he or she does not suffer from a general medical condition that would be a contraindication to surgery.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Hand surgery is usually performed by a microsurgeon, who may be a plastic surgeon (a surgeon with five years of general surgery training plus two years of plastic surgery training and another one to two years of training in microneurovascular surgery) or an orthopedic surgeon (a surgeon with one year of general surgery training, five years of orthopedic surgery training and additional years in microsurgery training).

Hand therapists are usually occupational therapists who have received specialized training in hand rehabilitation and are certified in hand therapy.

### Aftercare

Aftercare following hand surgery may include one or more of the following, depending on the specific procedure: oral painkilling medications; anti-inflammatory medications; **antibiotics**; splinting; **traction**; special **dressings** to reduce swelling; and heat or massage therapy. Because the hand is a very sensitive part of the body, the patient may experience severe pain for several days after surgery. The surgeon may prescribe injections of painkilling drugs to manage the patient's discomfort.

**Exercise** therapy is an important part of aftercare for most patients who are recovering from hand surgery. A rehabilitation hand specialist will demonstrate exercises for the hand, instruct the patient in proper **wound care**, massage the hand and wrist, and perform an ongoing assessment of the patient's recovery of strength and range of motion in the hand.

### Risks

According to the American Society of Plastic Surgeons, the most common complications associated with hand surgery are the following:

- infection
- poor healing
- loss of sensation or range of motion in the hand
- formation of blood clots
- allergic reactions to the anesthesia

Complications are relatively infrequent with hand surgery, however, and most can be successfully treated.



## QUESTIONS TO ASK THE DOCTOR

- Are there any alternatives to surgery for treating my hand?
- Is the disorder likely to recur?
- Will I need a second operation?
- How many patients with my condition have you treated, and what were their outcomes?
- Can I expect to recover full range of motion in my hand?
- What will my hand look like after surgery?

### Normal results

Normal results for hand surgery depend on the nature of the injury or disorder being treated.

### Morbidity and mortality rates

Mortality following hand surgery is virtually unknown. The rates of complications depend on the nature of the patient's disorder or injury and the specific surgical procedure used to treat it.

### Alternatives

Some disorders that affect the hand, such as osteoarthritis and rheumatoid arthritis, may be managed with such nonsurgical treatments as splinting, medications, physical therapy, or heat. Fractures, amputations, burns, bite injuries, congenital deformities, and severe cases of compression syndromes usually require surgery.

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HCT see **Hematocrit**

Head and neck surgery see **Ear, nose, and throat surgery**

## Health care proxy

### Definition

A health care proxy, or health care proxy form, is a legal document that allows a person to choose someone to make medical decisions on their behalf when they are unable to do so. In some states the person who is authorized may be called a proxy, in others the person may be called an agent.

### Description

A health care proxy form is part of a set of legal documents that allows a person to appoint someone to make medical decisions for them if they cannot act on their own behalf, and to make sure that health care professionals follow their wishes regarding specific medical treatments at the end of life. These documents are referred to as advance directives. The document naming the person appointed to make the decisions is called a health care proxy. The document that lists acceptable and unacceptable measures of artificial life support is called a **living will**. Most states have passed laws that authorize people to draw up living wills, but it is important to get specific information about the laws in one's own state.

Any competent adult can appoint a health care proxy or agent. It is not necessary to hire a lawyer to draw up or validate the form. Most states, however, require two adult witnesses to sign a proxy form. Many hospitals provide proxy forms on request.

It is important to have a health care proxy in order to be able to choose the person who will be making

## KEY TERMS

**Advance directive**—A general term for two types of documents, living wills and medical powers of attorney, that allow people to give instructions about health care in the event that they cannot speak for themselves.

**Proxy**—A person authorized or empowered to act on behalf of another; also, the document or written authorization appointing that person.

medical decisions on one's behalf. In addition to naming the specific person who will make those decisions, one should think about what life-sustaining treatments one would be willing to undergo in the event of a medical emergency or terminal illness.

A health care proxy form does not deprive a person of the right to make decisions about medical treatment as long as he or she is able to do so. It is put into effect only when the patient's health care team determines that the patient is unable to make decisions on his or her own. For example, a person may be in a coma following an automobile accident. The physician would document in the patient's medical record that the patient is unable to make his or her own medical decisions, the circumstances that led to the patient's present condition, the nature of the disease or injury, and the expected length of the patient's incapacitation.

The person named as proxy makes health care decisions only as long as the patient is unable to make them for him- or herself. If the person regains the ability to make his or her own decisions, the proxy will no longer make them. If the incapacitation is permanent, the proxy will continue to make health care decisions on the patient's behalf as long as the patient is alive, or until the proxy is no longer able to carry out the responsibility.

Any trusted adult can be named as a health care proxy. Most married people name their spouse, but it is not necessary to do so. In addition, it is important to select an alternate proxy, in the event that the person first named is unable to fulfill the responsibility. For example, if the spouse has been named as proxy, and both members of the couple were incapacitated in a house fire, then someone else should be empowered to act on their behalf. A married couple does not need to name the same individual as a proxy or as the alternate. It is best to choose someone who lives close enough to carry out the responsibilities of a proxy without having to travel across state lines.

One should consider whether a potential proxy will be able to ask the necessary questions of medical personnel in order to obtain information needed to make a decision. It is important to discuss with the proxy his or her own value system, and whether he or she could make a decision for someone else that he or she would not make for him or herself. It is a good idea to carry the name and contact information of the proxy in one's wallet in the event of an emergency or sudden incapacitation.

The purpose of a living will is to give specific instructions about emergency or end-of-life health care. In some states a living will may be part of the health care proxy document. But because it is impossible to plan for all possible situations, the health care proxy can interpret one's wishes to members of the health care team and make decisions that one could not foresee at the time of making a living will. This is why it is important for the proxy to understand one's value system, so that the proxy can use his or her judgment as to what one would want. The proxy should be given a written copy of all advance directives. Even if a living will is not legal in the state in which one resides, writing such a will is an opportunity to think through one's beliefs and health care preferences. The proxy or agent can then use the living will as a guide in making health care decisions as need arises.

Completing a health care proxy form and living will is useful because it helps one to think through one's value system and one's definition of quality of life. Some areas to consider are:

- What makes my life meaningful?
- What religious or personal beliefs do I hold that affect my health care decisions?
- Do I want my proxy to make health care decisions on his or her own, or are there other people I would want him or her to consult? If so, who are these people? Is there anyone who should *not* be consulted?
- Who besides myself will be affected by these decisions? Are they aware of my value system? Would they try to interfere with the proxy's decisions?
- What do I want to do about organ donation?
- Have I informed my physician of my wishes?

Appointing a health care proxy is not an irrevocable decision. One can change or revoke the proxy at any time, usually by filling out a new form. In some states, one can specify that the health care proxy will expire on a certain date or if certain events occur. If one has named one's spouse as an agent, the proxy is no longer in effect in the event of separation or divorce. People who want a former spouse to continue as their agent must complete a new proxy form.

In addition to keeping a copy of the proxy form in one's own file of important documents, one should give copies to the proxy, the alternate, and one's physicians.

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- American Medical Association, 515 N. State Street, Chicago, IL, 60610, (800) 621 8335, <http://www.ama-assn.org>.
- Caring Connections, National Hospice Foundation, Dept 6058, Washington, DC, 20042 6058, (703) 516 4928, <http://www.caringinfo.org>.
- National Cancer Institute, 6116 Executive Boulevard, Room 3036A, Bethesda, MD, 20892 8322, (800) 422 6237, <http://www.cancer.gov>.
- National Library of Medicine, 8600 Rockville Pike, Bethesda, MD, 20894, (888) 346 3656, <http://www.nlm.nih.gov>.

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## Health history

### Definition

The health history is a current collection of organized information unique to an individual. Relevant aspects of the history include biographical, demographic,

## KEY TERMS

**Holistic**—Pertaining to all aspects of the patient, including biological, psychosocial, and cultural factors.

**Subjective**—Influenced by the perspective of the information provider; potentially biased.

physical, mental, emotional, sociocultural, sexual, and spiritual data.

### Purpose

The health history aids both individuals and health care providers by supplying essential information that will assist with diagnosis, treatment decisions, and establishment of trust and rapport between lay persons and medical professionals. The information also helps determine an individual's baseline, or what is normal and expected for that person.

### Demographics

Every person should have a thorough health history recorded as a component of a periodic **physical examination**. These occur frequently (monthly at first) in infants and gradually reach a frequency of once per year for adolescents and adults.

### Description

The clinical interview is the most common method for obtaining a health history. When a person or a designated representative can communicate effectively, the clinical interview is a valuable means for obtaining information.

The information that comprises the health history may be obtained from a person's previous records, the individual, or, in some cases, significant others or caretakers. The depth and length of the history-taking process is affected by factors such as the purpose of the visit, the urgency of the complaint or condition, the person's willingness or ability to contribute information, and the environment in which information is sought. When circumstances allow, a history may be holistic and comprehensive, but at times only a cursory review of the most pertinent facts is possible. In cases where the history-gathering process needs to be abbreviated, the history focuses on a person's medical experiences.

Health histories can be organized in a variety of ways. Often a hospital or clinic will provide a form,

template, or computer database that serves as a guide and documentation tool for the history. Generally, the first aspect covered by the history is identifying data.

Identifying or basic demographic data includes facts such as:

- name;
- gender;
- age;
- date of birth;
- occupation;
- family structure or living arrangements; and
- source of referral.

Once the basic identifying data is collected, the history addresses the reason for the current visit in expanded detail. The reason for the visit is sometimes referred to as the chief complaint or the presenting complaint. Once the reason for the visit is established, additional data is solicited by asking for details that provide a more complete picture of the current clinical situation. For example, in the case of pain, aspects such as location, duration, intensity, precipitating factors, aggravating factors, relieving factors, and associated symptoms should be recorded. The full picture or story that accompanies the chief complaint is often referred to as the history of present illness (HPI).

The review of systems is a useful method for gathering medical information in an orderly fashion. This review is a series of questions about the person's current and past medical experiences. It usually proceeds from general to specific information. A thorough record of relevant dates is important in determining relevance of past illnesses or events to the current condition. A review of systems typically follows a head-to-toe order.

The names for categories in the review of systems may vary, but generally consists of variations on the following list:

- head, eyes, ears, nose, throat (HEENT);
- cardiovascular;
- respiratory;
- gastrointestinal;
- genitourinary;
- integumentary (skin);
- musculoskeletal, including joints;
- endocrine;
- nervous system, including both central and peripheral components; and
- mental, including psychiatric issues.

Past and current medical history includes details on medicines taken by the person, as well as allergies, illness, hospitalizations, procedures, pregnancies, environmental factors such as exposure to chemicals, toxins, or carcinogens, and health maintenance habits such as breast or testicular self-examination or immunizations.

An example of a series of questions might include the following:

- How are your ears?
- Are you having any trouble hearing?
- Have you ever had any trouble with your ears or with your hearing?

If an individual indicates a history of auditory difficulties, this would prompt further questions about medicines, surgeries, procedures, or associated problems related to the current or past condition.

In addition to identifying data, chief complaint, and review of systems, a comprehensive health history also includes factors such as a person's family and social life, family medical history, mental or emotional illnesses or stressors, detrimental or beneficial habits such as smoking or **exercise**, and aspects of culture, sexuality, and spirituality that are relevant to each individual. The clinicians also tailor their interviewing style to the age, culture, educational level, and attitudes of the persons being interviewed.

## Diagnosis/Preparation

The information obtained from the interview is subjective, therefore, it is important that the interviewer assess the person's level of understanding, education, communication skills, potential biases, or other information that may affect accurate communication. Thorough training and practice in techniques of interviewing such as asking open-ended questions, listening effectively, and approaching sensitive topics such as substance abuse, chemical dependency, domestic violence, or sexual practices assists a clinician in obtaining the maximum amount of information without upsetting the person being questioned or disrupting the interview. The interview should be preceded by a review of the chart and an introduction by the clinician. The health care professional should explain the scope and purpose of the interview and provide privacy for the person being interviewed. Others should only be present with the person's consent.

## Aftercare

Once a health history has been completed, the person being queried and the examiner should review the relevant findings. A health professional should



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A health history is best obtained by a physician who has the training to appreciate nuances and details that may be overlooked by those with less training. Other health care professionals such as physician assistants and nurse practitioners have similar but somewhat limited training. Health histories are usually obtained in professional offices or hospitals. Occasionally, they are obtained in private homes or in the field.

discuss any recommendations for treatment or follow-up visits. Suggestions or special instructions should be put in writing. This is also an opportunity for persons to ask any remaining questions about their own health concerns.

### Risks

There are virtually no risks associated with obtaining a health history. Only information is exchanged. The risk is potential embarrassment if confidential details are inappropriately distributed. Occasionally, a useful piece of information or data may be overlooked. In a sense, complications may arise from the findings of a health history. These usually trigger further investigations or initiate treatment. They are usually far more beneficial than negative as they often begin a process of treatment and recovery.

### Normal results

Normal results of a health history correspond to the appearance and normal functioning of the body. Abnormal results of a health history include any findings that indicate the presence of a disorder, disease, or underlying condition.

### Morbidity and mortality rates

Disease and disability are identified during the course of obtaining a health history. There are virtually no risks associated with the verbal exchange of information.

### Alternatives

There are no alternatives that are as effective as obtaining a complete health history. The only real alternative is to skip the history. This allows disease

## QUESTIONS TO ASK THE DOCTOR

- What are your interpretations of my history, both normal and abnormal?
- What has changed since the last health history was obtained?
- What do you recommend as a result of your interpretation of the information obtained in this health history?
- When do you want to repeat the health history?

and other pathologic or degenerative processes to go undetected. In the long run, this is not conducive to optimal health.

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### ORGANIZATIONS

American Academy of Family Physicians, 11400 Tomahawk Creek Parkway, Leawood, KS, 66211 2672, (913) 906 6000, <http://www.aafp.org>.

American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007 1098, (847) 434 4000, (847) 434 8000, [kidsdocs@aap.org](mailto:kidsdocs@aap.org), <http://www.aap.org>.

American College of Physicians, 190 N. Independence Mall West, Philadelphia, PA, 19106 1572, (215) 351 2400, (800) 523 1546, <http://www.acponline.org>.

American Medical Association, 515 N. State Street, Chicago, IL, 60610, (800) 621 8335, <http://www.ama-assn.org>.

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## Health Maintenance Organization (HMO)

### Definition

A Health Maintenance Organization provides health care coverage to individuals who are enrolled in it. Individuals enroll in an HMO through hospitals, physicians, and other healthcare providers, or through laboratories who have a contract with the HMO.

### Purpose

The purpose of an HMO is provide health care coverage at lower costs to the HMO, to the patient,

and to the employers or government who offer the HMO as an insurance option. HMOs have advantages and disadvantages, but can be a very important option for many individuals.

### Advantages

The advantage to the patient of an HMO over other types of health care insurance are lower costs. For example, a patient may pay a co-pay of \$10 for each visit to their primary care physician with HMO coverage, as opposed to 20% with traditional indemnity health care insurance. Frequently, the laboratory fees are covered completely if they are performed at a laboratory that has a contract with the HMO. The HMO monthly premium is usually lower than traditional indemnity insurance plans as well, because the health care providers contract with an HMO to receive a greater number of patients, but in doing so, usually agree to provide care at discounted fees. Another way that most HMOs keep costs down is by setting up a system of care based on specific care plans that are overseen by the patient's primary care physician; the patient cannot make an appointment with a specialist, and be covered by insurance, without prior authorization or referral by their primary care physician. Some HMOs do not have these restrictions, but they tend to have higher premiums. HMOs also focus on preventive healthcare programs to help prevent members from developing chronic conditions that could significantly increase their medical costs.

### Disadvantages

A major disadvantage to the patient of an HMO is that his or her preferred health care provider may not have a contract with that HMO and therefore, if the patient wants to see that particular provider, he or she would have to pay for the visits out of pocket. Another disadvantage of HMOs can be that providers may end up being at a financial disadvantage because of the reduced fees required to contract with the HMO. In some areas this has led to very few healthcare providers contracting with certain HMOs and thus the members of the HMO have very little choice in whom to see. For these same reasons, some healthcare providers will not re-sign a contract with an HMO and a patient who has been seeing that healthcare provider for years may end up not being able to choose that healthcare provider for the future.

## Resources

### ORGANIZATIONS

National Association of Insurance Commissioners, 2301 McGee Street, Suite 800, Kansas City, MO 64108. (816)842 3600.<http://www.naic.org/>.

### OTHER

Medline Plus a service of the National Library of Medicine and the National Institutes of Health, 8600 Rockville Pike, Bethesda, MD 20894.<http://www.nlm.nih.gov/medlineplus/managedcare.html>

Renee Laux, M.S.

## Heart-lung machines

### Definition

The heart-lung machine, sometimes called a pump oxygenator, is medical equipment that provides cardiopulmonary bypass, or mechanical circulatory support of the heart and lungs. The machine may consist of venous and arterial cannula (tubes), polyvinyl chloride (PVC) or silicone tubing, a reservoir (to hold blood), bubbler or membrane oxygenator, cardiotomy (a filtered reservoir), heat exchanger(s), arterial line filter, pump(s), flow meter, inline blood gas and electrolyte analyzer, and pressure-monitoring devices. Treatment provides removal of carbon dioxide from the blood, oxygen delivery to the blood, blood flow to the body, and/or temperature maintenance. Pediatric and adult patients both benefit from this technology.

### Purpose

In the **operating room**, the heart-lung machine is used primarily to provide blood flow and respiration for the patient while the heart is stopped. It allows surgeons to perform **heart transplantation**, coronary artery bypass grafting (CABG), open-heart surgery for valve repair or repair of cardiac anomalies, and aortic aneurysm repairs, along with treatment of other cardiac-related diseases.

The heart-lung machine provides the benefit of a motionless heart in an almost bloodless surgical field. Cardioplegia solution is delivered to the heart, resulting in cardiac arrest (heart stoppage). The heart-lung machine is invaluable during this time since the patient is unable to maintain blood flow to the lungs or the body.

## KEY TERMS

**Anticoagulant**—Pharmaceuticals to prevent clotting proteins and platelets in the blood to be activated to form a blood clot.

**Cannula**—A tube that provides access to the blood when inserted into the heart or blood vessels.

**Cardiopulmonary bypass**—Diversion of blood flow away from the right atrium and return of blood beyond the left ventricle, to bypass the heart and lungs.

**Extracorporeal**—Circulation of blood outside of the body.

In critical care units and **cardiac catheterization** laboratories, the heart-lung machine is used to support and maintain blood flow and respiration. The diseased heart or lung(s) is replaced by this technology, providing time for the organ(s) to heal. The heart-lung machine can be used with venoarterial extracorporeal membrane oxygenation (ECMO), which is used primarily in the treatment of lung disease. Cardiopulmonary support is useful during percutaneous transluminal coronary **angioplasty** (PTCA) and stent procedures performed with cardiac catheterization. Both treatments can be instituted in the critical care unit when severe heart or lung disease is no longer treatable by less-invasive conventional treatments such as pharmaceuticals, intra-aortic balloon pump (IABP), and **mechanical ventilation** with a respirator.

Use of this treatment in the emergency room is not limited to patients suffering heart or lung failure. In severe cases of hypothermia, a patient's **body temperature** can be corrected by extracorporeal circulation with the heart-lung machine. Blood is warmed as it passes over the heat exchanger. The warmed blood returns to the body, gradually increasing the patient's body temperature to normal.

Tertiary care facilities are able to support the staffing required to operate and maintain this technology. Level I trauma centers have access to this specialized treatment and equipment. Being that this technology serves both adult and pediatric patients, specialized children's hospitals may provide treatment with the heart-lung machine for venoarterial ECMO.

### Description

The pump oxygenator had its first success on May 6, 1953. Continued research and design have allowed the heart-lung machine to become a standard of care

in the treatment of heart and lung disease, while supporting other non-conventional treatments.

Foreign surfaces of the heart-lung machine activate blood coagulation factors, proteins, and platelets, which lead to clot formation. In the heart-lung machine, clot formation would block the flow of blood. As venous and arterial cannulas are inserted, medications are administered to prevent clotting of the blood. This allows blood to flow freely through the heart-lung machine.

Large vessels (veins and arteries) are required for cannulation, to insert the tubes (cannulas) that will carry the blood away from the patient to the heart-lung machine and to return the blood from the heart-lung machine to the patient. Cannulation sites for venous access can include the inferior and superior vena cava, the right atrium (upper chamber of the heart), the femoral vein (in the groin), or internal jugular vein. Oxygen-rich blood can be returned to the aorta, femoral artery, or carotid artery (in the neck). By removing oxygen-poor blood from the right side of the heart and returning oxygen-rich blood to the left side, heart-lung bypass is achieved.

The standard heart-lung machine typically includes up to five pump assemblies. A centrifugal or roller head pump can be used in the arterial position for extracorporeal circulation of the blood. The four remaining pumps are roller pump in design to provide fluid, gas, and liquid for delivery or removal to the heart chambers and surgical field. Left ventricular blood return is accomplished by roller pump, drawing blood away from the heart. Surgical suction created by the roller pump removes accumulated fluid from the general surgical field. The cardioplegia delivery pump is used to deliver a high potassium solution to the coronary vessels. The potassium arrests the heart so that the surgical field is motionless during surgical procedures. An additional pump is available for emergency backup of the arterial pump in case of mechanical failure.

A pump is required to produce blood flow. As of 2007, roller and centrifugal pump designs were the standard of care. Modern heart lung machines can provide pulsatile (pulsed, as from a heartbeat) or non-pulsatile (continuous) blood flow to the systemic circulation.

The roller assembly rotates and engages the tubing, PVC or silicone, which is then compressed against the pump's housing, propelling blood ahead of the roller head. Rotational frequency and inner diameter of the tubing determine blood flow. Because of its occlusive nature, the pump can be used to remove

blood from the surgical field by creating negative pressure on the inflow side of the pump head.

The centrifugal pump also has a negative inlet pressure. As a safety feature, this pump disengages when air bubbles are introduced. The centrifugal force draws blood into the center of the device. Blood is propelled and released to the outflow tract tangential to the pump housing. Rotational speed determines the amount of blood flow, which is measured by a flowmeter placed adjacent to the pump housing. If rotational frequency is too low, blood may flow in the wrong direction since the system is non-occlusive in nature. Magnetic coupling links the centrifugal pump to the control unit.

A reservoir collects blood drained from the venous circulation. Tubing connects the venous cannulas to the reservoir. Reservoir designs include open or closed systems. The open system displays graduated demarcations corresponding to blood volume in the container. The design is open to atmosphere, allowing blood to interface with atmospheric gasses. The pliable bag of the closed system eliminates the air-blood interface, while still being exposed to atmospheric pressure. Volume is measured by weight or by change in radius of the container. The closed reservoir collapses when emptied, as an additional safety feature.

Bubble oxygenators use the reservoir for ventilation. When the reservoir is examined from the exterior, the blood is already oxygen rich and appears bright red. As blood enters the reservoir, gaseous emboli are mixed directly with the blood. Oxygen and carbon dioxide are exchanged across the boundary layer of the blood and gas bubbles. The blood will then pass through a filter that is coated with an antifoam solution, which helps to remove fine bubbles. As blood pools in the reservoir, it has already exchanged carbon dioxide and oxygen. From here, tubing carries the blood to the rest of the heart-lung machine.

In opposition to this technique is the membrane oxygenator. Tubing carries the oxygen-poor blood from the reservoir through the pump to the membrane oxygenator. Oxygen and carbon dioxide cross a membrane that separates the blood from the ventilation gasses. As blood leaves the oxygenator, it is oxygen rich and bright red in color.

When blood is ready to be returned from the heart-lung machine to the patient, the arterial line filter will be encountered. This device is used to filter small air bubbles that may have entered, or been generated by, the heart-lung machine. Following this, filter tubing completes the blood path as it returns the blood to the arterial cannula to enter the body.



Fluid being returned from the left ventricle and surgical suction require filtration before the blood is reintroduced to the heart-lung machine. Blood enters a filtered reservoir, called a cardiotomy, which is connected with tubing to the venous reservoir. Other fluids such as blood products and medications are also added into the cardiotomy for filtration of particulate.

Heat exchangers allow body and organ temperatures to be adjusted. The simplest heat exchange design is a bucket of water. As the blood passes through the tubing placed in the bath, the blood temperature will change. A more sophisticated system separates the blood and water interface with a metallic barrier. As the water temperature is changed, so is the blood temperature, which enters the body or organ circulation, which changes the tissue temperature. Once the tissue temperature reaches the desired level, the water temperature is maintained. Being able to cool the blood helps to preserve the organ and body by metabolizing fewer energy stores.

Because respiration is being controlled, and a machine is meeting metabolic demand, it is necessary to monitor the patient's blood chemical makeup. Chemical sensors placed in the blood path are able to detect the amount of oxygen bound to hemoglobin. Other, more elaborate sensors can constantly trend the blood pH, partial pressure of oxygen and carbon dioxide, and electrolytes. This constant trending can quickly analyze the metabolic demands of the body.

Sensors that communicate system pressures are also a necessity. These transducers are placed in areas where pressure is high, after the pump. Readings outside of normal ranges often alert the operator to obstructions in the blood-flow path. The alert of high pressure must be corrected quickly as the heart-lung machine equipment may disengage under the stress of abnormally elevated pressures. Low-pressure readings can be just as serious, alerting the user to faulty connections or equipment. Constant monitoring and proper alarms help to protect the integrity of the system.

Constant scanning of all components and monitoring devices is required. Normal values can quickly change due to device failure or sudden mechanical constrictions. The diagnosis of a problem and quick troubleshooting techniques will prevent additional complications.

### Normal results

Continuous scanning of all patient monitors is necessary for proper treatment and troubleshooting. Documentation of patient status is obtained every 15–30 minutes. This information allows the physician and nursing staff to follow trends that will help better

manage the patient once treatment is discontinued. At the termination of device support, the perfusionist or ECMO specialist must communicate clearly to the physician all changes in support status. This allows the entire team to assess changes in patient parameters that are consistent with the patient becoming less dependent on the device, while the patient's heart and lungs meet the metabolic demands of the body.

It is the responsibility of the perfusionist or ECMO specialist to be at the device controls at all times.

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American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242 8721, <http://www.americanheart.org>.

Extracorporeal Life Support Organization, 1327 Jones Drive, Suite 101, Ann Arbor, MI, 48105, (734) 998 6601, <http://www.elso.med.umich.edu>.

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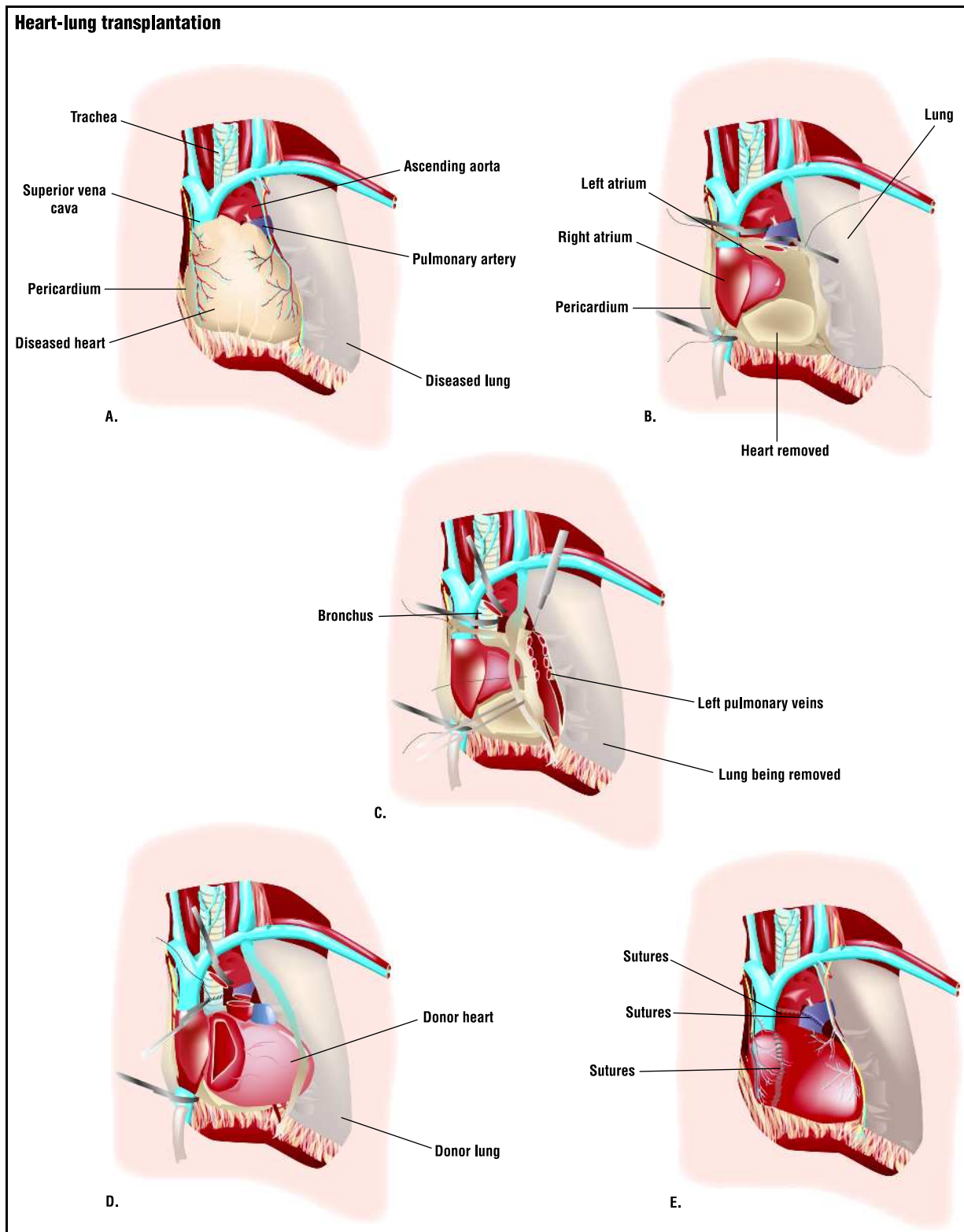
## Heart-lung transplantation

### Definition

Heart-lung transplantation is the surgical replacement of a person's severely diseased or dysfunctional heart and lungs with a healthy human donor heart and lungs.

### Purpose

Heart-lung transplantation is an uncommon operation. It is performed when the person has both end-stage lung disease and end-stage heart disease that



Chest is opened to expose the diseased heart and lung to be removed (A). Heart and lung function is taken over by a heart-lung machine. Major blood vessels are severed, and the heart is removed (B). Bronchus and blood vessels leading to the lung are severed, and the lung is removed (C). Donor heart and lung are placed in the patient's chest cavity (D). They are sutured to their appropriate connections, and the heart is restarted before the patient is taken off the heart-lung machine (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

do not respond to any other medical treatments. It is also sometimes performed on children with severe congenital heart defects. The purpose of **heart transplantation** is to extend and improve the life of a person who would otherwise die.

### Demographics

Heart-lung transplant recipients are not limited by sex, race, or ethnicity. Patients who are severely limited in daily activity, as defined by their doctors, and have a very limited life expectancy, may be candidates for heart-lung transplantation. Healthy donor hearts and lungs are in short supply, therefore, strict rules dictate criteria for transplant recipients. Patients who may be too sick to survive the surgery or the side effects of immunosuppressive therapy are not considered transplant candidates. Other factors that absolutely contraindicate (rule out) heart-lung transplantation include multiple organ system dysfunction, current substance abuse, bone marrow failure, active malignancy (cancer), and HIV infection. Other relative contraindications include age greater than 60, anorexia, obesity, peripheral and coronary vascular disease, ventilator support, steroid dependency, chest wall deformity, resistant bacterial or fungal infections, and certain psychiatric conditions.

According to the Organ Procurement and Transplantation Network, in the United States 961 heart-lung transplants were performed between 1988 and November 2007. Overall, slightly more women than men have received heart-lung transplants in the United States, and more than 800 of the recipients were white. Internationally 800–1,000 heart-lung transplants are performed each year.

### Description

Patients with end-stage heart and lung disease unresponsive to medical treatment must have a complete medical examination before they can be put on the transplant waiting list. Many types of tests are done, including blood tests, X-rays, and tests of heart, lung, and other organ function. The results of these tests indicate to doctors how serious the heart disease is and whether the patient is healthy enough to survive the **transplant surgery**.

#### *Patient-donor matching*

All patients placed on the waiting list are registered with the United Network for Organ Sharing (UNOS). UNOS has organ transplant specialists who run a national computer network that connects all the transplant centers and organ-donation organizations. Patients

### KEY TERMS

**Aorta**—The main artery that carries blood from the heart to the rest of the body. The aorta is the largest artery in the body.

**Cardiopulmonary bypass**—Mechanically circulating the blood with a heart-lung machine that bypasses the heart and lungs.

**Congenital defect**—A defect present at birth that occurs during the growth and development of the fetus in the womb.

**Coronary vascular disease**—Or cardiovascular disease; disease of the heart or blood vessels, such as atherosclerosis (hardening of the arteries).

**End-stage heart or lung failure**—Severe heart or lung disease that does not respond adequately to medical or surgical treatment.

**Nephrotoxicity**—A building up of poisons in the kidneys.

**Osteoporosis**—Loss of bone mass, causing bones to break easily.

**Pulmonary hypertension**—Increased blood pressure in the blood vessels of the lungs.

**Resistant infections**—Infections that are not cured by standard antibiotic treatment.

are grouped in terms of priority based on how long they can live without a transplant. The list is national and independent of the heart transplant center where the surgery will take place.

Established criteria for donor organ matching include the following:

- anatomic compatibility between the donor and recipient;
- immunologic compatibility between the donor and recipient;
- medical urgency; and
- location of the patient and donor.

The heart and lungs must be transplanted as quickly as possible, therefore, after anatomic and blood group compatibility have been determined, a list of local patients is checked first for a suitable match. After that, a regional list and then a national list are checked. The patient's transplant team of heart and lung transplant specialists makes the final decision as to whether a donor organ is suitable for the patient.

### *The transplant procedure*

Under **general anesthesia**, an incision is made in the patient's chest to access the heart and lungs. Anti-coagulation (anti-clotting) and antibiotic medications are provided, and cardiopulmonary bypass to a heart-lung machine is established. Blood flow through the heart is stopped by application of a clamp across the aorta. The surgeon removes the diseased organs. In the heart, the back parts of the patient's own right and left atriums are often left intact, along with the aorta beyond the coronary arteries. This provides large suture lines that allow decreased surgical time and result in fewer bleeding complications.

The donor heart is dissected to match the remaining native heart and aorta. The sutures are made to join the structures. Once completed, the cardiac chambers are filled with the patient's blood that is diverted away from the heart and lung machine. **Mechanical ventilation** of the donor lungs helps inflate the lung tissue.

### Diagnosis/Preparation

History, examination, and laboratory studies are performed before referral to a transplant center. These records are reviewed on-site for qualification to be placed on the United Network for Organ Sharing (UNOS) national waiting list. Procedures necessary for evaluation include a chest X-ray, arterial blood samples, air flow studies, ventilation and perfusion scanning (studies the exchange of oxygen with carbon dioxide in the lungs), and **cardiac catheterization** of both the right and left sides of the heart.

### Aftercare

The patient will be treated in the **intensive care unit** upon completion of the surgery, and cardiac monitoring will be continued. Medications for cardiac support will be continued until cardiac function stabilizes. Mechanical circulatory support may be continued until cardiac and respiratory functions improve. Ventilator support will be continued until the patient is able to breathe independently. After leaving the intensive care unit, the patient will spend a week or more in a special transplant unit. Medications to prevent organ rejection will be continued indefinitely, as will medications to prevent infection. The patient will be evaluated before discharge and provided with specific instructions to recognize infection and organ rejection. The patient will be given directions to contact the physician after discharge along with criteria for emergency room care.

### WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Cardiac surgeons and cardiovascular surgeons can be trained in transplantation surgery during their residency. Young adults and pediatric patients are treated at centers that specialize in the care of children.

### Risks

General anesthesia and cardiopulmonary bypass carry certain risks unassociated with the heart-lung transplant procedure. Graft rejection and technical failure are often a result of lung injury sustained during the stoppage and restarting of the organ. Infection by cytomegalovirus (CMV) often occurs in the first year, but is usually treatable. Immunosuppressive drugs to prevent rejection have side effects associated with malignancies, lymphomas or tumors of the skin and lips being most common. Osteoporosis and nephrotoxicity are also associated with the immunosuppressive therapies.

### Normal results

Lung and cardiac function are drastically improved after transplantation. Strenuous **exercise** may still be limited, but quality of life is greatly improved. The patient will continue with medical visits frequently throughout the first year, including required tissue biopsies to test for rejection and cardiac catheterizations. The frequency of medical visits will decrease after the first year, but invasive medical procedures will still be necessary. Medications to suppress rejection of the organs and prevent infection are continued.

### Morbidity and mortality rates

**Death** within the first 30 days is usually associated with technical and graft failure of the transplanted organ. Causes of death after 30 days often include immune system rejection of the transplant, infection of the airways or other infection, and the development of coronary artery disease. The one-year survival rate is 65%. The five-year survival rate is 40%.

Systemic hypertension (high blood pressure) is common at one year after surgery and can be relieved with medical treatment. Chronic bronchiolitis (infection of the airways) is expected in one-third of patients



## QUESTIONS TO ASK THE DOCTOR

- How many of these procedures have been performed at this center in the last year and last five years?
- How many of these procedures has the surgeon performed in the last year and last five years?
- What is the length of time spent on the waiting list for a patient with the pathology of the patient?
- What are the complications associated with this procedure?
- What are the complications associated with the duration of the transplantation?
- What type of limitations will be faced if the transplant is successful?
- How frequent will future medical visits be after the procedure during the first year and after that?

at five years. Hyperlipidemia (high lipid concentration in blood), diabetes mellitus, and kidney dysfunction are also seen in some patients within the first year of transplantation and continue to affect an increasing number of patients each year. Malignancies that include lymphoma and lip and skin tumors are seen at a higher rate than in general populations.

### Alternatives

There are no good alternatives when both heart and lungs are seriously diseased. Individuals with only end-stage heart disease sometimes do well with a ventricular-assist device that helps the heart pump. Individuals with end-stage lung disease but a healthy heart often do well with a lung transplant. When both organs are seriously diseased, there are few alternatives to a heart-lung transplant if a suitable donor can be found.

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#### ORGANIZATIONS

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242 8721, <http://www.americanheart.org>.

American Society of Transplantation, 15000 Commerce Parkway, Suite C, Mount Laurel, NJ, 08054, (856) 439 9986, <http://www.asot.org>.

National Heart, Lung and Blood Institute, National Institutes of Health, P.O. Box 30105, Bethesda, MD, 20824 0105, [NHLBIinfo@nhlbi.nih.gov](mailto:NHLBIinfo@nhlbi.nih.gov), <http://www.nhlbi.nih.gov>.

United Network for Organ Sharing, P.O. Box 2484, Richmond, VA, 23218, (804) 782 4800, <http://www.unos.org>.

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Heart catheterization see **Cardiac catheterization**

Heart defect surgery see **Heart surgery for congenital defects**

Heart resection see **Myocardial resection**

Heart sonogram see **Echocardiography**

## Heart surgery for congenital defects

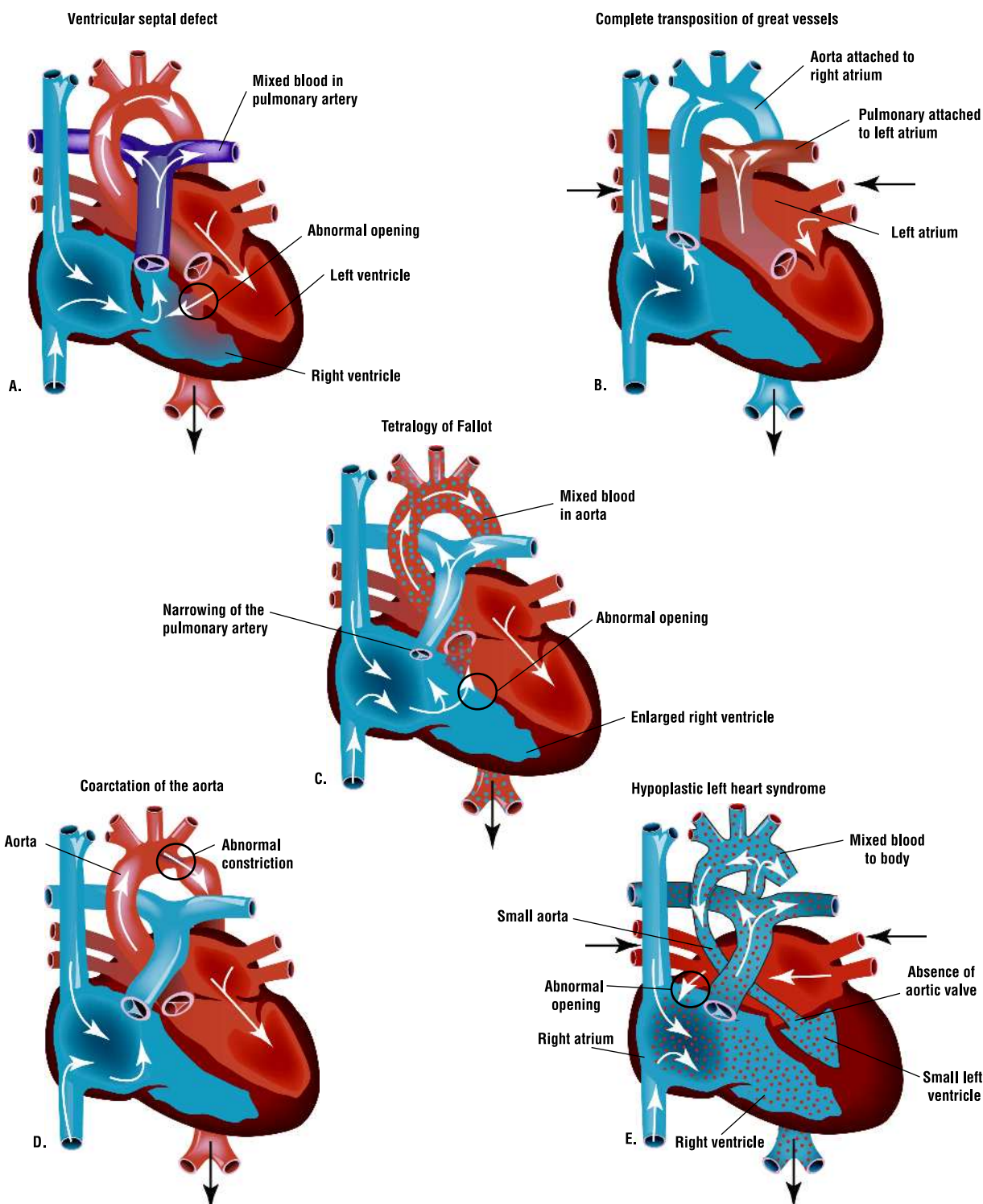
### Definition

Heart surgery for congenital defects consists of a variety of surgical procedures that are performed to repair the many types of heart defects that may be present at birth and can go undiagnosed into adulthood.

### Purpose

Heart surgery for congenital defects is performed to repair a defect, providing improved blood flow to the pulmonary and systemic circulations and better oxygen delivery to the body. Congenital heart defects that are symptomatic at birth must be treated with palliative or complete surgical repair. Defects that are not symptomatic at birth may be discovered later in life, and will be treated to relieve symptoms by palliative or complete surgical repair. Surgery is recommended for congenital heart defects that result in a lack of oxygen, a poor quality of life, or when a patient fails to thrive. Even lesions that are asymptomatic may be treated surgically to avoid additional complications later in life.

## Heart surgery for congenital defects



The most common types of congenital heart defects are ventricular septal defect (A), complete transposition of the great vessels (B), tetralogy of Fallot (C), coarctation of the aorta (D), and hypoplastic left heart syndrome (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Atresia**—Lack of development. In tricuspid atresia, the tricuspid valve has not developed. In pulmonary atresia, the pulmonary valve has not developed.

**Coarctation of the aorta**—A congenital defect in which severe narrowing or constriction of the aorta obstructs the flow of blood.

**Congenital heart defects**—Congenital (conditions that are present at birth) heart disease includes a variety of defects that occur during fetal development.

**Cyanotic**—Inadequate oxygen in the systemic arterial circulation.

**Mitral valve**—The heart valve connecting the left atrium and the left ventricle.

**Patent ductus arteriosus**—A congenital defect in which the temporary blood vessel connecting the left pulmonary artery to the aorta in the fetus fails to close in the newborn.

**Pulmonary valve**—The heart valve connecting the left atrium and the pulmonary arteries.

**Septal defects**—Openings in the septum, the muscular wall separating the right and left sides of the

heart. Atrial septal defects are openings between the two upper heart chambers and ventricular septal defects are openings between the two lower heart chambers.

**Stenosis**—A narrowing of the heart's valves.

**Tetralogy of Fallot**—A cyanotic defect in which the blood pumped through the body has too little oxygen. Tetralogy of Fallot includes four defects: a ventricular septal defect, narrowing at or beneath the pulmonary valve, infundibular pulmonary stenosis (obstruction of blood flow out of the right ventricle through the pulmonary valve), and overriding aorta (the aorta crosses the ventricular septal defect into the right ventricle).

**Transposition of the great vessels**—A cyanotic defect in which the blood pumped through the body has too little oxygen because the pulmonary artery receives its blood incorrectly from the left ventricle and the aorta incorrectly receives blood flow from the right ventricle.

**Tricuspid valve**—The heart valve connecting the right atrium and right ventricle.

## Demographics

Congenital heart disease is estimated to involve less than 1% of all live births. As some defects are not found until later in life, or may never be diagnosed, this number may actually be higher. Many congenital defects are often incompatible with life leading to miscarriage and stillbirths. During a child's first year of life, the most common defects that are symptomatic include ventricular septal defect (VSD), transposition of the great vessels (TGV), tetralogy of Fallot, coarctation of the aorta, and hypoplastic left heart syndrome. Premature infants have an increased presentation of VSD and patent ductus arteriosus. Diabetic mothers have infants with a higher incidence of congenital heart defects than non-diabetic mothers. Abnormal chromosomes increase the incidence of congenital heart defects. Specific to trisomy 21 (Down syndrome), 23–56% of infants have a congenital heart defect.

## Description

Congenital heart defects can be named by a number of specific lesions, but may have additional lesions. Classification best describes lesions by the amount

of pulmonary blood flow (increased or decreased pulmonary blood flow) or the presence of an obstruction to blood flow. The dynamic circulation of the newborn as well as the size of the defect will determine the symptoms. Recommended ages for surgery for the most common congenital heart defects are:

- atrial septal defects: during the preschool years
- patent ductus arteriosus: between ages one and two
- coarctation of the aorta: in infancy, if it is symptomatic, at age four otherwise
- tetralogy of Fallot: age varies, depending on the patient's symptoms
- transposition of the great arteries: often in the first weeks after birth, but before the patient is 12 months old

Surgical procedures seek to repair the defect and restore normal pulmonary and systemic circulation. Sometimes, multiple, serial surgical procedures are necessary.

Many congenital defects are often associated so that the surgical procedures described may be combined for complete repair of a specific congenital defect.

Repair for simple cardiac lesions can be performed in the **cardiac catheterization** lab. Catheterization procedures include balloon atrial septostomy and **balloon valvuloplasty**. Surgical procedures include arterial switch, Damus-Kaye-Stansel procedure, Fontan procedure, Ross procedure, shunt procedure, and venous switch or intra-atrial baffle.

### *Catheterization procedures*

Balloon atrial septostomy and balloon valvuloplasty are cardiac catheterization procedures. Cardiac catheterization procedures can save the lives of critically ill neonates and, in some cases, eliminate or delay more invasive surgical procedures. It is expected that catheterization procedures will continue to replace more types of surgery for congenital heart defects in the future. A thin tube called a catheter is inserted into an artery or vein in the leg, groin, or arm and threaded into the area of the heart that needs repair. The patient receives a local anesthetic at the insertion site. General anesthetic or sedation may be used.

**BALLOON ATRIAL SEPTOSTOMY.** Balloon atrial septostomy is the standard procedure for correcting transposition of the great arteries; it is sometimes used in patients with mitral, pulmonary, or tricuspid atresia. (Atresia is lack of or poor development of a structure.) Balloon atrial septostomy enlarges the atrial septal opening, which normally closes in the days following birth. A special balloon-tipped catheter is inserted into the right atrium and passed into the left atrium. The balloon is inflated in the left atrium and pulled back across the septum to create a larger opening in the atrial septum.

**BALLOON VALVULOPLASTY.** Balloon valvuloplasty uses a balloon-tipped catheter to open a stenotic (narrowed) heart valve, improving the flow of blood through the valve. It is the procedure of choice in pulmonary stenosis and is sometimes used in aortic and mitral stenosis. A balloon is placed beyond the valve, inflated, and pulled backward across the valve.

### *Surgical procedures*

These procedures are performed under **general anesthesia**. Some require the use of a heart-lung machine, which takes over for the heart and lungs during the procedure, providing cardiopulmonary bypass. The heart-lung machine can cool the body to reduce the need for oxygen, allowing deep hypothermic circulatory arrest (DHCA) to be performed. DHCA benefits the surgeon by creating a bloodless surgical field.

**ARTERIAL SWITCH.** Arterial switch is performed to correct transposition of the great vessels, where the position of the pulmonary artery and the aorta are reversed. The procedure involves connecting the

aorta to the left ventricle and the pulmonary artery to the right ventricle.

**DAMUS-KAYE-STANSEL PROCEDURE.** Transposition of the great vessels can also be corrected by the Damus-Kaye-Stansel procedure, in which the pulmonary artery is cut in two and connected to the ascending aorta and right ventricle.

**VENOUS SWITCH.** For transposition of the great vessels, venous switch creates a tunnel inside the atria to redirect oxygen-rich blood to the right ventricle and aorta and venous blood to the left ventricle and pulmonary artery. This procedure differs from the arterial switch and Damus-Kaye-Stansel procedures in that blood flow is redirected through the heart.

**FONTAN PROCEDURE.** For tricuspid atresia and pulmonary atresia, the Fontan procedure connects the right atrium to the pulmonary artery directly or with a conduit, and the atrial septal defect is closed.

**PULMONARY ARTERY BANDING.** Pulmonary artery banding is narrowing the pulmonary artery with a band to reduce blood flow and pressure in the lungs. It is used for temporary repair of ventricular septal defect, atrio-ventricular canal defect, and tricuspid atresia. Later, the band can be removed and the defect corrected with a complete repair once the patient has grown.

**ROSS PROCEDURE.** To correct aortic stenosis, the Ross procedure grafts the pulmonary artery to the aorta.

**SHUNT PROCEDURE.** For tetralogy of Fallot, tricuspid atresia, or pulmonary atresia, the shunt procedure creates a passage between blood vessels, directing blood flow into the pulmonary or systemic circulations.

**OTHER TYPES OF SURGERY.** Surgical procedures are also used to treat common congenital heart defects. To close a medium to large ventricular or atrial septal defect, it is recommended that it be sutured or covered with a Dacron patch. For patent ductus arteriosus, surgery consists of dividing the ductus into two and tying off the ends. If performed within the child's first few years, there is practically no risk associated with this operation. Surgery for coarctation of the aorta involves opening the chest wall, removing the defect, and reconnecting the ends of the aorta. If the defect is too long to be reconnected, a Dacron graft is used to replace the missing piece.

## **Diagnosis/Preparation**

Before surgery for congenital heart defects, the patient will receive a complete evaluation, which includes a physical exam, a detailed family history, a **chest x ray**, an **electrocardiogram**, an echocardiogram, and usually, cardiac catheterization. Blood tests will be performed to measure formed blood elements, electrolytes, and blood



## WHO PERFORMS THIS PROCEDURE AND WHERE IS IT PERFORMED?

Pediatric cardiologists and cardiac surgeons specialize in treatment of congenital defects. Hospitals dedicated to the care of children may provide cardiac surgery services. Congenital defects diagnosed at birth may require immediate transport of the infant to a facility that can provide timely treatment.

glucose. Additional tests for sickle cell and digoxin levels may be performed, if applicable. For six to eight hours before the surgery, the patient cannot eat or drink anything.

### Aftercare

After heart surgery for congenital defects, the patient goes to an **intensive care unit** for continued cardiac monitoring. The patient may also require continued ventilator support. Chest tubes allow blood to be drained from inside the chest as the surgical site heals. Pain medications will be continued, and the patient may remain under general anesthetic. Within 24 hours, the chest tubes and ventilation may be discontinued. Any cardiac drugs used to help the heart perform better will be adjusted appropriate with the patient's condition.

For temporary procedures, additional follow-up with the physician will be required to judge timing for complete repair. In the meantime, the patient should continue to grow and thrive normally. Complete repair requires follow-up with the physician initially to judge the adequacy of repair, but thereafter will be infrequent with good prognosis. The child should be made aware of any procedure to be communicated for future medical care in adulthood.

### Risks

Depending on the institution and the type of congenital defect repair, many risks can be identified, including shock, congestive heart failure, lack of oxygen or too much carbon dioxide in the blood, irregular heartbeat, stroke, infection, kidney damage, lung blood clot, low blood pressure, hemorrhage, cardiac arrest, and **death**. These risks should not impede the surgical procedure, as death is certain without surgical treatment. Neurological dysfunction in the postoperative period occurs in as much as 25% of surgical patients. Seizures are expected in 20% of cases, but are usually limited with no long-

## QUESTIONS TO ASK THE DOCTOR

- What type of congenital defect has been diagnosed?
- What type of palliative and corrective surgical options are available, and what are the risks associated with each?
- Where can more information about the congenital defect and its surgical procedures be found?
- When will the repair be made?
- How many procedures of this type has the surgeon completed, and what are the surgeon-specific outcome statistics?
- What type of care will the child require until the repair can be made?
- What types of limitations are expected prior to and after the surgical procedure?
- What type of mental health support is provided for parents or caregivers?
- What type of continued care is provided for after the hospital stay?
- What type of financial support is available for the family and caregivers?

term effects. Additional risks include blood **transfusion** reactions and blood-borne pathogens.

### Morbidity and mortality rates

Use of cardiopulmonary bypass has associated risks not related to the congenital defect repair. Procedures performed in association with cardiac catheterization have excellent long-term results, with an associated mortality of 2–4% of procedures. The Fontan procedure carries a survival rate of over 90%. Surgical procedures to repair coarctation of the aorta, in uncomplicated cases, has a risk of operative mortality from 1–2%.

### Alternatives

Alternatives are limited for this patient population. Cardiac transplant is an option, but a limited number of organ donors restrict this treatment. Ventricular-assist devices and total artificial heart technology are not yet a suitable option. Temporary procedures do allow additional growth of the patient prior to corrective surgery, allowing them to gain strength and size before treatment.

## Resources

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### ORGANIZATIONS

- American Heart Association. 7320 Greenville Ave., Dallas, TX 75231. (214) 373 6300. <http://www.americanheart.org>.
- Children’s Health Information Network. 1561 Clark Drive, Yardley, PA 19067. (215) 493 3068. <http://www.tchin.org>.
- Congenital Heart Anomalies Support, Education & Resources, Inc. 2112 North Wilkins Road, Swanton, OH 43558. (419) 825 5575. <http://www.csun.edu/~hfmth006/chaser>.
- Texas Heart Institute. Heart Information Service. P.O. Box 20345, Houston, TX 77225 0345. <http://www.tmc.edu/thi>.

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## Heart transplantation

### Definition

Heart transplantation, also called cardiac transplantation, is the replacement of a patient’s diseased or injured heart with a healthy donor heart.

## Purpose

Heart transplantation is performed on patients with end-stage heart failure or some other life-threatening heart disease. Before a doctor recommends heart transplantation for a patient, all other possible treatments for his or her disease must have been attempted. The purpose of heart transplantation is to extend and improve the life of a person who would otherwise die from heart failure. Most patients who receive a new heart are so sick before transplantation that they cannot live a normal life. Replacing a patient’s diseased heart with a healthy, functioning donor heart often allows the recipient to return to normal daily activities.

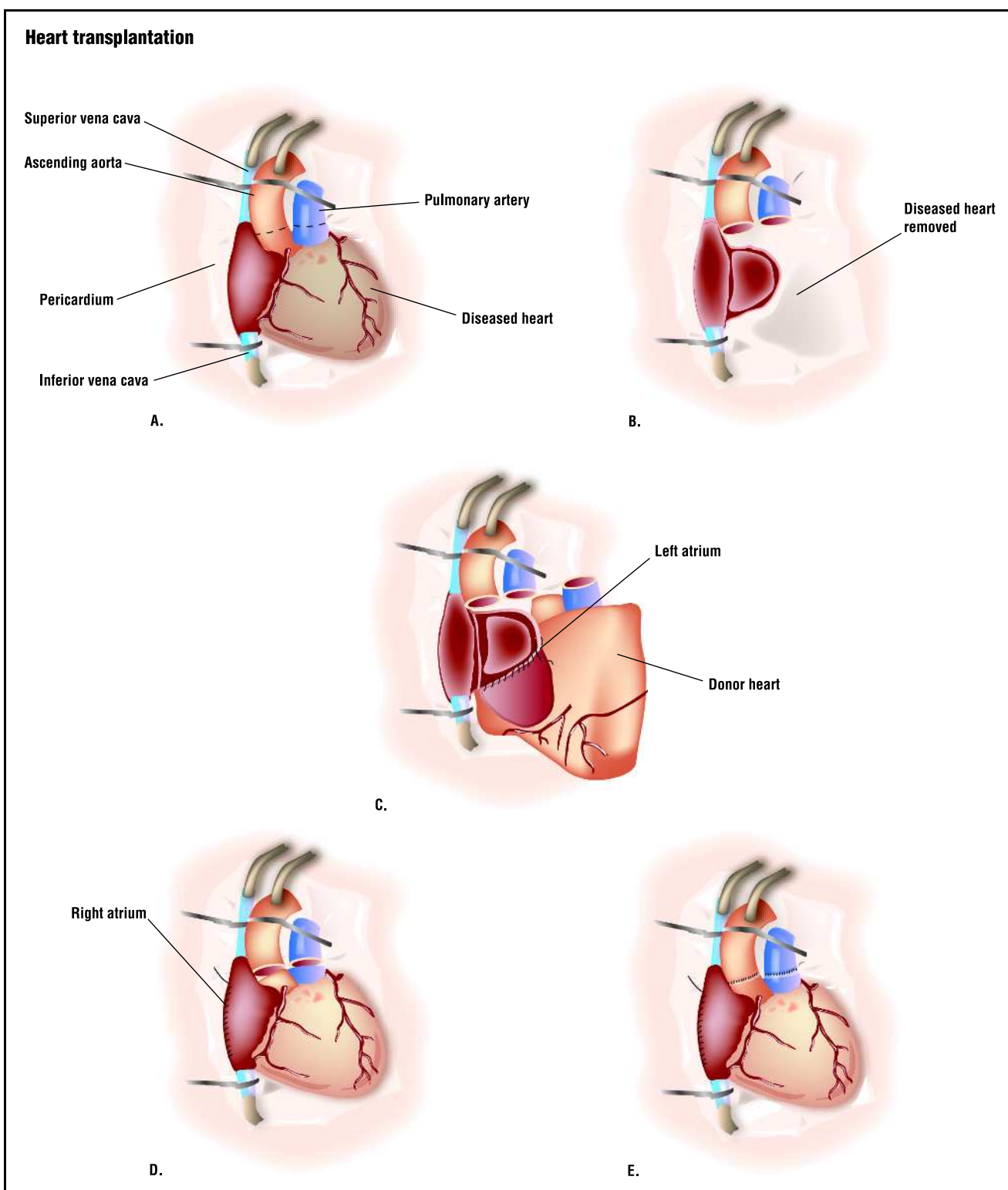
## Demographics

Heart transplant recipients are not limited by sex, race, or ethnicity. Nevertheless, because healthy donor hearts are in short supply, strict rules dictate criteria for heart transplant recipients. Patients who may be too sick to survive the surgery or the side effects of immunosuppressive therapy would not be good transplant candidates.

In 2008, according to the Organ Procurement and Transplantation Network, 2,030 heart transplants were performed in the United States, bringing the total performed since 1988 to 49,132. Of these, people between the ages of 50 and 64 were most likely to receive a heart transplant, while children ages 6–10 were least likely to have heart transplantation surgery. In 2007, men received almost three times more heart transplants than women, and whites had more than twice as many heart transplants as all other races/ethnicities combined. The primary diagnoses of adult patients receiving heart transplantation include coronary artery disease, cardiomyopathy, congenital heart diseases, and retransplantation associated with organ rejection.

These conditions are contraindications for heart transplantation:

- active infection;
- pulmonary hypertension;
- chronic lung disease with loss of more than 40% of lung function;
- untreatable liver or kidney disease;
- diabetes that has caused serious damage to vital organs;
- disease of the blood vessels in the brain, such as a stroke;
- serious disease of the arteries;



For a heart transplantation, the area around the heart is exposed through a chest incision (A). The blood vessels leading to the heart are clamped, and the heart function is replaced by a heart-lung machine. The diseased heart is removed (B). The donor heart is placed in the chest, and the left atrium is attached (C). The right atrium is connected (D), and the aorta and pulmonary artery are finally attached (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Angina**—Also called angina pectoris, chest pain or discomfort that occurs when diseased blood vessels restrict blood flow to the heart.

**Cardiopulmonary bypass**—Mechanically circulating the blood with a heart-lung machine that bypasses the heart and lungs.

**Complete blood count (CBC)**—A blood test to check the numbers of red blood cells, white blood cells, and platelets in the blood.

**Coronary artery disease**—Also called atherosclerosis, it is a build-up of fatty matter and debris in the coronary artery wall that causes narrowing of the artery.

**Cross-match**—A test to determine if patient and donor tissues are compatible.

**Echocardiogram**—An imaging procedure used to create a picture of the heart's movement, valves, and chambers.

**Electrocardiogram (ECG)**—A test that measures electrical impulses in the heart.

**End-stage heart failure**—Severe heart disease that does not respond adequately to medical or surgical treatment.

**Endomyocardial biopsy**—Removal of a small sample of heart tissue to check it for signs of damage caused by organ rejection.

**Graft**—To implant living tissue surgically. Graft also refers to the tissue that is transplanted.

**Pulmonary hypertension**—An increase in the pressure in the blood vessels of the lungs.

- mental illness or any condition that would make a patient unable to take the necessary drugs and treatments on schedule; or
- continuing alcohol or drug abuse.

## Description

Patients with end-stage heart disease unresponsive to medical treatment may be considered for heart transplantation. Potential candidates must have a complete medical examination before they can be put on the transplant waiting list. Many types of tests are done, including blood tests, x rays, and tests of heart, lung, and other organ function. The results of these tests indicate to doctors how serious the heart disease is

and whether the patient is healthy enough to survive the **transplant surgery**.

### *Organ waiting list*

A person approved for heart transplantation is placed on the heart transplant waiting list. Patients requesting a heart transplant must be under age 69 at the time they join the list; once on the list they may remain on past that age. All patients on the waiting list are registered with the United Network for Organ Sharing (UNOS). UNOS has organ transplant specialists who run a national computer network that connects all the transplant centers and organ-donation organizations. Patients are grouped in terms of priority based on how long they can live without a transplant. The list is national and independent of the heart transplant center where the surgery will take place. As of 2008, there were 141 UNOS-approved heart transplant programs.

The need for donated hearts outweighs the supply. At any given time, about 3,000 people are waiting for hearts, while only about 2,200 hearts are available each year. When a donor heart becomes available, information about the donor heart is entered into the UNOS computer and compared to information about patients on the waiting list. The computer program produces a list of patients ranked according to blood type, size of the heart, and how urgently they need a heart. Because the heart must be transplanted as quickly as possible, a list of local patients is checked first for a good match. After that, a regional list and then a national list are checked. The patient's transplant team of heart and transplant specialists makes the final decision as to whether a donor heart is suitable for the patient.

### *The transplant procedure*

When a heart becomes available and is approved for a patient, it is packed in a sterile cold solution and rushed to the hospital where the recipient is waiting. The heart can safely remain outside the body for only about four hours, so speed is critical. The recipient will be contacted to return immediately to the hospital if chronic care occurs outside of the hospital.

A general description of the transplant procedure follows. If the operation goes well, the actual surgery takes about three hours.

- The patient undergoes final pre-operative blood work and testing.
- General anesthesia is provided by an anesthesiologist experienced with cardiac patients.



- Intravenous antibiotics are given to prevent bacterial wound infections.
- The patient is put on a heart/lung machine, which performs the functions of the heart and lungs by pumping the blood to the rest of the body during surgery. This procedure is called cardiopulmonary bypass.
- Once the donor heart has arrived to the operating room, the patient's diseased heart is removed.
- The donor heart is attached to the patient's blood vessels, including the atria, pulmonary artery, and aorta.
- After the blood vessels are connected, the new heart is perfused with the patient's blood and begins beating. If the heart does not begin to beat immediately, the surgeon may use defibrillation (electric shock) to gain a productive rhythm.
- The patient is taken off the heart-lung machine.
- The new heart is stimulated to maintain a regular beat with medications and/or a pacemaker for two to five days after surgery, until the new heart functions normally on its own.

Heart transplant recipients are given immunosuppressive drugs to prevent the body from rejecting the new heart. These drugs are usually started before or during the heart transplant surgery. Immunosuppressive drugs keep the body's immune system from recognizing and attacking the new heart as foreign tissue. Normally, immune system cells recognize and attack foreign or abnormal cells such as bacteria, cancer cells, and cells from a transplanted organ. The drugs suppress the immune cells and allow the new heart to function properly; however, they can also allow infections and other adverse effects to occur to the patient because the patient's natural resistance to infections is suppressed.

The chance of rejection is highest during the first few months after the transplantation, therefore, recipients are usually given a combination of three or four immunosuppressive drugs in high doses during this time. Afterwards, they must take maintenance doses of immunosuppressive drugs for the rest of their lives.

### *Cost and insurance coverage*

The total cost for heart transplantation varies considerably, depending on where it is performed, whether transportation and lodging are needed, and whether there are any complications. The National Foundation for Transplants estimates that the cost for uncomplicated heart transplantation surgery in 2007 was about \$350,000. This does not include pre-operative care and post-operative follow-up visits.

Insurance coverage for heart transplantation varies, depending on the policy. Most commercial insurance

companies pay a fixed percentage of heart transplant costs. **Medicare** pays for heart transplants if the surgery is performed at Medicare-approved centers. **Medicaid** pays for heart transplants in some states. Social workers at the transplant center can help patients and their families figure out their insurance coverage and put them in touch with non-profit organizations that help transplant recipients when insurance is inadequate.

## Diagnosis/Preparation

Before patients are put on the transplant waiting list, their blood type is determined so a compatible donor heart can be found. The heart must come from a person with the same blood type as the patient, unless it is blood type O negative. A blood type O negative heart is a universal donor and is suitable for any patient regardless of blood type.

A panel reactive antibodies (PRA) test is also done before heart transplantation. This test tells doctors whether the patient is at high risk for having a hyperacute reaction against a donor heart. A hyperacute reaction is a strong immune response against the new heart that happens within minutes to hours after the new heart is transplanted. If the PRA shows that a patient has a high risk for this kind of reaction, then a cross-match is done between a patient and a donor heart before transplant surgery. A cross-match checks how close the match is between the patient's tissue type and the tissue type of the donor heart. Most people are not high risk, and a cross-match usually is not done before the transplant because the surgery must be done as quickly as possible after a donor heart is found.

While waiting for heart transplantation, patients are given treatment to keep the heart as healthy as possible. They are regularly checked to make sure the heart is pumping enough blood. Intravenous medications may be used to improve cardiac output. If these drugs are not effective, a ventricular-assist device can maintain cardiac output until a donor heart becomes available.

## Aftercare

Immediately following surgery, patients are monitored closely in the **intensive care unit (ICU)** of the hospital for 24–72 hours. Most patients need to receive oxygen for four to 24 hours following surgery. Continuous cardiac monitoring is used to diagnose and treat donor heart function. Renal, liver, brain, and pulmonary functions are carefully monitored during this time. Patients are then moved to a transplant unit where they remain a week or more.

Heart transplant patients start taking immunosuppressive drugs before or during surgery to prevent immune rejection of the heart. High doses of immunosuppressive drugs are given at this time because rejection is most likely to happen within the first few months after the surgery. A few months after surgery, lower doses of immunosuppressive drugs usually are given, and then must be taken for the rest of the patient's life.

For about three months after the transplant surgery, patients usually come back to the transplant center twice a week for physical examinations and medical tests. These check for signs of infection, rejection of the new heart, or other complications.

In addition to **physical examination**, the following tests may be done during these visits:

- laboratory tests to check for infection;
- **chest x ray** to check for early signs of lung infection;
- electrocardiogram (ECG) to check heart function;
- echocardiogram to check the function of the ventricles in the heart;
- blood tests to check liver and kidney function;
- complete blood counts (CBC) to check the numbers of blood cells; and
- taking of a small tissue sample from the donor heart (endomyocardial biopsy) to check for signs of rejection.

During the physical examination, blood pressure is checked and heart sounds are monitored with a **stethoscope** to determine if the heart is beating properly and pumping enough blood. Kidney and liver functions are checked because these organs may lose function if the heart is being rejected.

An endomyocardial biopsy is the removal of a small sample of the heart muscle. This is done by **cardiac catheterization**. The heart muscle tissue is examined under a microscope for signs that the heart is being rejected. Endomyocardial biopsy is usually done weekly for the first four to eight weeks after transplant surgery, and then at longer intervals after that.

### Risks

The most common and dangerous complications of heart transplant surgery are organ rejection and infection. Immunosuppressive drugs are given to prevent rejection of the heart. Most heart transplant patients have a rejection episode soon after transplantation. Rapid diagnosis ensures quick treatment, and when the response is quick, drug therapy is most successful. Rejection is treated with combinations of immunosuppressive drugs given in higher doses than immunosuppressive maintenance. Most of these rejection situations are successfully treated.

## WHO PERFORMS THIS PROCEDURE AND WHERE IS IT PERFORMED?

In 2008, there were 141 UNOS-approved transplant programs in the United States. To meet criteria to be listed with UNOS, centers must perform 12 cardiac transplants per year with a one-year survival of 70%. A cardiac surgeon and surgical team with additional training in transplant surgery will perform the operation.

Infection can result from the surgery, but most infections are a side effect of the immunosuppressive drugs. Immunosuppressive drugs keep the immune system from attacking the foreign cells of the donor heart; however, the suppressed immune cells are then unable to adequately fight bacteria, viruses, and other microorganisms. Microorganisms that normally do not affect persons with healthy immune systems can cause dangerous infections in transplant patients taking immunosuppressive drugs.

Patients are given **antibiotics** during surgery to prevent bacterial infection. They may also be given an antiviral drug to prevent virus infections. Patients who develop infections may need to have their immunosuppressive drugs changed or the dose adjusted. Infections are treated with antibiotics or other drugs, depending on the type of infection.

Other complications that can happen immediately after surgery are:

- bleeding;
- pressure on the heart caused by fluid in the space surrounding the heart (pericardial tamponade);
- irregular heart beats;
- reduced cardiac output;
- increased amount of blood in the circulatory system; and
- decreased amount of blood in the circulatory system.

Up to half of all heart transplant patients develop coronary artery disease one to five years after the transplant. The coronary arteries supply blood to the heart. Patients with this problem develop chest pains called angina. Other names for this complication are coronary allograft vascular disease and chronic rejection.

### Normal results

Heart transplantation is an appropriate treatment for many patients with end-stage heart failure. The outcomes of heart transplantation depend on the

## QUESTIONS TO ASK THE DOCTOR

- Is the transplant center listed with UNOS?
- How many transplants have been performed at this center in the last year, and what is the one-year survival rate?
- May I be introduced to the transplant coordinator and any other physicians who may be involved in patient care?
- What precautions are in place to guarantee that the donor heart will be a correct match?
- If the donor heart is rejected, what is the likelihood of another donor heart becoming available?
- Given my situation, how long do you think the wait on the transplant list will be?
- What type of medical treatment will be supplied while awaiting cardiac transplantation?
- What alternative therapies are available?

patient's age, health, and other factors. According to a year 2004 data collected by the Organ Procurement and Transplantation Network, 88% of transplant recipients survive one year. During the first year, infection and acute rejection are the leading causes of **death**. The three-year survival rate is 82% and the five-year survival rate is 79%.

After transplant, most patients regain normal heart function, meaning the heart pumps a normal amount of blood. A transplanted heart usually beats slightly faster than normal because the heart nerves are cut during surgery. The new heart also does not increase its rate as quickly during **exercise**. Even so, most patients feel much better and their capacity for exercise is dramatically improved from before they received the new heart. About 90% of survivors at five years will have no symptoms of heart failure. Patients return to work and other daily activities. Many are able to participate in sports.

### Alternatives

End-stage heart disease is associated with a high mortality rate even with associated medical treatment. A ventricular-assist device can be a viable alternative for patients not eligible for cardiac transplant or who are awaiting a donor heart. Such therapies as the total artificial heart may provide other alternatives for the transplant candidate in the future.

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- American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242 8721, <http://www.americanheart.org>.
- American Society of Transplantation, 15000 Commerce Parkway, Suite C, Mount Laurel, NJ, 08054, (856) 439 9986, <http://www.a s t.org>.
- National Heart, Lung and Blood Institute, National Institutes of Health, P.O. Box 30105, Bethesda, MD, 20824 0105, [NHLBIinfo@nhlbi.nih.gov](mailto:NHLBIinfo@nhlbi.nih.gov), <http://www.nhlbi.nih.gov>.
- United Network for Organ Sharing, P.O. Box 2484, Richmond, VA, 23218, (804) 782 4800, <http://www.unos.org>.

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Heart valve repair see **Mitral valve repair**  
Heart valve replacement see **Mitral valve replacement; Aortic valve replacement**

## Heller myotomy

### Definition

A Heller myotomy, also called esophagomyotomy, is a surgical procedure during which the muscles of the lower part of the esophagus are cut. This operation is used to treat a condition called "achalasia," in which spasms of the esophagus prevent the normal passage of liquids and food into the stomach.

### Purpose

The esophagus is a muscular tube leading from the throat into the stomach. The upper zone of the esophagus is attached to the throat. It is a muscular ring referred to as the "upper esophageal sphincter," or UES, and is responsible for preventing swallowed food and liquid from passing upward from the esophagus and back into the throat. The lowest area of the

esophagus is referred to as the “lower esophageal sphincter,” or LES. This area joins with the upper part of the stomach, the cardia. A swallowing disorder is the result of the LES’s inability to relax. Cutting the LES can relieve this problem, allowing normal eating and drinking to take place.

Achalasia can be either primary or secondary. Primary achalasia occurs on its own, and is a disorder of the LES itself; no other underlying disorder accounts for the condition. Secondary achalasia occurs when there is another disease that has affected LES functioning. The two most common underlying conditions that can result in achalasia are esophageal cancer and Chagas disease. Symptoms of achalasia include difficulty swallowing, regurgitation, and weight loss.

Men are three to four times more likely to develop esophageal cancer than are women, and African-Americans are about 50% more likely to develop the condition. According to the American Cancer Society, about 16,470 new cases of esophageal cancer will be diagnosed in the United States in 2008, and the disease will be responsible for about 14,280 deaths. The disease is much more common in other countries, such as Iran, northern China, India, and southern Africa, where rates are between ten and 100 times as high as they are in the United States. Still, esophageal cancer rates among white men in Western countries are increasing steadily, at a rate of about 2% per year; the rate has held steady among white women. Among patients diagnosed at all stages of esophageal cancer, five-year survival rates are about 18% in white patients and 11% in African-American patients.

Chagas disease is a parasitic disease found primarily in South America. This protozoan infection is passed to humans during the bite of a bug colloquially referred to as an “assassin bug.” It can also be acquired during infected blood transfusions, when food is infected with the protozoa, and by a fetus if its mother is infected. Chagas disease has two phases, acute and chronic. It is during the chronic phase that the lower esophageal sphincter may be affected, causing achalasia.

Achalasia often requires treatment because it can cause a number of complications. Patients with achalasia often suffer from the discomfort of heartburn or gastroesophageal reflux disease. Additionally, the constant exposure of the vulnerable lining of the esophagus to a backwash of stomach acid may result in a condition called Barrett’s esophagus. This occurs when the lining cells begin to take on pre-malignant characteristics, and patients have a high risk of eventually developing esophageal cancer. When foods and

liquids cannot be fully swallowed, they may also be sucked into the lungs, putting the individual at risk for aspiration pneumonia.

### Precautions

Patients who are taking blood thinners, aspirin, or nonsteroidal anti-inflammatory medications may need to discontinue their use in advance of the test, to avoid increasing the risk of bleeding.

### Description

Patients undergoing Heller myotomy require general anesthesia. This will be administered in the form of intravenous medications as well as anesthetic gasses that are inhaled. The patient will be intubated and on a ventilator for the duration of the surgery.

A Heller myotomy can be achieved through a traditional upper abdominal incision, or through multiple very small laparoscopic incision. These days, the laparoscopic approach is most common. Laparoscopic Heller myotomy involves the introduction of a video-scope through one of the keyhole incisions, and the use of other tiny incisions for introducing the miniature surgical instruments necessary for the operation. Once the esophagus is accessed, a lengthwise incision through the outer muscular layer is made. Sometimes, a bit of the stomach is wrapped around the lower part of the esophagus and secured, to try to avoid further gastric reflux. This is referred to as a fundoplication.

### Preparations

Patients will need to stop eating and drinking for about 12–16 hours prior to their operation. The evening before the operation, a series of enemas and/or laxatives are used to empty the GI tract of feces. An intravenous line will be placed in order to provide the patient with fluids, general anesthesia agents, sedatives, and pain medicines during the operation. A urinary catheter will be placed in the patient’s bladder. The patient will be attached to a variety of monitors to keep track of blood pressure, heart rate, and blood oxygen level throughout the procedure.

### Aftercare

The hospital stay after Heller myotomy is usually 2–3 days. Clear liquids are introduced on the same day as the surgery, and within a few days the patient will be allowed to begin taking soft foods. Over time, the patient’s diet will slowly be reinstated, progressing gradually from liquids to soft foods to solids. If swallowing remains problematic, a therapist specializing in



re-teaching swallowing may be needed to help design a rehabilitative program.

### Risks

During the course of a Heller myotomy, there is some risk that the esophagus will become perforated by one of the surgical instruments. Patients who have had a Heller myotomy have a continued high risk of gastric esophageal reflux. Many patients require re-treatment, either another myotomy or removal of a section of esophagus (esophagectomy).

The risk of perforation during Heller myotomy is about 1%. The risk of death is about 0.2%. In general, studies have shown that hospital and surgeon experience with esophagogastrectomy reduces the risk of morbidity and mortality for patients.

### Normal results

Normal results occur when the overly tight LES is released, allowing the normal passage of food and liquids through the esophagus and into the stomach.

### Abnormal results

Abnormal results include a continued inability to swallow or inadvertent perforation of the esophagus during surgery.

### Resources

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Rosalyn Carson-DeWitt, MD

## Hemangioma excision

### Definition

Hemangioma excision is the use of surgical techniques to remove benign tumors made up of blood vessels that are often located within the skin. Strawberry hemangiomas are often called strawberry birthmarks.

Hemangioma surgery involves the removal of the abnormal growth in a way that minimizes both physical and psychological scarring of the patient.

### Purpose

Almost all hemangiomas will undergo a long, slow regression, known as involution, without treatment. The end result of involution is potentially worse than the scarring that would occur with surgery. Thus, surgical intervention is commonly indicated only if the growth of the tumor is life threatening or highly problematic from a medical or psychosocial point of view. For example, tumor growths that affect the ability of the eye to see, the ear to hear, or the passage of air in and out of the lungs are frequently candidates for surgical treatment. Tumors that have ulcerated are also common candidates for surgical treatment. Surgery after involution can be used to remove remaining scar tissue.

Although controversial, some surgeons also recommend surgery before or during the involution process, in an attempt to minimize the final cosmetic deformity. Small lesions that are in areas that can be excised without cosmetic or functional risk are particularly well-suited to early surgical treatment.

### Demographics

Hemangiomas are the most common tumor of infancy, occurring in approximately 10–12% of all white children and are nearly twice as common in premature infants. For unknown reasons, the occurrence in children of black or Asian background is much lower, approximately 0.8–1.4%. The tumors have been reported to be from two to six times more common in females than in males. The great majority of these tumors are located in the head and neck, with the remaining appearing throughout the body, including internally.

At present, an estimated 60% of patients with hemangiomas require some form of corrective surgery sometime during recovery from the tumor surgery. The remaining 40% rely on the spontaneous involution process to resolve the lesion, although complete return to normalcy is extremely rare.

### Description

Hemangiomas undergo a characteristic set of stages during the tumor development. Approximately 30% are present at birth, with the remainder appearing within the first few weeks of life, often beginning as

## KEY TERMS

**Angiography**—An x ray of the blood vessels after introduction of a medium that increases the contrast between the vessel path and the surrounding tissues.

**Benign**—Describes a tumor that is not malignant, that is unlikely to recur or spread to other areas of the body.

**Embolization**—The purposeful introduction of a substance into a blood vessel to stop blood flow.

**Involution**—The slow healing and resolution stage of a hemangioma.

**Lenticular**—Lens-shaped; describes a shape of a surgical excision sometimes used to remove hemangiomas.

**Proliferation**—The rapid growth stage of a hemangioma.

**Purse-string closure**—A technique used to close circular or irregularly shaped wounds that involves threading the suture through the edges of the wound and pulling it taut, bringing the edges together.

**Radial**—Star-shaped or radiating out from a central point; used to describe the scar-folds that results from a purse-string closure.

a well-demarcated pale spot that becomes more noticeable when the child cries. The tumors are highly variable in presentation and range from flat, reddish areas known as superficial hemangiomas, to those that are bluish in color and located further under the skin, and are known as deep hemangiomas.

During the first six to 18 months of life, hemangiomas undergo a stage where they grow at an excessive rate in size due to abnormal cell division. The final size of the tumors can range from tiny, hardly noticeable red areas to large, disfiguring growths. In almost all hemangiomas, a long, slow involution process that follows the proliferation stage can take years to complete. Among the first signs of the involution process is a deepening of the red color of the tumor, a graying of the surface, and the appearance of white spots. In general, 50% of all hemangiomas are completely involuted by age five, and 75–90% have completed the process by age seven.

Once a decision to treat a hemangioma with surgery is made, the exact technique to be utilized must also be determined. The most commonly used technique for small lesions is very straightforward and

involves removing the abnormal vascular tissue with a lenticular, or lens-shaped excision, that results in a linear scar. Recently, some surgeons have been advocating the use of an elliptical, circular, or irregular incision shapes, followed by a purse-string-type closure. This technique does result in a scar having radial (star-shaped) ridges that can take several weeks to flatten. However, the overall result is a shorter scar that can be followed up by removal, using the lenticular excision technique.

Larger, more extensive lesions may require **angiography**, a process that maps the path of the vessels feeding the lesion, and embolization, the deliberate blocking of these blood vessels using small particles of inert material. This process is followed by complete removal of the abnormal tissue.

Depending on the size and nature of the tumor, the excision surgery can be done on an outpatient or inpatient basis. For very small lesions, local anesthetic may be sufficient, but for the great majority, **general anesthesia** is necessary to keep the patient comfortable.

## Diagnosis/Preparation

Initial correct diagnosis of the hemangioma is necessary for effective treatment. Generally, hemangiomas are not present at birth; they proliferate during the first year of the patient's life, and then commonly begin an involution process. These clinical characteristics distinguish hemangiomas from another type of congenital vascular lesion called a vascular malformation. Vascular malformations are always present at birth, do not proliferate, and do not involute. Vascular malformations are developmental abnormalities and can involve veins, arteries, or lymphatic tissue. Because of the lack of rapid proliferation, the expectation for vascular malformations differs from those with a hemangioma, and so the precise type of lesion has a significant impact on treatment decisions.

## Aftercare

Aftercare for a hemangioma excision involves **wound care** and maintenance such as changing of **bandages**.

## Risks

The greatest risk of hemangioma excision is bleeding during the operation, as these tumors are comprised of abnormal blood vessels. Surgeons often utilize special surgical tools to reduce this risk, including thermoscalpels (an electrically heated scapel) and

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The procedure is generally performed by plastic surgeons and, except for extremely small lesions, is done on an inpatient basis in a hospital operating room.

electrocauteries (a tool that stops bleeding using an electrical charge).

A second risk of the surgery is recurrence of the tumor, that is, an incomplete excision of the abnormally growing tissue. Surgery may also result in scarring that is at least as noticeable as what would remain after involution, if not more so. Patients and their caregivers should carefully consider this possibility when deciding to undergo surgical treatment for hemangiomas.

Other risks of the surgery are very low, and include those that accompany any surgical procedure, such as reactions to anesthesia and possible infections of the incision.

### Normal results

Completely normal appearance after surgery is very rare. However, for significantly disfiguring tumors or those that impact physical function, the surgical scar may be preferable to the presence of the tumor.

### Morbidity and mortality rates

Morbidity and mortality resulting from this surgery is close to zero, particularly because of the new surgical techniques and tools that prevent intra-operative bleeding of the tumor.

### Alternatives

Several alternatives to surgical excision include observation (“watchful waiting”), treatment with steroids during the proliferation stage to shrink the tumor and speed the involution process, and **laser surgery** techniques to alter the appearance of the tumor. Commonly, a combination of these treatment methods, including surgery, will be used to tailor a therapeutic approach for a patient’s particular tumor.

## QUESTIONS TO ASK THE DOCTOR

- What is the predicted cosmetic outcome of the surgery and how does this compare to the outcome after involution?
- What are the risks of the surgery and how does this compare with the risks of continuing to observe the tumor?
- Is treatment of this hemangioma using steroids a possibility?
- Are laser techniques a viable option for this tumor?

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American Society of Plastic Surgeons. 444 E. Algonquin Rd. Arlington Heights, IL 60005. (800) 475 2784. [www.plasticsurgery.org](http://www.plasticsurgery.org).

Vascular Birthmark Foundation. P.O. Box 106, Latham, NY 12110. (877) VBF LOOK (daytime) and (877) VBF 4646 (evenings and weekends). [www.birthmark.org](http://www.birthmark.org).

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## Hematocrit

### Definition

The hematocrit is a test that measures the percentage of blood that is comprised of red blood cells.

## Purpose

The hematocrit is used to screen for anemia, or is measured on a person to determine the extent of anemia. An anemic person has fewer or smaller than normal red blood cells. A low hematocrit, combined with other abnormal blood tests, confirms the diagnosis. The hematocrit is decreased in a variety of common conditions including chronic and recent acute blood loss, some cancers, kidney and liver diseases, malnutrition, vitamin B<sub>12</sub> and folic acid deficiencies, iron deficiency, pregnancy, systemic lupus erythematosus, rheumatoid arthritis and peptic ulcer disease. An elevated hematocrit is most often associated with severe burns, diarrhea, shock, Addison's disease, and dehydration, which is a decreased amount of water in the tissues. These conditions reduce the volume of plasma water causing a relative increase in RBCs, which concentrates the RBCs, called hemoconcentration. An elevated hematocrit may also be caused by an absolute increase in blood cells, called polycythemia. This may be secondary to a decreased amount of oxygen, called hypoxia, or the result of a proliferation of blood forming cells in the bone marrow (polycythemia vera).

Critically high or low levels should be immediately called to the attention of the patient's nurse or doctor. **Transfusion** decisions are based on the results of laboratory tests, including the hematocrit. Generally, transfusion is not considered necessary if the hematocrit is above 21%. The hematocrit is also used as a guide to how many transfusions are needed. Each unit of packed red blood cells administered to an adult is expected to increase the hematocrit by approximately 3% to 4%.

## Precautions

Fluid volume in the blood affects hematocrit values. Accordingly, the blood sample should not be taken from an arm receiving IV fluid or during hemodialysis. It should be noted that pregnant women have extra fluid, which dilutes the blood, decreasing the hematocrit. Dehydration concentrates the blood, which increases the hematocrit.

In addition, certain drugs such as penicillin and chloramphenicol may decrease the hematocrit, while glucose levels above 400 mg/dL are known to elevate results. Blood for hematocrit may be collected either by finger puncture, or sticking a needle into a vein, called venipuncture. When performing a finger puncture, the first drop of blood should be wiped away because it dilutes the sample with tissue fluid. A nurse or phlebotomist usually collects the sample following cleaning and disinfecting the skin at the site of the needle stick.

## KEY TERMS

**Anemia**—A lack of oxygen carrying capacity commonly caused by a decrease in red blood cell number, size, or function.

**Dehydration**—A decreased amount of water in the tissues.

**Hematocrit**—The volume of blood occupied by the red blood cells, and expressed in percent.

**Hypoxia**—A decreased amount of oxygen in the tissues.

**Polycythemia**—A condition in which the amount of RBCs are increased in the blood.

## Description

Blood is made up of red blood cells, white blood cells (WBCs), platelets, and plasma. A decrease in the number or size of red cells also decreases the amount of space they occupy, resulting in a lower hematocrit. Conversely, an increase in the number or size of red cells increases the amount of space they occupy, resulting in a higher hematocrit. Thalassemia minor is an exception in that it usually causes an increase in the number of red blood cells, but because they are small, it results in a decreased hematocrit.

The hematocrit may be measured manually by centrifugation. A thin capillary tube called a microhematocrit tube is filled with blood and sealed at the bottom. The tube is centrifuged at 10,000 RPM (revolutions per minute) for five minutes. The RBCs have the greatest weight and are forced to the bottom of the tube. The WBCs and platelets form a thin layer, called the buffy coat, between the RBCs and the plasma, and the liquid plasma rises to the top. The height of the red cell column is measured as a percent of the total blood column. The higher the column of red cells, the higher the hematocrit. Most commonly, the hematocrit is measured indirectly by an automated blood cell counter. It is important to recognize that different results may be obtained when different measurement principles are used. For example, the microhematocrit tube method will give slightly higher results than the electronic methods when RBCs of abnormal shape are present because more plasma is trapped between the cells.

## Aftercare

Discomfort or bruising may occur at the puncture site. Pressure to the puncture site until the bleeding stops reduces bruising; warm packs relieve discomfort.



Some people feel dizzy or faint after blood has been drawn, and lying down and relaxing for awhile is helpful for these people.

### Risks

Other than potential bruising at the puncture site, and/or dizziness, there are no complications associated with this test.

### Normal results

Normal values vary with age and sex. Some representative ranges are:

- at birth: 42-60%
- six to 12 months: 33-40%
- adult males: 42-52%
- adult females: 35-47%

### Resources

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#### ORGANIZATIONS

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## Hemispherectomy

### Definition

Hemispherectomy is a surgical treatment for epilepsy in which one of the two cerebral hemispheres, which together make up the majority of the brain, is removed.

### Purpose

Hemispherectomy is used to treat epilepsy when it cannot be sufficiently controlled by medications.

The cerebral cortex is the wrinkled outer portion of the brain. It is divided into left and right hemispheres,

which communicate with each other through a bundle of nerve fibers called the corpus callosum, located at the base of the hemispheres.

The seizures of epilepsy are due to unregulated electrical activity in the brain. This activity often begins in a discrete brain region called the focus of the seizure, and then spreads to other regions. Removing or disconnecting the focus from the rest of the brain can reduce seizure frequency and intensity.

In some people with epilepsy, there is no single focus. If there are multiple focal points within one hemisphere, or if the focus is undefined but restricted to one hemisphere, hemispherectomy may be indicated for treatment.

Removing an entire hemisphere of the brain is an effective treatment. The hemisphere that is removed is usually quite damaged by the effects of multiple seizures, and the other side of the brain has already assumed many of the functions of the damaged side. In addition, the brain has many "redundant systems," which allow healthy regions to make up for the loss of the damaged side.

Children who are candidates for hemispherectomy usually have significant impairments due to their epilepsy, including partial or complete paralysis and partial or complete loss of sensation on the side of the body opposite to the affected brain region.

### Demographics

Epilepsy affects up to 1% of all people. Approximately 40% of patients are inadequately treated by medications, and so may be surgery candidates. Hemispherectomy is a relatively rare type of epilepsy surgery. The number performed per year in the United States is likely less than 100. Hemispherectomy is most often considered in children, whose brains are better able to adapt to the loss of brain matter than adults.

### Description

Hemispherectomy may be "anatomic" or "functional." In an anatomic hemispherectomy, a hemisphere is removed, while in a functional hemispherectomy, some tissue is left in place, but its connections to other brain centers are cut so that it no longer functions.

Several variations of the anatomic hemispherectomy exist, which are designed to minimize complications. Lower portions of the brain may be left relatively intact, or muscle tissue may be transplanted in order to

protect the brain's ventricles (fluid-filled cavities) and prevent leakage of cerebrospinal fluid from them.

Most surgical centers perform functional hemispherectomy. In this procedure, the temporal lobe (that region closest to the temple) and the part of the central portion of the cortex are removed. Additionally, numerous connecting fibers within the remaining brain are severed, as is the corpus callosum, which connects the two hemispheres.

During either procedure, the patient is under **general anesthesia**, lying on the back. The head is shaved and a portion of the skull is removed for access to the brain. After all tissue has been cut and removed and all bleeding is stopped, the underlying tissues are sutured and the skull and scalp are replaced and sutured.

### Diagnosis/Preparation

The candidate for hemispherectomy has epilepsy untreatable by medications, with seizure focal points that are numerous or ill defined, but localized to one hemisphere. Such patients may have one of a wide variety of disorders that have caused seizures, including:

- neonatal brain injury
- Rasmussen disease
- hemimegalencephaly
- Sturge-Weber syndrome

The candidate for any type of epilepsy surgery will have had a wide range of tests prior to surgery. These include **electroencephalography (EEG)**, in which electrodes are placed on the scalp, on the brain surface, or within the brain to record electrical activity. EEG is used to attempt to locate the focal point(s) of the seizure activity.

Several neuroimaging procedures are used to obtain images of the brain. These may reveal structural abnormalities that the neurosurgeon must be aware of. These procedures will include **magnetic resonance imaging (MRI)**, x rays, computed tomography (**CT scans**), or **positron emission tomography (PET)** imaging.

Neuropsychological tests may be done to provide a baseline against which the results of the surgery are measured. A Wada test may also be performed, in which a drug is injected into the artery leading to one half of the brain, putting it to sleep. This allows the neurologist to determine where in the brain language and other functions are localized, and may also be useful for predicting the result of the surgery.

### Aftercare

Immediately after the operation, the patient may be on a mechanical ventilator for up to 24 hours. Patients remain in the hospital for at least one week.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Hemispherectomy is performed by a neurosurgical team in a hospital. It is also performed by a relatively small number of specialized centers.

Physical and occupational therapy are part of the rehabilitation program to improve strength and motor function.

### Risks

Hemorrhage during or after surgery is a risk for hemispherectomy. Disseminated intravascular coagulation, or blood clotting within the circulatory system, is a risk that may be managed with **anticoagulant drugs**. "Aseptic meningitis," an inflammation of the brain's covering without infection, may occur. Hydrocephalus, or increased fluid pressure within the remaining brain, may occur in 20–30% of patients. **Death** from surgery is a risk that has decreased as surgical techniques have improved, but it still occurs in approximately 2% of patients.

The patient will lose any remaining sensation or muscle control in the extremities on the side opposite the removed hemisphere. However, upper arm and thigh movements may be retained, allowing adapted function with these parts of the body.

### Normal results

Seizures are eliminated in 70–85% of patients, and reduced by 80% in another 10–20% of patients. Patients with Rasmussen disease, which is progressive, will not benefit as much. Medications may be reduced, and some improvement in intellectual function may occur.

### Morbidity and mortality rates

Death may occur in 1–2% of patients undergoing hemispherectomy. Serious but treatable complications may occur in 10–20% of patients.

### Alternatives

**Corpus callosotomy** may be an alternative for some patients, although its ability to eliminate seizures completely is much less. Multiple subpial transection, in which several bundles of nerve fibers are cut, is also an alternative for some patients.

## QUESTIONS TO ASK THE DOCTOR

- Can medications be used to treat the epilepsy first?
- Will the operation be an anatomic or functional hemispherectomy?
- Is there another type of surgery that may be effective?

### Resources

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#### ORGANIZATIONS

*Epilepsy Foundation*. <http://www.epilepsyfoundation.org>.

Richard Robinson

Hemodialysis see **Kidney dialysis**

Hemodialysis fistula see **Arteriovenous fistula**

## Hemoglobin test

### Definition

Hemoglobin is a protein inside red blood cells that carries oxygen. A hemoglobin test reveals how much hemoglobin is in a person's blood. This information can be used to help physician's diagnose and monitor anemia (a low hemoglobin level) and polycythemia vera (a high hemoglobin level).

### Purpose

A hemoglobin test is performed to determine the amount of hemoglobin in a person's red blood cells (RBCs). This is important because the amount of oxygen available to tissues depends upon how much oxygen is in the RBCs, and local perfusion of the tissues. Without sufficient hemoglobin, the tissues lack oxygen and the heart and lungs must work harder to compensate.

A low hemoglobin measurement usually means the person has anemia. Anemia results from a decrease in the number, size, or function of RBCs. Common causes include excessive bleeding, a deficiency of iron, vitamin B<sub>12</sub>, or folic acid, destruction of red cells by antibodies or mechanical trauma, and structurally

## KEY TERMS

**Anemia**—A diminished oxygen carrying capacity caused by a decrease in the size, number, or function of red blood cells.

**Hemoglobin**—A protein inside red blood cells that carries oxygen to body tissues.

**Hypoxia**—A decreased amount of oxygen in the tissues.

**Polycythemia vera**—A disease in which the bone marrow makes too many blood cells.

**Protein**—A polypeptide chain, or a chain of amino acids linked together.

abnormal hemoglobin. Hemoglobin levels are also decreased due to cancer, kidney diseases, other chronic diseases, and excessive IV fluids. An elevated hemoglobin may be caused by dehydration (decreased water), hypoxia (decreased oxygen), or polycythemia vera. Hypoxia may result from high altitudes, smoking, chronic obstructive lung diseases (such as emphysema), and congestive heart failure. Hemoglobin levels are also used to determine if a person needs a blood **transfusion**. Usually a person's hemoglobin must be below 7–8 g/dL before a transfusion is considered, or higher if the person has heart or lung disease. The hemoglobin concentration is also used to determine how many units of packed red blood cells should be transfused. A common rule of thumb is that each unit of red cells should increase the hemoglobin by approximately 1.0–1.5 g/dL.

### Precautions

Fluid volume in the blood affects hemoglobin values. Accordingly, the blood sample should not be taken from an arm receiving IV fluid. It should also be noted that pregnant women and people with cirrhosis, a type of permanent liver disease, have extra fluid, which dilutes the blood, decreasing the hemoglobin. Dehydration, a decreased amount of water in the body, concentrates the blood, which may cause an increased hemoglobin result.

Certain drugs such as **antibiotics**, **aspirin**, anti-neoplastic drugs, doxapram, indomethacin, **sulfonamides**, primaquine, rifampin, and trimethadione, may also decrease the hemoglobin level.

A nurse or phlebotomist usually collects the sample by inserting a needle into a vein, or venipuncture, after cleaning the skin, which helps prevent infections.

## Description

Hemoglobin is a complex protein composed of four subunits. Each subunit consists of a protein, or polypeptide chain, that enfolds a heme group. Each heme contains iron ( $\text{Fe}^{2+}$ ) that can bind a molecule of oxygen. The iron gives blood its red color. After the first year of life, 95–97% of the hemoglobin molecules contain two pairs of polypeptide chains designated alpha and beta. This form of hemoglobin is called hemoglobin A.

Hemoglobin is most commonly measured in whole blood. Hemoglobin measurement is most often performed as part of a **complete blood count** (CBC), a test that includes counts of the red blood cells, white blood cells, and platelets (thrombocytes).

Some people inherit hemoglobin with an abnormal structure. The abnormal hemoglobin results from a point mutation in one or both genes that code for the alpha or beta polypeptide chains. Examples of hemoglobin abnormalities resulting from a single amino acid substitution in the beta chain are sickle cell and hemoglobin C disease. Most abnormal hemoglobin molecules can be detected by hemoglobin electrophoresis, which separates hemoglobin molecules that have different electrical charges.

## Preparation

No special preparation is required other than cleaning and disinfecting the skin at the puncture site. Blood is collected in a tube by venipuncture. The tube has an anticoagulant in it so that the blood does not clot in the tube, and so that the blood will remain a liquid.

## Aftercare

Discomfort or bruising may occur at the puncture site. Pressure to the puncture site until the bleeding stops reduces bruising; warm packs relieve discomfort. Some people feel dizzy or faint after blood has been drawn, and lying down and relaxing for awhile is helpful for these people.

## Risks

Other than potential bruising at the puncture site, and/or dizziness, there are usually no complications associated with this test.

## Normal results

Normal values vary with age and sex, with women generally having lower hemoglobin values than men.

Normal results for men range from 13–18 g/dL. For women the normal range is 12–16 g/dL. Critical limits (panic values) for both males and females are below 5.0 g/dL or above 20.0 g/dL.

A low hemoglobin value usually indicates the person has anemia. Different tests are done to discover the cause and type of anemia. Dangerously low hemoglobin levels put a person at risk of a heart attack, congestive heart failure, or stroke. A high hemoglobin value indicates the body may be making too many red blood cells. Other tests are performed to differentiate the cause of the abnormal hemoglobin level. Laboratory scientists perform hemoglobin tests using automated laboratory equipment. Critically high or low levels should be immediately called to the attention of the patient's doctor.

## Resources

### BOOKS

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### OTHER

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## Hemoperfusion

### Definition

Hemoperfusion is a treatment technique in which large volumes of the patient's blood are passed over an adsorbent substance in order to remove toxic substances from the blood. Adsorption is a process in which molecules or particles of one substance are attracted to the surface of a solid material and held there. These solid materials are called sorbents. Hemoperfusion is sometimes described as an extracorporeal form of



treatment because the blood is pumped through a device outside the patient's body.

The sorbents most commonly used in hemoperfusion are resins and various forms of activated carbon or charcoal. Resin sorbents are presently used in Europe but not in the United States; since 1999, all hemoperfusion systems manufactured in the United States use cartridges or columns containing carbon sorbents. A newer type of cartridge containing an adsorbent polymer has been undergoing clinical tests in the United States since the summer of 2002.

### Purpose

Hemoperfusion has three major uses:

- to remove nephrotoxic drugs or poisons from the blood in emergency situations (a nephrotoxic substance is one that is harmful to the kidneys);
- to remove waste products from the blood in patients with kidney disease; and
- to provide supportive treatment before and after transplantation for patients in liver failure.

Hemoperfusion is more effective than other methods of treatment for removing certain specific poisons from the blood, particularly those that bind to proteins in the body or are difficult to dissolve in water. It is used to treat overdoses of **barbiturates**, meprobamate, glutethimide, theophylline, digitalis, carbamazepine, methotrexate, ethchlorvynol, and **acetaminophen**, as well as treating paraquat poisoning. Paraquat is a highly toxic weed killer that is sometimes used by people in developing countries to commit suicide.

### Description

A hemoperfusion system can be used with or without a hemodialysis machine. After the patient has been made comfortable, two catheters are placed in the arm, one in an artery and one in a nearby vein. After the catheters have been checked for accurate placement, the catheter in the artery is connected to tubing leading into the hemoperfusion system, and the catheter in the vein is connected to tubing leading from the system through a pressure monitor. The patient is given heparin at the beginning of the procedure and at 15–20-minute intervals throughout the hemoperfusion in order to prevent the blood from clotting. The patient's blood pressure is also taken regularly. A typical hemoperfusion treatment takes about three hours.

Hemoperfusion works by pumping the blood drawn through the arterial catheter into a column or cartridge containing the sorbent material. As the blood passes over the carbon or resin particles in the column,

## KEY TERMS

**Adsorb**—To attract and hold another substance on the surface of a solid material.

**Clearance**—The rate at which a substance is removed from the blood by normal kidney function or by such methods as hemoperfusion.

**Extracorporeal**—Occurring outside the patient's body.

**Heparin**—A complex sugar compound used in medicine to prevent the formation of blood clots during hemodialysis, hemoperfusion, and open-heart surgery.

**Nephrotoxic**—Destructive to kidney cells. Hemoperfusion can be used to remove nephrotoxic chemicals from the blood.

**Paraquat**—A highly toxic restricted-use pesticide. Death following ingestion usually results from multiple organ failure.

**Sorbent**—A material used during hemoperfusion to adsorb toxic or waste substances from the blood. Most hemoperfusion systems use resin or activated carbon as sorbents.

the toxic molecules or particles are drawn to the surfaces of the sorbent particles and trapped within the column. The blood flows out the other end of the column and is returned to the patient through the tubing attached to the venous catheter. Hemoperfusion is able to clear toxins from a larger volume of blood than hemodialysis or other filtration methods; it can process over 300 mL of blood per minute.

### Preparation

In emergency situations, preparation of the patient may be limited to cleansing the skin on the inside of the arm with an antiseptic solution and giving a local anesthetic to minimize pain caused by the needles used to insert the catheters.

The hemoperfusion system is prepared by sterilizing the cartridge containing the sorbent and rinsing it with heparinized saline solution. The system is then pressure-tested before the tubing is connected to the catheters in the patient's arm.

### Normal results

Normal results include satisfactory clearance of the toxic substance or waste products from the patient's

blood. The success of hemoperfusion depends in part, however, on the nature of the drug or poison to be cleared from the blood. Some drugs, such as the tricyclic antidepressants, enter the tissues of the patient's body as well as the bloodstream. As a result, even though hemoperfusion may remove as much as 80% of the drug found in the blood plasma, that may be only a small fraction of the total amount of the drug in the patient's body.

## Risks

The risks associated with hemoperfusion are similar to those for hemodialysis, including infection, bleeding, blood clotting, destruction of blood platelets, an abnormal drop in blood pressure, and equipment failure. When hemoperfusion is performed by a qualified health professional, the risks are minor compared to the effects of poisoning or organ failure.

## Resources

### BOOKS

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## ORGANIZATIONS

American Academy of Emergency Medicine, 555 East Wells Street, Suite 1100, Milwaukee, WI, 53202 3823, (800) 884 2236, <http://www.aaem.org>.

Center for Emergency Medicine of Western Pennsylvania, 230 McKee Place, Suite 500, Pittsburgh, PA, 15213, (412) 647 5300, <http://www.centerem.org>.

National Kidney Foundation, 30 East 33rd Street, New York, NY, 10016, (212) 889 2210, (800) 622 9010, <http://www.kidney.org>.

Society of Toxicology, 1821 Michael Faraday Drive, Suite 300, Reston, VA, 20190, (703) 438 3115, <http://www.toxicology.org>.

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## Hemorrhoidectomy

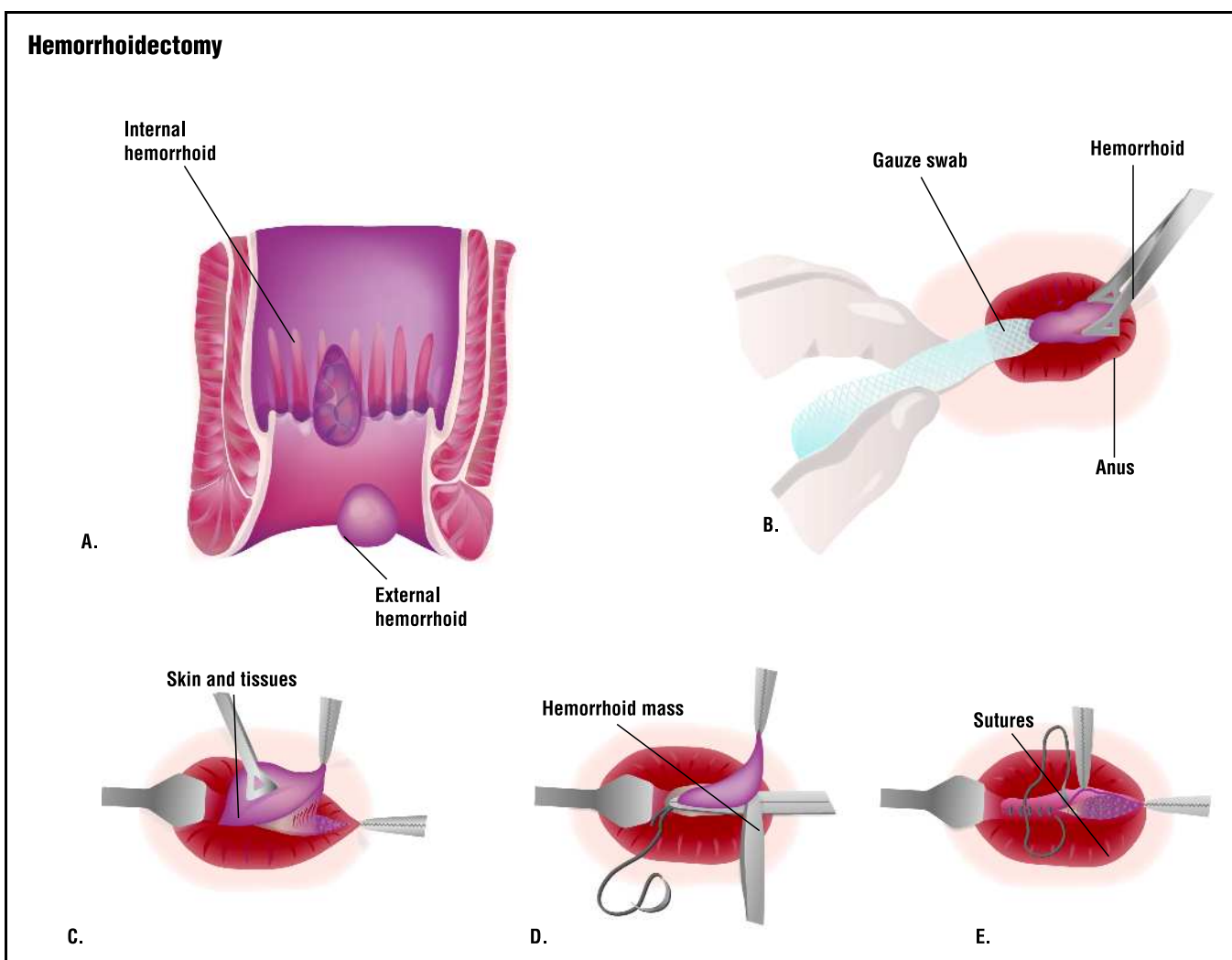
### Definition

A hemorrhoidectomy is the surgical removal of a hemorrhoid, which is an enlarged, swollen, inflamed cluster of vascular tissue combined with smooth muscle and connective tissue located in the lower part of the rectum or around the anus. A hemorrhoid is not a varicose vein in the strictest sense. Hemorrhoids are also known as piles.

### Purpose

The primary purpose of a hemorrhoidectomy is to relieve the symptoms associated with hemorrhoids that have not responded to more conservative treatments. These symptoms commonly include bleeding and pain. In some cases the hemorrhoid may protrude from the patient's anus. Less commonly, the patient may notice a discharge of mucus or have the feeling that they have not completely emptied the bowel after defecating. Hemorrhoids are usually treated with dietary and medical measures before surgery is recommended because they are not dangerous, and are only rarely a medical emergency. Many people have hemorrhoids that do not produce any symptoms at all.

As of 2003, inpatient hemorrhoidectomies are performed significantly less frequently than they were as recently as the 1970s. In 1974, there were 117 hospital hemorrhoidectomies performed per 100,000 people in the general United States population; this figure declined to 37 per 100,000 by 1987.



Hemorrhoids can occur inside the rectum, or at its opening (A). To remove them, the surgeon feeds a gauze swab into the anus and removes it slowly. A hemorrhoid will adhere to the gauze, allowing its exposure (B). The outer layers of skin and tissue are removed (C), and then the hemorrhoid itself (D). The tissues and skin are then repaired (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

### Demographics

Hemorrhoids are a fairly common problem among adults in the United States and Canada; it is estimated that ten million people in North America, or about 4% of the adult population, have hemorrhoids. About a third of these people seek medical treatment in an average year; nearly 1.5 million prescriptions are filled annually for medications to relieve the discomfort of hemorrhoids. Most patients with symptomatic hemorrhoids are between the ages of 45 and 65.

Risk factors for the development of symptomatic hemorrhoids include the following:

- hormonal changes associated with pregnancy and childbirth
- normal aging
- not getting enough fiber in the diet
- chronic diarrhea
- anal intercourse
- constipation resulting from medications, dehydration, or other causes
- sitting too long on the toilet

Hemorrhoids are categorized as either external or internal hemorrhoids. External hemorrhoids develop under the skin surrounding the anus; they may cause

## KEY TERMS

**Defecation**—The act of passing a bowel movement.

**Fistula (plural, fistulae)**—An abnormal passageway or opening between the rectum and the skin near the anus.

**Ligation**—Tying off a blood vessel or other structure with cotton, silk, or some other material. Rubber band ligation is one approach to treating internal hemorrhoids.

**Piles**—Another name for hemorrhoids.

**Prolapse**—The falling down or sinking of an internal organ or part of the body. Internal hemorrhoids may prolapse and cause a spasm of the anal sphincter muscle.

**Psyllium**—The seeds of the fleawort plant, taken with water to produce a bland, jelly-like bulk which helps to move waste products through the digestive tract and prevent constipation.

**Resection**—Surgical removal of part or all of a hemorrhoid, organ, or other structure.

**Sclerotherapy**—A technique for shrinking hemorrhoids by injecting an irritating chemical into the blood vessels.

**Sphincter**—A circular band of muscle fibers that constricts or closes a passageway in the body.

**Thrombosed**—Affected by the formation of a blood clot, or thrombus, along the wall of a blood vessel. Some external hemorrhoids become thrombosed.

pain and bleeding when the vein in the hemorrhoid forms a clot. This is known as a thrombosed hemorrhoid. In addition, the piece of skin, known as a skin tag, that is left behind when a thrombosed hemorrhoid heals often causes problems for the patient's hygiene. Internal hemorrhoids develop inside the anus. They can cause pain when they prolapse (fall down toward the outside of the body) and cause the anal sphincter to go into spasm. They may bleed or release mucus that can cause irritation of the skin surrounding the anus. Lastly, internal hemorrhoids may become incarcerated or strangulated.

## Description

There are several types of surgical procedures that can reduce hemorrhoids. Most surgical procedures in current use can be performed on an outpatient level or office visit under **local anesthesia**.

Rubber band ligation is a technique that works well with internal hemorrhoids that protrude outward with bowel movements. A small rubber band is tied over the hemorrhoid, which cuts off the blood supply. The hemorrhoid and the rubber band will fall off within a few days and the wound will usually heal in a period of one to two weeks. The procedure causes mild discomfort and bleeding. Another procedure, sclerotherapy, utilizes a chemical solution that is injected around the blood vessel to shrink the hemorrhoid. A third effective method is infrared coagulation, which uses a special device to shrink hemorrhoidal tissue by heating. Both injection and coagulation techniques can be effectively used to treat bleeding hemorrhoids that do not protrude. Some surgeons use a combination of rubber band ligation, sclerotherapy, and infrared coagulation; this combination has been reported to have a success rate of 90.5%.

Surgical resection (removal) of hemorrhoids is reserved for patients who do not respond to more conservative therapies and who have severe problems with external hemorrhoids or skin tags. Hemorrhoidectomies done with a laser do not appear to yield better results than those done with a scalpel. Both types of surgical resection can be performed with the patient under local anesthesia.

## Diagnosis/Preparation

### Diagnosis

Most patients with hemorrhoids are diagnosed because they notice blood on their toilet paper or in the toilet bowl after a bowel movement and consult their doctor. It is important for patients to visit the doctor whenever they notice bleeding from the rectum, because it may be a symptom of colorectal cancer or other serious disease of the digestive tract. In addition, such other symptoms in the anorectal region as itching, irritation, and pain may be caused by abscesses, fissures in the skin, bacterial infections, fistulae, and other disorders as well as hemorrhoids. The doctor will perform a digital examination of the patient's rectum in order to rule out these other possible causes.

Following the digital examination, the doctor will use an anoscope or sigmoidoscope in order to view the inside of the rectum and the lower part of the large intestine to check for internal hemorrhoids. The patient may be given a **barium enema** if the doctor suspects cancer of the colon; otherwise, imaging studies are not routinely performed in diagnosing hemorrhoids. In some cases, a laboratory test called a stool guaiac may be used to detect the presence of blood in stools.



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A board certified general surgeon who has completed one additional year of advanced training in colon and rectal surgery performs the procedure. Specialists typically pass a board certification examination in the diagnosis and surgical treatment of diseases in the colon and rectum, and are certified by the American Board of Colon and Rectal Surgeons. Most hemorrhoidectomies can be performed in the surgeon's office, an outpatient clinic, or an ambulatory surgery center.

### Preparation

Patients who are scheduled for a surgical hemorrhoidectomy are given a sedative intravenously before the procedure. They are also given small-volume saline enemas to cleanse the rectal area and lower part of the large intestine. This preparation provides the surgeon with a clean operating field.

### Aftercare

Patients may experience pain after surgery as the anus tightens and relaxes. The doctor may prescribe narcotics to relieve the pain. The patient should take stool softeners and attempt to avoid straining during both defecation and urination. Soaking in a warm bath can be comforting and may provide symptomatic relief. The total recovery period following a surgical hemorrhoidectomy is about two weeks.

### Risks

As with other surgeries involving the use of a local anesthetic, risks associated with a hemorrhoidectomy include infection, bleeding, and an allergic reaction to the anesthetic. Risks that are specific to a hemorrhoidectomy include stenosis (narrowing) of the anus; recurrence of the hemorrhoid; fistula formation; and nonhealing wounds.

### Normal results

Hemorrhoidectomies have a high rate of success; most patients have an uncomplicated recovery with no recurrence of the hemorrhoids. Complete recovery is typically expected with a maximum period of two weeks.

## QUESTIONS TO ASK THE DOCTOR

- How many of your patients recover from hemorrhoids without undergoing surgery?
- How many hemorrhoidectomies have you performed?
- How many of your patients have reported complications from surgical resection of their hemorrhoids?
- What are the chances that the hemorrhoids will recur?

### Morbidity and mortality rates

Rubber band ligation has a 30–50% recurrence rate within five to 10 years of the procedure whereas surgical resection of hemorrhoids has only a 5% recurrence rate. Well-trained surgeons report complications in fewer than 5% of their patients; these complications may include anal stenosis, recurrence of the hemorrhoid, fistula formation, bleeding, infection, and urinary retention.

### Alternatives

Doctors recommend conservative therapies as the first line of treatment for either internal or external hemorrhoids. A nonsurgical treatment protocol generally includes drinking plenty of liquids; eating foods that are rich in fiber; sitting in a plain warm water bath for five to 10 minutes; applying anesthetic creams or witch hazel compresses; and using psyllium or other stool bulking agents. In patients with mild symptoms, these measures will usually decrease swelling and pain in about two to seven days. The amount of fiber in the diet can be increased by eating five servings of fruit and vegetables each day; replacing white bread with whole-grain bread and cereals; and eating raw rather than cooked vegetables.

### Resources

#### BOOKS

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American Gastroenterological Association. 4930 Del Ray Avenue, Bethesda, MD 20814. (301) 654 2055; Fax: (301) 652 3890. [www.gastro.org](http://www.gastro.org).

American Society of Colon and Rectal Surgeons. 85 W. Algonquin Road, Suite 550, Arlington Heights, IL 60005. [www.fascrs.org](http://www.fascrs.org).

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## Hepatectomy

### Definition

A hepatectomy is the surgical removal of the liver.

### Purpose

Hepatectomies are performed to surgically remove tumors from the liver. Most liver cancers start in liver cells called "hepatocytes." The resulting cancer is called hepatocellular carcinoma or malignant hepatoma.

The type of cancer that can be removed by hepatectomy is called a localized resectable (removable) liver cancer. It is diagnosed as such when there is no evidence that it has spread to the nearby lymph nodes or to any other parts of the body. Laboratory tests also show that the liver is working well. As part of a multidisciplinary approach, the procedure can offer a chance of long-term remission to patients otherwise guaranteed of having a poor outcome.

### Demographics

According to the National Cancer Institute (NCI), liver cancer is relatively uncommon in the United States, although its incidence is rising, mostly as a result of the spread of hepatitis C. However, it is the most common cancer in Africa and Asia, with

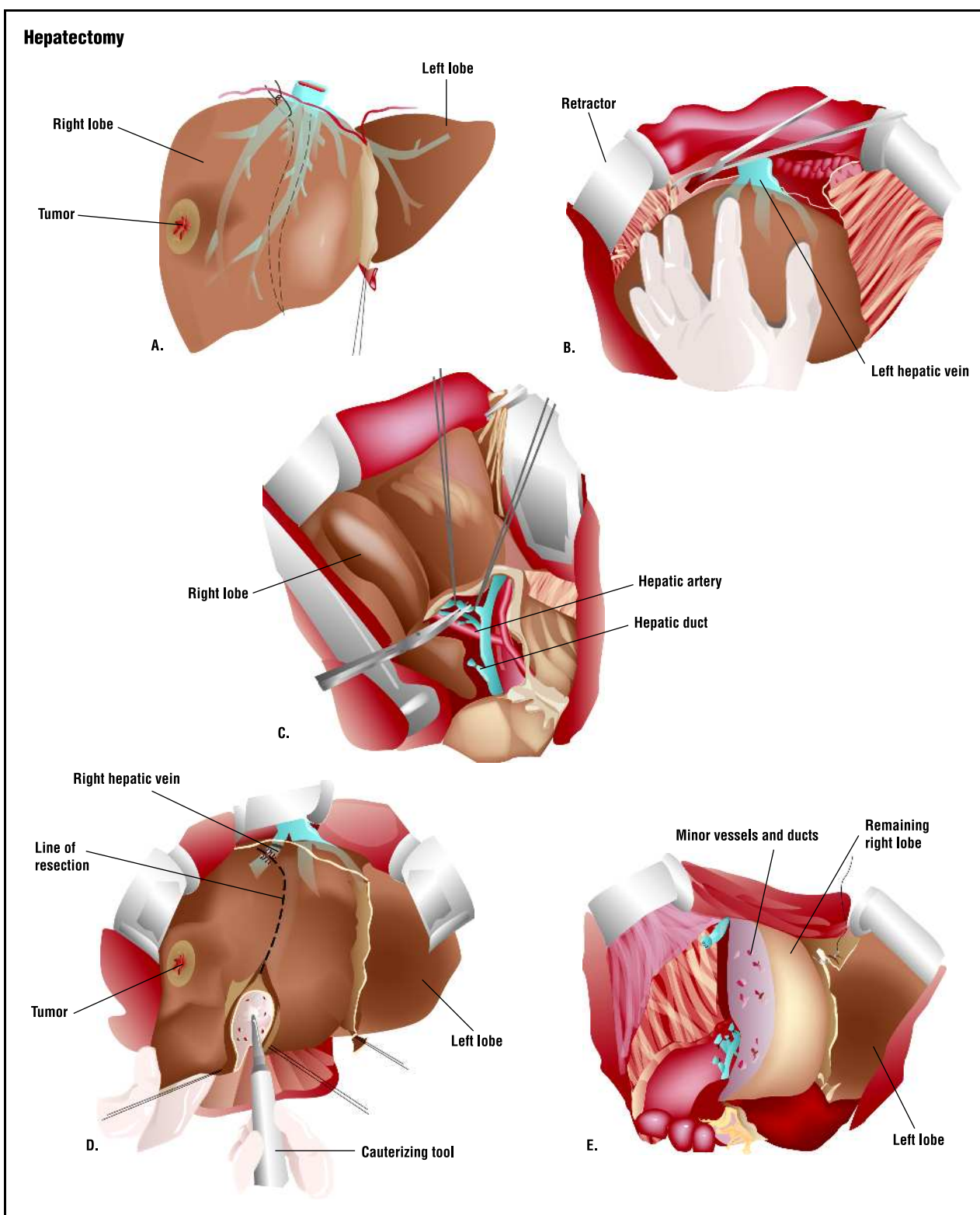
more than one million new cases diagnosed each year. In the United States, liver cancer and cancer of the bile ducts only account for about 1.5% of all cancer cases. Liver cancer is also associated with cirrhosis in 50–80% of patients.

### Description

The extent of the hepatectomy will depend on the size, number, and location of the cancer. It also depends on whether liver function is still adequate. The surgeon may remove a part of the liver that contains the tumor, an entire lobe, or an even larger portion of the liver. In a partial hepatectomy, the surgeon leaves a margin of healthy liver tissue to maintain the functions of the liver. For some patients, **liver transplantation** may be indicated. In this case, the transplant surgeon performs a total hepatectomy, meaning that the patient's entire liver is removed, and it is replaced with a healthy liver from a donor. A liver transplant is an option only if the cancer has not spread outside the liver and only if a suitable donor liver can be found that matches the patient. While waiting for an adequate donor, the health care team monitors the patient's health while providing other therapy.

The surgical procedure is performed under **general anesthesia** and is quite lengthy, requiring three to four hours. The anesthetized patient is face-up and both arms are drawn away from the body. Surgeons often use a heating pad and wrappings around the arms and legs to reduce losses in **body temperature** during the surgery. The patient's abdomen is opened by an incision across the upper abdomen and a midline-extension incision up to the xiphoid (the cartilage located at the bottom middle of the rib cage). The main steps of a partial hepatectomy then proceed as follows:

- Freeing the liver. The first task of the surgeon is to free the liver by cutting the long fibers that wrap it.
- Removal of segments. Once the surgeon has freed the liver, the removal of segments can start. The surgeon must avoid rupturing important blood vessels to avoid a hemorrhage. Two different techniques can be used. The first has the surgeon make a superficial burn with an electric lancet on the surface of the liver to mark the junction between the sections marked for removal and the rest of the liver. He or she cuts out the section, and then tears towards the hepatic parenchyma. It is the difference in resistance between the parenchyma and the vessels that allows the surgeon to identify the presence of a vessel. At this point, he/she isolates the vessel by removing the surrounding connective tissue, and then clamps it. The surgeon can then cut the vessel, without any danger to the



To remove a portion of the liver, the surgeon enters the patient's abdomen, and frees the affected part of the liver from the connecting tissues (B). The artery to the liver and hepatic duct are disconnected from the liver (C). The diseased part of the liver is cut away, and a cauterizing tool is used to stop the bleeding as the surgeon progresses (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Biopsy**—The removal of cells or tissues for examination under a microscope.

**Cirrhosis**—A type of chronic, progressive liver disease in which liver cells are replaced by scar tissue.

**Computed tomography (CT) scan**—A series of detailed images of areas inside the body taken at various angles; the images are created on a computer linked to an X-ray machine.

**Hepatitis**—Disease of the liver causing inflammation. Symptoms include an enlarged liver, fever, nausea, vomiting, abdominal pain, and dark urine.

**Hepatocellular carcinoma**—The most common type of liver tumor.

**Hepatocytes**—Liver cells.

**Hepatoma**—A liver tumor.

**Magnetic resonance imaging (MRI)**—An imaging technique in which a magnet linked to a computer produces images of areas inside the body.

**Parenchyma**—The essential elements of an organ, used in anatomical nomenclature as a general term to designate the functional elements of an organ, as distinguished from its framework.

**Resectable**—Part or all of an organ that can be removed by surgery.

patient. The second technique involves identifying the large vessels feeding the segments to be removed. The surgeon operates first at the level of the veins to free and then clamp the vessels required. Finally, the surgeon can make incisions without worrying about cutting little vessels.

## Diagnosis/Preparation

A diagnosis of liver cancer requiring an hepatectomy is obtained with the following procedures:

- physical examination;
- blood tests;
- computed tomography (CT) scan;
- ultrasound test;
- magnetic resonance imaging (MRI);
- angiograms; and
- biopsy.

To prepare a patient for a hepatectomy, clean towels are laid across the patient's face, along the sides, and across the knees. The anterior portion of

the chest, the abdomen, and the lower extremities down to the knees are scrubbed with betadine for 10 minutes. In the event of a patient being allergic to iodine, hibiscrub may be used as an alternative. On completion of the scrub, two sterile towels are used to pat the area dry. The area is then painted with iodine in alcohol, and draping proceeds with side drapes, arm board drapes, top and bottom drapes, and a large steridrape. Three suction devices, one diathermy pencil, and a pair of forceps are placed conveniently around the field.

## Aftercare

After an hepatectomy, the healing process takes time; the amount of time required to recover varies from patient to patient. Patients are often uncomfortable for the first few days following surgery and they are usually prescribed pain medication. The treating physician or nurse is available to discuss **pain management**. Patients usually feel very tired or weak for a while. Also, patients may have diarrhea and a feeling of fullness in the abdomen. The health care team closely monitors the patient for bleeding, infection, liver failure, or other problems requiring immediate medical attention.

After a total hepatectomy followed by a liver transplant, the patient usually stays in the hospital for several weeks. During that time, the health care team constantly monitors how well the patient is accepting the donated liver. The patient is prescribed drugs to prevent the body from rejecting the transplant, which may cause puffiness in the face, high blood pressure, or an increase in body hair.

## Risks

Patients with chronic hepatitis and cirrhosis are at high risk when an hepatectomy is performed.

There are always risks with any surgery, but a hepatectomy that removes 25–60% of the liver carries more than the average risk. Pain, bleeding, infection, and/or injury to other areas in the abdomen, as well as **death**, are potential risks. Other risks include postoperative fevers, pneumonia, and urinary tract infection. Patients who undergo any type of abdominal surgery are also at risk to form blood clots in their legs. These blood clots can break free and move through the heart to the lungs. In the lungs, the blood clot may cause a serious problem called pulmonary embolism, a condition usually treated with blood-thinning medication. In some cases, embolisms can cause death. There are special devices used to keep blood flowing through the legs during surgery to try to prevent clot formation.



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A hepatectomy is performed in a hospital setting by a surgeon assisted by a full abdominal surgery team, and possibly an oncologist.

There are also risks that are specific only to liver surgery. During the preoperative evaluation, the treatment team tries to evaluate the patient's liver so that they can decide what piece can safely be removed. Removal of a portion of the liver may cause the remaining liver to work poorly for a short period of time. The remaining part of the liver will begin to grow back within a few weeks and will improve; however, a patient may develop liver failure.

### Normal results

The results of a hepatectomy are considered normal when liver function resumes following a partial hepatectomy, or when the transplant liver starts functioning in the case of a total hepatectomy.

### Morbidity and mortality rates

Liver cancer may be cured by hepatectomy, although surgery is the treatment of choice for only a small fraction of patients with localized disease. Prognosis depends on the extent of the cancer and of liver function impairment. According to the NCI, five-year survival rates are very low in the United States, usually less than 10%. Non-Hispanic white men and women have the lowest incidence of and mortality rates for primary liver cancer. Rates in the black and Hispanic populations are roughly twice as high as the rates in whites. The highest incidence rate is in Vietnamese men (41.8 per 100,000), probably reflecting risks associated with the high prevalence of viral hepatitis infections in their homeland. Other Asian-American groups also have liver cancer incidence and mortality rates several times higher than the white population.

### Alternatives

There are no alternatives because hepatectomies are performed when liver cancer does not respond to other treatments.

## QUESTIONS TO ASK THE DOCTOR

- What tests do I need to determine what type of hepatectomy is required?
- What are the risks involved?
- How many hepatectomies do you perform in a year?
- How long do I need to remain in the hospital?
- How will the hepatectomy affect my normal activities?

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**ORGANIZATIONS**

American College of Surgeons, 633 N. Saint Clair St., Chicago, IL, 60611 3211, (312) 202 5000, (800) 621 4111, (312) 202 5001, [postmaster@facs.org](mailto:postmaster@facs.org), <http://www.facs.org>.

National Cancer Institute, 6116 Executive Boulevard, Room 3036A, Bethesda, MD, 20892 8322, (800) 422 6237, <http://www.cancer.gov>.

Society of Toxicology, 1821 Michael Faraday Drive, Suite 300, Reston, VA, 20190, (703) 438 3115, <http://www.toxicology.org>.

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Hernia repair, femoral *see* **Femoral hernia repair**

Hernia repair, incisional *see* **Incisional hernia repair**

Hernia repair, inguinal *see* **Inguinal hernia repair**

Hernia repair, umbilical *see* **Umbilical hernia repair**

Heterotopic transplant *see* **Liver transplantation**

inspiration (breathing in), the muscle of the diaphragm contracts. This increases the volume of the thoracic cavity, and suction allows air to enter the lungs. During expiration, the diaphragm relaxes, and air is expelled from the lungs. The esophagus passes through an area of the diaphragm (the hiatus) on the way to the stomach, which helps prevent the backflow of stomach acid up the esophagus. The diaphragm plays a role in other functions, by virtue of its ability to increase pressure within the abdomen (intra-abdominal pressure)—in this capacity, it is crucial to the acts of vomiting, defecation, and urination.

**Demographics**

A hiatal hernia can occur due to an injury, or can develop over time due to some inherent weakness in the muscle fibers. Greatly increased intra-abdominal pressure, as may occur during pregnancy, can also induce a hiatal hernia. The following factors may contribute to the development of a hiatal hernia:

- Obesity
- Family history of hiatal hernia
- Repeated straining due to constipation
- Smoking
- Heavy lifting
- Chronic cough
- Extreme bouts of violent vomiting
- Age (about 60% of people develop some degree of hiatal hernia by the time they reach the age of 60)

**Description**

A hiatal hernia occurs when the stomach enters the chest cavity through a weakness or tear in the area of the diaphragm where the esophagus passes through. The most common form of hiatal hernia occurs when the gastroesophageal junction (the area where the esophagus enters the stomach) slides upward through the hernia opening. This is referred to as a sliding hiatal hernia. A rolling or paraesophageal hiatal hernia is much more rare. In this instance, the gastroesophageal junction doesn't protrude up into the thoracic cavity; instead, a portion of the stomach slides up alongside the esophagus, and protrudes into the chest cavity through the hiatal opening. This type of hiatal hernia is more dangerous, since there is a risk that the narrow confines through which the stomach protrudes will prevent proper blood circulation into this area of the stomach, causing its tissue to become oxygen deprived (strangulated).

While some people can have a hiatal hernia without any recognizable symptoms, other people have

**Hiatal hernia****Definition**

A hiatal hernia is a condition in which a weakness or actual gap or tear in the large muscle of the diaphragm serves as an opening through which the stomach can enter the chest. Hiatal hernias can exist at birth (congenital hiatal hernia) or can develop later in life.

The diaphragm is a large dome-shaped sheet of muscle tissue that spans from the left to the right ribcage. It divides the chest area (thoracic cavity) from the abdominal cavity. The esophageal hiatus is the area of the diaphragm where the esophagus penetrates, joining the stomach below.

Along with other muscles of the abdomen and thoracic cavity, the diaphragm plays an important role in the process of respiration (breathing). During

clear-cut discomfort related to the condition. Symptoms of a hiatal hernia are very similar to symptoms of gastric acid reflux, and include

- Heartburn
- Chest pain
- Nausea
- Frequent belching

Symptoms often get worse based on position (lying down, leaning forward) and activity (lifting heavy objects, straining for any reason). Over time, symptoms can worsen and cause coughing and asthma-like symptoms, sore throat, and swallowing problems (dysphagia). Anemia can develop when chronic acid reflux causes esophagitis with erosions of the esophagus or upper stomach.

### Diagnosis/Preparations

Hiatal hernia is sometimes diagnosed when a **chest x ray** is performed for some other reason. In other instances, tests such as a barium swallow (upper GI series) or upper endoscopy may be performed specifically to look for the presence of a hiatal hernia.

### Treatment

Treatment of a hiatal hernia often starts with treatment of the symptoms of gastroesophageal reflux that it induces, including medications such as antacids, H-2 blockers, and proton pump inhibitors. Practical recommendations include weight loss, stopping smoking, elevating the head of the bed at night, so that gravity discourages acid reflux, adjusting the diet to avoid constipation (and therefore straining at stool), and avoiding activities that cause straining (such as heavy lifting).

In some cases, surgical interventions will be required, particularly with very large hiatal hernias or with the rolling or paraesophageal form of hiatal hernia. Several surgical approaches may be utilized, all with the purpose of pulling the stomach back down into the abdomen, and decreasing the size of the hiatal opening. The surgery may be performed through an incision in the chest (thoracic access), abdomen (abdominal access), or using minimally invasive, laparoscopic techniques. Some of the surgeries used include Nissen fundoplication, Belsey (Mark IV) fundoplication, and Hill repair.

### Resources

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## HIDA Scan

### Definition

A HIDA scan (hepatobiliary iminodiacetic acid scan), also called cholescintigraphy, is performed in order to assess the patency and functioning of the gallbladder and the bile ducts. A radioactive tracer chemical, called iminodiacetic acid, is injected into a vein. Over time, the radioactive chemical goes to the liver and is excreted into the bile ducts. A special scanner that picks up radioactive signals (similar to a Geiger counter) allows the generation of images of the liver, gallbladder, and bile ducts to be recorded. Although the contrast material utilized is radioactive, the scan itself does not involve any radiation exposure to the patient.

### Purpose

HIDA scans are usually done when patients have signs of gallbladder disease, including chronic indigestion, fever, white or clay colored bowel movements, colicky right upper quadrant pain, jaundice, nausea, vomiting.

The gallbladder is an organ that is located behind the liver. It is a muscular pouch that contains fluid called bile which is crucial to the digestion of fats. When crystals form in the bile, the crystals can clump together and create gallstones. Gallstones can irritate the inside of the gallbladder, causing it to become swollen and painful. This condition is called cholecystitis. Gallstones can also block the ducts that lead from the gallbladder, the liver, or the pancreas to the upper part of the small intestine, the duodenum. When this happens, pain in the right upper quadrant of the abdomen can be quite severe. Under very rare circumstances, the obstruction may be caused not by a gallstone, but by the presence of a parasite, blood clot, or tumor. Blockages may also result in jaundice, an increase in bilirubin in the blood which can cause the whites of the eyes and the skin to turn yellow. Sometimes, obstruction of the biliary system leads to bacterial infection, a condition called cholangitis.

## KEY TERMS

**Bile**—A fluid produced by the liver and stored in the gallbladder. Bile is important for the appropriate digestion of fats in the intestine.

**Biliary system**—The term used to describe the system of ducts that carries the bile flow through the liver and the gallbladder, and ultimately empties into the duodenum.

**Cholangitis**—A bacterial infection of the biliary system.

**Cholecystitis**—Swelling and inflammation of the gall bladder.

**Duodenum**—The first part of the small intestine. The duodenum receives stomach contents, as well as digestive juices from the gallbladder, liver, and pancreas.

**Jaundice**—A condition in which elevated bilirubin in the bloodstream causes the whites of the eyes and the skin to turn yellow.

## Demographics

95% of the time, gallbladder inflammation or cholecystitis is due to the presence of gallstones. Gallstones strike about 0.6% of the general population. Some ethnic groups are more prone to gallstones than others (for example, more than 75% of Native Americans over the age of 60 have gallstones). Between the ages of 20 and 60, women are three times as likely as men to develop gallstones.

## Description

During a HIDA scan, a radioactive dye or tracer is injected into a vein in the arm. As the tracer proceeds through the liver, gallbladder, and small intestine, a scanner positioned over the abdomen records a series of images. Scans are performed at set intervals (usually about every 5–10 minutes) over the course of the 90-minute examination. If the tracer is moving very slowly through the patient's system, the patient may be asked to return as late as the next day in order to repeat a scan to see whether tracer is still present.

Another chemical, called cholecystokinin or CCK, may also be used during the course of a HIDA scan. CCK stimulates the gallbladder to contract, and images taken following CCK injection can give important information about how well the gallbladder is functioning.

## Preparation

Bismuth (found in certain heartburn medicines) and barium (used to perform x-ray studies such as upper and lower GI series) can both interfere with the scanning results. Therefore, patients should be advised to delay undergoing a HIDA scan by at least four days after the use of bismuth or barium. Patients are also asked to stop eating and drinking during the four to twelve hours prior to the HIDA scan. Women who are breastfeeding and who undergo a HIDA scan should feed their baby with formula for two days following the procedure, and should pump and discard their breast milk, since it will be contaminated with the radioactive dye.

Patients are often asked to eat a fatty meal the night before having a HIDA scan.

## Aftercare

There is no aftercare necessary following a HIDA scan. The patient can return to a normal diet and normal activities.

## Risks

HIDA scans pose very little risk to the patient, although some patients do experience pain during the course of the exam, due to contraction of the inflamed gall bladder. Under rare circumstances, patients may exhibit signs of allergy to the tracer.

## Normal results

Normal results of a HIDA scan show the gallbladder in the appropriate anatomical location, with normal measurements and shape. Scanning over time reveals that the tracer progresses in an appropriate and timely fashion through the liver, into the gallbladder, and then into the duodenum.

## Abnormal results

A HIDA scan is abnormal when the gallbladder is not normal size, or if a blockage (from either a gallstone or inflammation) prevents the gallbladder or duodenum from being visualized because the tracer cannot flow freely through the normal route. Liver disease may be present if the liver does not take up the tracer from the bloodstream. If tracer is evident outside of the usual path of the biliary system, there may be some kind of a leak from the bile ducts or the gallbladder. If cholecystokinin has been administered, swelling or scarring of the gallbladder wall may be indicated by the continued presence of radioactive tracer in the gallbladder, which cannot perform its normal activity of contracting to empty bile into the duodenum.



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## Hip osteotomy

### Definition

A hip osteotomy is a surgical procedure in which the bones of the hip joint are cut, reoriented, and fixed in a new position. Healthy cartilage is placed in the weight-bearing area of the joint, followed by reconstruction of the joint in a more normal position.

### Purpose

To understand hip surgery, it is helpful to have a brief description of the structure of the human hip. The femur, or thigh bone, is connected to the knee at its lower end and forms part of the hip joint at its upper end. The femur ends in a ball-shaped piece of bone called the femoral head. The short, slanted segment of the femur that lies between the femoral head and the long vertical femoral shaft is called the neck of the femur. In a normal hip, the femoral head fits snugly into a socket called the acetabulum. The hip joint thus consists of two parts, the pelvic socket or acetabulum, and the femoral head.

The hip is susceptible to damage from a number of diseases and disorders, including arthritis, traumatic injury, avascular necrosis, cerebral palsy, or Legg-Calve-Perthes (LCP) disease in young patients. The hip socket may be too shallow, too large, or too small, or the femoral head may lose its proper round contour. Problems related to the shape of the bones in the hip joint are usually referred to as hip dysplasia.

**Hip replacement** surgery is often the preferred treatment for disorders of the hip in older patients. Adolescents and young adults, however, are rarely considered for this type of surgery due to their active lifestyle; they have few good options for alleviating their pain and improving joint function if they are stricken by a hip disorder. Osteotomies are performed in these patients, using the patient's own tissue in order to restore joint

function in the hip and eliminate pain. An osteotomy corrects a hip deformity by cutting and repositioning the bone, most commonly in patients with misalignment of certain joints or mild osteoarthritis. The procedure is also useful for people with osteoarthritis in only one hip who are too young for a total joint replacement.

### Demographics

The incidence of hip dysplasia is four per 1000 live births in the general world population, although it occurs much more frequently in Lapps and Native Americans. In addition, the condition tends to run in families and is more common among girls and first-borns. Acetabular dysplasia patients are usually in their late teens to early thirties, with the female-male ratio in the United States being five to one.

### Description

A hip osteotomy is performed under **general anesthesia**. Once the patient has been anesthetized, the surgeon makes an incision to expose the hip joint. The surgeon then proceeds to cut away portions of damaged bone and tissue to change the way they fit together in the hip joint. This part of the procedure may involve removing bone from the femoral head or from the acetabulum, allowing the bone to be moved slightly within the joint. By changing the position of these bones, the surgeon tries to shift the brunt of the patient's weight from damaged joint surfaces to healthier cartilage. He or she then inserts a metal plate or pin to keep the bone in its new place and closes the incision.

There are different hip osteotomy procedures, depending on the type of bone correction required. Two common procedures are:

- **Varus rotational osteotomy (VRO)**, also called a varus derotational osteotomy (VDO). In some patients, the femoral neck is too straight and is not angled far enough toward the acetabulum. This condition is called femoral neck valgus or just plain valgus. The VRO procedure corrects the shape of the femoral neck. In other patients, the femoral neck is not straight enough, in which case the condition is referred to as a femoral neck varus.
- **Pelvic osteotomy**. Many hip disorders are caused by a deformed acetabulum that cannot accommodate the femoral head. In this procedure, the surgeon redirects the acetabular cartilage or augments a deficient acetabulum with bone taken from outside the joint.

## KEY TERMS

**Acetabular dysplasia**—A type of arthritis resulting in a shallow hip socket.

**Acetabulum**—The hollow, cuplike portion of the pelvis into which the femoral head is fitted to make the hip joint.

**Arthrodesis**—Surgical fusion of the femoral head to the acetabulum.

**Avascular necrosis**—Destruction of cartilage tissue due to impaired blood supply.

**Femoral head**—The upper end of the femur.

**Hip dysplasia**—Abnormal development of the hip joint.

**Legg-Calve-Perthes disease (LCP)**—A disorder in which the femoral head deteriorates within the hip joint as a result of insufficient blood supply.

**Osteotomy**—The surgical cutting of any bone.

**Valgus**—A deformity in which a body part is angled away from the midline of the body.

**Varus**—A deformity in which a body part is angled toward the midline of the body.

## Diagnosis/Preparation

A **physical examination** performed by a pediatrician or an orthopaedic surgeon is the best method for diagnosing developmental dysplasia of the hip. Other aids to diagnosis include **ultrasound** examination of the hips during the first six months of life. An ultrasound study is better than an x ray for evaluating hip dysplasia in an infant because much of the hip is made of cartilage at this age and does not show up clearly on x rays. Ultrasound imaging can accurately determine the location of the femoral head in the acetabulum, as well as the depth of the baby's hip socket. An x-ray examination of the pelvis can be performed after six months of age when the child's bones are better developed. Diagnosis in adults also relies on x-ray studies.

To prepare for a hip osteotomy, the patient should come to the clinic or hospital one to seven days prior to surgery. The physician will review the proposed surgery with the patient and answer any questions. He or she will also review the patient's medical evaluation, laboratory test results, and x-ray findings, and schedule any other tests that are required. Patients are instructed not to eat or drink anything after midnight the night before surgery to prevent nausea and vomiting during the operation.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A hip osteotomy is performed in a hospital by surgeons who specialize in the treatment of hip disorders, such as reconstructive orthopedic surgeons, pediatric orthopedic surgeons, and physiatrists.

## Aftercare

Immediately following a hip osteotomy, patients are taken to the **recovery room** where they are kept for one to two hours. The patient's blood pressure, circulation, respiration, temperature, and wound drainage are carefully monitored. **Antibiotics** and fluids are given through the IV line that was placed in the arm vein during surgery. After a few days the IV is disconnected; if antibiotics are still needed, they are given by mouth for a few more days. If the patient feels some discomfort, pain medication is given every three to four hours as needed.

Patients usually remain in the hospital for several days after a hip osteotomy. Most VRO patients also require a body cast that includes the legs, which is known as a spica cast. Because of the extent of the surgery that must be done and healing that must occur to restore the pelvis to full strength, the patient's hip may be kept from bearing the full weight of the upper body for about eight to 10 weeks. A second operation may be performed after the patient's pelvis has healed to remove some of the hardware that the surgeon had inserted. Full recovery following an osteotomy usually takes longer than with a total hip replacement; it may be about four to six months before the patient can walk without assistive devices.

## Risks

Although complications following hip osteotomy are rare, there is a small chance of infection or blood clot formation. There is also a very low risk of the bone not healing properly, surgical damage to a nerve or artery, or poor skin healing.

## Normal results

Full recovery from an osteotomy takes six to 12 months. Most patients, however, have good outcomes following the procedure.

## QUESTIONS TO ASK THE DOCTOR

- What are the alternatives to hip osteotomy in my case?
- What are the chances that my hip can be corrected?
- How long will it take to recover from the surgery?
- Will I need a second operation?
- What procedure do you usually use?
- How many osteotomies do you perform each year?

### Alternatives

One alternative is to postpone surgery, if the patient's pain can be sufficiently controlled with medication to allow reasonable comfort, and if the patient is willing to accept a lower range of motion in the affected hip.

Surgical alternatives to a hip osteotomy include:

- **Total hip replacement.** Total hip replacement is an operation designed to replace the entire damaged hip joint. Various prosthetic designs and types of procedures are available. The procedure involves surgical removal of the damaged parts of the hip joint and replacing them with artificial components made from ceramic or metal alloys. The bearing surface is usually made from a durable type of polyethylene, but other materials including ceramics, newer plastics, or metals may be used.
- **Arthrodesis.** This procedure is rarely performed as of 2003, but is considered particularly effective for younger patients who are short in stature and otherwise healthy. Arthrodesis relieves pain by fusing the femoral head to the acetabulum. It has none of the limitations that a joint replacement or other procedure imposes on the patient's activity level. An arthrodesis is especially suited for patients with strong backs and no other symptoms. The procedure generally requires internal fixation with a plate and screws. The patient may be immobilized in a cast while healing takes place. An arthrodesis can be converted to a total hip replacement at a later date.
- **Pseudarthrosis.** This procedure is also called a Girdlestone operation. A pseudarthrosis involves removing the femoral head without replacing it with an artificial part. It is performed in patients with hip infections and those whose bones cannot tolerate a reconstructive procedure. Pseudarthrosis

leaves the patient with one leg shorter and usually less stable than the other. After this procedure, the patient almost always needs at least one crutch, especially for long-distance walking.

### Resources

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## ORGANIZATIONS

American Academy of Orthopaedic Surgeons, 6300 N. River Road, Rosemont, IL, 60018 4262, (847) 823 7186, (800) 346 AAOS, (847) 823 8125, <http://www.aaos.org>.

American College of Surgeons, 633 N. Saint Clair St., Chicago, IL, 60611 3211, (312) 202 5000, (800) 621 4111, (312) 202 5001, [postmaster@facs.org](mailto:postmaster@facs.org), <http://www.facs.org>.

American Society for Bone and Mineral Research, 2025 M Street, NW, Suite 800, Washington, DC, 20036 3309, (202) 367 1161, <http://www.asbmr.org>.

Arthritis Foundation, P.O. Box 7669, Atlanta, GA, 30357 0669, (800) 283 7800, <http://www.arthritis.org>.

Orthopedic Trauma Association, 6300 N. River Road, Suite 727, Rosemont, IL, 60018 4226, (847) 698 1631, <http://www.ota.org/links.htm>.

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Hip prosthesis surgery see **Hip revision surgery**

## Hip replacement

### Definition

Hip replacement is a procedure in which the surgeon removes damaged or diseased parts of the patient's hip joint and replaces them with new artificial parts. The operation itself is called hip **arthroplasty**. Arthroplasty comes from two Greek words, *arthros*, or joint, and *plassein*, "to form or shape." It is a type of surgery done to replace or reconstruct a joint. The artificial joint itself is called a prosthesis. Hip prostheses may be made of metal, ceramic, plastic, or various combinations of these materials.

### Purpose

Hip arthroplasty has two primary purposes: pain relief and improved functioning of the hip joint.

### Pain relief

Because total hip replacement (THR) is considered major surgery, with all the usual risks involved, it is usually not considered as a treatment option until the patient's pain cannot be managed any longer by more conservative nonsurgical treatment.

Joint pain interferes with a person's quality of life in many ways. If the pain in the hip area is chronic, affecting the person even when he or she is resting, it can lead to depression and other emotional disturbances. Severe

chronic pain also strains a person's relationships with family members, employer, and workplace colleagues; it is now recognized to be the most common underlying cause of suicide in the United States.

In most cases, however, pain in the hip joint is a gradual development. Typically, the patient finds that their hip begins to ache when they are exercising vigorously, walking, or standing for a long time. They may cut back on athletic activities only to find that they are starting to limp when they walk and that sitting down is also becoming uncomfortable. Many patients then begin to have trouble driving, sitting through a concert or movie, or working at a desk without pain. It is usually at this point, when a person's ability to live independently is threatened, that he or she considers hip replacement surgery.

### Joint function

Restoration of joint function is the other major purpose of hip replacement surgery. The hip joint is one of the most active joints in the human body, designed for many different types of movement. It consists of the head (top) of the femur (thighbone), which is shaped like a ball, and a part of the pelvic bone called the acetabulum, which looks like a hollow or socket. In a healthy hip joint, a layer of cartilage lies between the head of the femur and the acetabulum. The cartilage keeps the bony surfaces from grinding against each other, and allows the head of the femur to rotate or swivel in different directions inside the socket formed by the acetabulum. It is this range of motion, as well as the hip's ability to support the weight of the upper body, that is gradually lost when the hip joint deteriorates. The prostheses that are used in hip replacement surgery are intended to restore as much of the functioning of the hip joint as possible. The level of function in the hip after the surgery depends in part on the reason for the damage to the joint.

Disorders and conditions that may lead to the need for hip replacement surgery include:

- **Osteoarthritis (OA).** Osteoarthritis is a disorder in which the cartilage in the joints of the body gradually breaks down, allowing the surfaces of the bones to rub directly and wear against each other. Eventually the patient experiences swelling, pain, inflammation, and increasing loss of mobility. OA most often affects adults over age 45, and is thought to result from a combination of wear and tear on the joint, lifestyle, and genetic factors. OA is the most common cause of joint damage requiring hip replacement.



## KEY TERMS

**Acetabulum**—The socket-shaped part of the pelvis that forms part of the hip joint.

**Analgesic**—A medication given to relieve pain.

**Ankylosing spondylitis**—A form of inflammatory arthritis in which the bones in the spine and pelvis gradually fuse when inflamed connective tissue is replaced by bone.

**Arthrodesis**—A surgical procedure sometimes used to treat younger patients with hip problems, in which the head of the femur is fused directly to the acetabulum.

**Arthroplasty**—The medical term for surgical replacement of a joint. Arthroplasty can refer to knee as well as hip replacement.

**Autologous blood**—The patient's own blood is drawn and set aside for use during surgery in case a transfusion is needed.

**Avascular necrosis**—A disorder in which bone tissue dies and collapses following the temporary or permanent loss of its blood supply; it is also known as osteonecrosis.

**Cartilage**—A whitish elastic connective tissue that allows the bones forming the hip joint to move smoothly against each other.

**Cortisone**—A steroid compound used to treat autoimmune diseases and inflammatory conditions. It is sometimes injected into a joint to relieve the pain of arthritis.

**Deep venous thrombosis (DVT)**—The formation of a blood clot in the deep vein of the leg. It is considered a serious complication of hip replacement surgery.

**Epidural**—A method of administering anesthesia by injecting it into the lower spine in the space around the spinal cord. Epidural anesthesia blocks sensation in the parts of the body below the level of the injection.

**Femur**—The medical name for the thighbone.

**Heterotopic bone**—Bone that develops as an excess growth around the hip joint following surgery.

**Nonsteroidal anti-inflammatory drugs (NSAIDs)**—A term used for a group of analgesics that also reduce inflammation when used over a period of time. NSAIDs are often given to patients with osteoarthritis.

**Orthopaedics**—The branch of surgery that treats deformities or disorders affecting the musculoskeletal system.

**Osteolysis**—Dissolution and loss of bone resulting from inflammation caused by particles of debris from a prosthesis.

**Osteotomy**—A surgical alternative to a hip prosthesis, in which the surgeon cuts through the pelvis or femur in order to realign the hip.

**Prosthesis (plural, prostheses)**—An artificial device that substitutes for or supplements a missing or damaged body part. Prostheses may be either external or implanted inside the body.

**Tourniquet**—A tube or pressure cuff that is tightened around a limb in order to compress a vein to stop bleeding.

- **Rheumatoid arthritis (RA).** Rheumatoid arthritis is a disease that begins earlier in life than OA and affects the whole body. Women are three times as likely as men to develop RA. Its symptoms are caused by the immune system's attacks on the body's own cells and tissues. Patients with RA often suffer intense pain even when they are not putting weight on the affected joints.
- **Trauma.** Damage to the hip joint from a fall, automobile accident, or workplace or athletic injury may trigger the process of cartilage breakdown in the hip joint.
- **Avascular necrosis.** Avascular necrosis, which is also called osteonecrosis, is a disorder caused by the loss of blood supply to bone tissue. Bone starved for blood supply becomes weak and eventually collapses. The most common reasons for loss of blood supply include trauma, the use of steroid medications, certain blood

disorders, and alcoholism. Avascular necrosis often affects the top of the femur that forms part of the hip joint. It develops most frequently in adults between the ages of 30 and 50.

- **Ankylosing spondylitis (AS).** Ankylosing spondylitis is a less common form of arthritis that primarily affects the bones in the spine and pelvis. These bones gradually fuse together when the body replaces inflamed tendons or ligaments with new bone instead of elastic connective tissue. AS typically develops in the patient's late teens or early twenties, with three times as many men affected as women.

## Demographics

Between 200,000 and 300,000 hip replacement operations are performed in the United States each

year, most of them in patients over the age of 60. According to the American Academy of Orthopaedic Surgeons (AAOS), only 5–10% of total hip replacements were in patients younger than 50. There are two reasons for this concentration in older adults. Arthritis and other degenerative joint disorders are the most common health problems requiring hip replacement, and they become more severe as people grow older. The second reason is the limited life expectancy of the prostheses used in hip replacements. Because THR is a complex procedure and requires a long period of recovery after surgery, doctors generally advise patients to put off the operation as long as possible so that they will not need to undergo a second operation later to insert a new prosthesis.

This demographic picture is changing rapidly, however, because of advances in designing hip prostheses, as well as changes in older Americans' rising expectations of quality of life. Many people are less willing to tolerate years of pain or limited activity in order to postpone surgery. In addition, hip prostheses are lasting longer than those used in the 1960s; one study found that 65% of the prostheses in patients who had had THR before the age of 50 were still intact and functioning well 25 years after the surgery. A larger number of hip replacements are now being done in younger patients, and the operation itself is being performed more often. One expert estimates that the annual number of hip replacements in the United States will rise to 600,000 by 2015.

## Description

Hip replacement surgery is a relatively recent procedure that had to wait for the invention of plastics and other synthetic materials to make reliable prostheses that could withstand years of wear. The first successful total hip replacement was performed in 1962 by Sir John Charnley (1911–1982), a British orthopedic surgeon who designed a device that is still known as a Charnley prosthesis. Charnley used a stainless steel ball mounted on a stem that was inserted into the patient's thighbone to replace the femoral head. A high-density polyethylene socket was fitted into the acetabular side of the joint. Both parts of the Charnley prosthesis were secured to their respective sides of the joint with acrylic polymer cement. More recent developments include the use of cobalt chrome alloys or ceramic materials in place of stainless steel, as well as methods for holding the prosthesis in place without cement.

There are three major types of hip replacement surgery performed in the United States: a standard procedure for hip replacement; a newer technique known as minimally invasive surgery (MIS), pioneered

in Chicago in February 2001; and revision surgery, which is done to replace a loosened or damaged prosthesis.

### *Standard hip replacement surgery*

A standard hip replacement operation takes between one and a half and three hours. The patient may be given a choice of general, spinal, or epidural anesthesia. An epidural anesthesia, which is injected into the space around the spinal cord to block sensation in the lower body, causes less blood loss and also lowers the risk of blood clots or breathing problems after surgery. After the patient is anesthetized, the surgeon makes an incision 8–12 in (20–30 cm) long down the side of the patient's upper thigh. The surgeon may then choose to enter the joint itself from the side, back, or front. The back approach is the most common. The ligaments and muscles under the skin are then separated.

Once inside the joint, the surgeon separates the head of the femur from the acetabulum and removes the head with a saw. The surgeon uses a power drill and a special reamer to remove the cartilage from the acetabulum and shape it to accept the acetabular part of the prosthesis. This part of the new prosthesis is a curved piece of metal lined with plastic or ceramic.

After selecting the correct size for the patient, the surgeon inserts the acetabular component. If the new joint is to be cemented, the surgeon will attach the component to the bone with a type of epoxy. Otherwise, the metal plate will be held in place by screws or by the tightness of the fit itself.

To replace the femoral head, the surgeon first drills a hole inside the thighbone to accept a stem for the femoral component. The stem may be cemented in place or held in place by the tightness of the fit. A metal or ceramic ball to replace the head of the femur is then attached to the stem.

After the prosthesis is in place, an x ray is taken to verify that it is correctly positioned. The incision is then washed with saline solution as a safeguard against infection. The sutures used to close the deeper layers of tissue are made of a material that the body eventually absorbs, while the uppermost layer of skin is closed with metal surgical **staples**. The staples are removed 10–14 days after surgery.

Finally, a large triangular pillow known as a Charnley pillow is placed between the patient's ankles to prevent dislocation of the hip during the first few days after surgery.

### *Minimally invasive hip replacement surgery*

Minimally invasive surgery (MIS) is a new technique of hip replacement introduced in 2001. Instead of making one long incision, the surgeon uses two 2-in (5 cm) incisions or one 3.5-in (9 cm) incision. Using newly designed smaller implements, the surgeon removes the damaged bone and inserts the parts of the new prosthesis. MIS hip replacement takes only an hour and a half. As there is less bleeding, the patient can leave the hospital the next day. However, obese patients or those with very weak bones are not considered for MIS.

### *Revision surgery*

Revision surgery is most commonly performed to replace a prosthesis that no longer fits or functions well because the bone in which it is implanted has deteriorated with age or disease. Revision surgery is a much more complicated process than first-time hip replacement; it sometimes requires a specialized prosthesis, as well as bone grafts from the patient's pelvis, and its results are not usually as good. On the other hand, some patients have had as many as three revision operations with satisfactory results.

### **Diagnosis/Preparation**

Because pain in the hip joint is usually a gradual development, its cause has been diagnosed in most cases by the time the patient is ready to consider hip replacement surgery. The doctor will have taken a careful medical and employment history in order to determine the most likely cause of the pain and whether the patient's job may be a factor. The doctor will also ask about a family history of osteoarthritis as well as other disorders known to run in families. The patient will be asked about injuries, falls, or other accidents that may have affected the hip joint, and about his or her use of alcohol and prescription medications—particularly steroids, which can cause avascular necrosis.

The patient will then be given a complete **physical examination** to evaluate his or her fitness for surgery. Certain disorders, including Parkinson's disease, dementia and other conditions of altered mental status, kidney disease, advanced osteoporosis, disorders associated with muscle weakness, diabetes, and an unstable cardiovascular system are generally considered contraindications to hip replacement surgery. People with weakened immune systems may also be advised against surgery. In the case of obesity, the operation may be postponed until the patient loses weight. The stress placed on the hip joint during

normal walking can be as high as three times the patient's body weight; thus, each pound in weight reduction equals three pounds in stress reduction. Consequently, weight reduction lowers an obese patient's risk of complications after the operation.

The doctor will also order an x ray of the affected hip. The results will show the location and extent of damage to the hip joint.

### *Diagnostic tests*

The doctor may also order one or more specialized tests, depending on the known or suspected causes of the pain:

- **Aspiration.** Aspiration is a procedure in which fluid is withdrawn from the joint by a needle and sent to a laboratory for analysis. It is done to check for infection in the joint.
- **Arthrogram.** An arthrogram is a special type of x ray in which a contrast dye is injected into the hip to outline the cavity surrounding the joint.
- **Magnetic resonance imaging (MRI).** An MRI uses a large magnet, radio waves, and a computer to generate images of the head and back. It is helpful in diagnosing avascular necrosis.
- **Computed axial tomography (CAT) scan.** A CAT scan is another specialized type of x ray that uses computers to generate three-dimensional images of the hip joint. It is most often used to evaluate the severity of avascular necrosis and to obtain a more accurate picture of malformed or unusually shaped joints.
- **Bone densitometry test.** This test measures the density or strength of the patient's bones. It does not require injections; the patient lies flat on a padded table while an imager passes overhead. This test is most often given to patients at risk for osteoporosis or other disorders that affect bone density.

### *Preoperative preparation*

Hip replacement surgery requires extensive and detailed preparation on the patient's part because it affects so many aspects of life.

**LEGAL AND FINANCIAL CONSIDERATIONS.** In the United States, physicians and hospitals are required to verify the patient's insurance benefits before surgery and to obtain pre-certification from the patient's insurer or from **Medicare**. Without health insurance, the total cost of a hip replacement can run tens of thousands of dollars. In addition to insurance documentation, patients are legally required to sign an **informed consent** form prior to surgery to signify

that the patient is a knowledgeable participant in making healthcare decisions. The doctor will discuss all of the following with the patient before he or she signs the form: the nature of the surgery; reasonable alternatives to the surgery; and the risks, benefits, and uncertainties of each option. Informed consent also requires the doctor to make sure that the patient understands the information that has been given.

**MEDICAL CONSIDERATIONS.** Patients are asked to do the following in preparation for hip replacement surgery:

- Get in shape physically by doing exercises for strengthening the heart and lungs, building up the muscles around the hip, and increasing the range of motion of the hip joint. Many clinics and hospitals distribute illustrated pamphlets of pre-operation exercises.
- Lose weight if the surgeon recommends it.
- Quit smoking as smoking weakens the cardiovascular system and increases the risks that the patient will have breathing difficulties under anesthesia.
- Make donations of one's own blood for storage in case a transfusion is necessary during surgery. This procedure is known as autologous blood donation; it has the advantage of avoiding the risk of transfusion reactions or transmission of diseases from infected blood donors.
- Have necessary dental work completed before the operation. This precaution is necessary because small numbers of bacteria enter the bloodstream whenever a dentist performs any procedure that causes the gums to bleed. Bacteria from the mouth can be carried to the site of the hip replacement and cause an infection.
- Discontinue taking birth control pills and any anti-inflammatory medications (aspirin or NSAIDs) two weeks before surgery. Most doctors also recommend discontinuing any alternative herbal preparations at this time, as some of them interact with anesthetics and pain medications.

**LIFESTYLE CHANGES.** Hip replacement surgery requires a long period of **recovery at home** after leaving the hospital. Since the patient's physical mobility will be limited, he or she should do the following before the operation:

- Arrange for leave from work, help at home, help with driving, and similar tasks and commitments.
- Obtain a handicapped parking permit.
- Check the living quarters thoroughly for needed adjustments to furniture, appliances, lighting, and personal conveniences. People recovering from hip

replacement surgery must minimize bending, stooping, and any risk of falling.

- Stock up on nonperishable groceries, cleaning supplies, and similar items in order to minimize the need for shopping.
- Have a supply of easy-care clothing with elastic waistbands and simple fasteners in front rather than complicated ties or buttons in the back. Shoes should be slip-ons or fastened with Velcro.

Many hospitals and clinics now have classes for patients scheduled for hip replacement surgery. These classes answer questions regarding preparation for the operation and what to expect during recovery, but in addition they provide opportunities for patients to share concerns and experiences. Studies indicate that patients who have attended these pre-operation classes are less anxious before surgery and generally recover more rapidly.

### Aftercare

Aftercare following hip replacement surgery begins while the patient is still in the hospital. Most patients will remain there for five to 10 days after the operation. During this period, the patient will be given fluids and antibiotic medications intravenously to prevent infection. Medications for pain will be given every three to four hours, or through a device known as a PCA (patient-controlled anesthesia), which is a small pump that delivers a dose of medication into the IV when the patient pushes a button. To get the lungs back to normal functioning, a respiratory therapist will ask the patient to cough several times a day or breathe into blow bottles.

Aftercare during the hospital stay is also intended to lower the risk of a venous thromboembolism (VTE), or blood clot in the deep veins of the leg. Prevention of VTE involves medications to thin the blood; exercises for the feet and ankles while lying in bed; and wearing thromboembolic deterrent (TED) or deep vein thrombosis (DVT) stockings. TED stockings are made of nylon (usually white) and may be knee-length or thigh-length; they help to reduce the risk of a blood clot forming in the leg vein by putting mild pressure on the veins. TED stockings are worn for two to six weeks after surgery.

Physical therapy is also begun during the patient's hospital stay, often on the second day after the operation. The physical therapist will introduce the patient to using a walker or crutches and explain how to manage such activities as getting out of bed or showering without dislocating the new prosthesis. In addition to increasing the patient's level of physical activity



each day, the physical therapist will help the patient select special equipment for recovery at home. Commonly recommended devices include a reacher for picking up objects without bending too far, a sock cone and special shoehorn, and bathing equipment.

Following **discharge from the hospital**, the patient may go to a skilled nursing facility, rehabilitation center, or directly home. Ongoing physical therapy is the most important part of recovery for the first four to five months following surgery. Most insurance companies in the United States allow home visits by a home health aide, visiting nurse, and physical therapist for three to four weeks after surgery. The physical therapist will monitor the patient's progress, as well as suggest specific exercises to improve strength and range of motion. After the home visits, the patient is encouraged to take up other forms of physical activity in addition to the exercises; swimming, walking, and pedaling a stationary bicycle are all good ways to speed recovery. The patient may take a mild medication for pain (usually **aspirin** or ibuprofen) 30–45 minutes before an **exercise** session, if needed.

Most patients can start driving six to eight weeks after the operation and return to work full time after eight to 10 weeks, depending on the amount and type of physical exertion their jobs requires. Some patients arrange to work on a part-time basis until their normal level of energy returns.

## Risks

Hip replacement surgery involves both short- and long-term risks.

### Short-term risks

The most common risks associated with hip replacement are as follows:

- **Dislocation of the new prosthesis.** Dislocation is most likely to occur in the first 10–12 weeks after surgery. It is a risk because the ball and socket in the prosthesis are smaller than the parts of the natural joint, and can move out of place if the patient places the hip in certain positions. The three major rules for avoiding dislocation are: do not cross the legs when lying, sitting, or standing; never lean forward past a 90° angle at the waist; and do not roll the legs inward toward each other—keep the feet pointed forward or turned slightly outward.
- **Deep vein thrombosis (DVT).** There is some risk (about 1.5% in the United States) of a clot developing in the deep vein of the leg after hip replacement surgery because the blood supply to the leg is cut off by a tourniquet during the operation. The blood-

thinning medications and TED stockings used after surgery are intended to minimize the risk of DVT.

- **Infection.** The risk of infection is minimized by storing autologous blood for transfusion and administering intravenous antibiotics after surgery. Infections occur in fewer than 1% of hip replacement operations.
- **Injury to the nerves that govern sensation in the leg.** This problem usually resolves over time.

### Long-term risks

The long-term risks of hip replacement surgery include:

- **Inflammation related to wear and tear on the prosthesis.** Tiny particles of debris from the prosthesis can cause inflammation in the hip joint and lead eventually to dissolution and loss of bone. This condition is known as osteolysis.
- **Heterotopic bone.** Heterotopic bone is bone that develops in the space between the femur and the pelvis after hip replacement surgery. It can cause stiffness and pain, and may have to be removed surgically. The cause is not completely understood, but is thought to be a reaction to the trauma of the operation. In the United States, patients are usually given indomethacin (Indocin) to prevent this process; in Germany, surgeons are using postoperative radiation treatments together with Indocin.
- **Changed length of leg.** Some patients find that the operated leg remains slightly longer than the other leg even after recovery. This problem does not interfere with mobility and can usually be helped by an orthotic shoe insert.
- **Loosening or damage to the prosthesis itself.** This development is treated with revision surgery.

## Normal results

Normal results are relief of chronic pain, greater ease of movement, and much improved quality of life. Specific areas of improvement depend on a number of factors, including the patient's age, weight, and previous level of activity; the disease or disorder that caused the pain; the type of prosthesis; and the patient's attitude toward recovery. In general, total hip replacement is considered one of the most successful procedures in modern surgery.

It is difficult to estimate the “normal” lifespan of a hip prosthesis. The figure quoted by many surgeons—between 10 and 15 years—is based on statistics from the early 1990s. It is too soon to tell how much longer the newer prostheses will last. In addition, as hip replacements become more common, the increased

size of the worldwide patient database will allow for more accurate predictions. It is known that younger patients and obese patients wear out hip prostheses more rapidly.

### Morbidity and mortality rates

Information about mortality and complication rates following THR is limited because the procedure is considered elective. The most important factor affecting morbidity and mortality rates in the United States, according to a Harvard study, is the volume of THRs performed at a given hospital or by a specific surgeon: the higher the volume, the better the outcomes.

### Alternatives

#### *Nonsurgical alternatives*

The most common conservative alternatives to hip replacement surgery are assistive devices (canes or walkers) to reduce stress on the affected hip; exercise regimens to maintain joint flexibility; dietary changes, particularly if the patient is overweight; and **analgesics**, or painkilling medications. Most patients who try medication begin with an over-the-counter NSAID such as ibuprofen (Advil). If the pain cannot be controlled by nonprescription analgesics, the doctor may give the patient cortisone injections, which relieve the pain of arthritis by reducing inflammation. Unfortunately, the relief provided by cortisone tends to diminish with each injection; moreover, the drug can produce serious side effects.

#### *Complementary and alternative (CAM) approaches*

Complementary and alternative forms of therapy cannot be used as substitutes for hip replacement surgery, but they are helpful in managing pain before and after the operation, and in speeding physical recovery. Many patients also find that CAM therapies help them maintain a positive mental attitude in coping with the emotional stress of surgery and physical therapy. CAM therapies that have been shown to relieve the pain of rheumatoid and osteoarthritis include acupuncture, music therapy, naturopathic treatment, homeopathy, Ayurvedic medicine, and certain herbal preparations. Chronic pain from other disorders affecting the hip has been successfully treated with **biofeedback**, relaxation techniques, chiropractic manipulation, and mindfulness meditation.

Some types of movement therapy are recommended in order to postpone the need for hip surgery. Yoga, tai chi, qigong, and dance therapy help to

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Hip replacement surgery is performed by an orthopedic surgeon, who has received advanced training in surgical treatment of disorders of the musculoskeletal system. Qualification for this specialty in the United States requires a minimum of five years of training after medical school. Most orthopedic surgeons who perform joint replacements have had additional specialized training in these specific procedures. If surgery is being considered, it is a good idea to find out how many hip replacements the surgeon performs each year; those who perform 200 or more have had more opportunities to refine their technique.

Hip replacement surgery can be performed in a hospital with a department of orthopedic surgery, but is also performed in specialized clinics or institutes for joint disorders. MIS is performed in a small number of specialized facilities and teaching hospitals attached to major university medical schools.

maintain strength and flexibility in the hip joint, and to slow down the deterioration of cartilage and muscle tissue. Exercise in general has been shown to reduce a person's risk of developing osteoporosis.

#### *Alternative surgical procedures*

Other surgical options include:

- **Osteotomy.** An osteotomy is a procedure in which the surgeon cuts the thigh bone or pelvis in order to realign the hip. It is done more frequently in Europe than in the United States, but it has the advantage of not requiring artificial materials.
- **Arthrodesis.** This type of operation is rarely performed except in younger patients with injury to one hip. In this procedure, the head of the femur is fused to the acetabulum with a plate and screws. The major advantage of arthrodesis is that it places fewer restrictions on the patient's activity level than a hip replacement.
- **Pseudarthrosis.** In this procedure, the head of the femur is removed without any replacement, resulting in a shorter leg on the affected side. It is usually performed when the patient's bones are too weak for implanting a prosthesis or when the hip joint is badly infected. This procedure is sometimes called a

## QUESTIONS TO ASK THE DOCTOR

- What alternatives to hip replacement might work for me?
- Am I a candidate for minimally invasive surgery?
- How many hip replacement operations do you perform each year?
- How many patients have you treated with my specific condition have you treated?
- Does the hospital have pre-operative patient groups that I can attend?

Girdlestone operation, after the surgeon who first used it in the 1940s.

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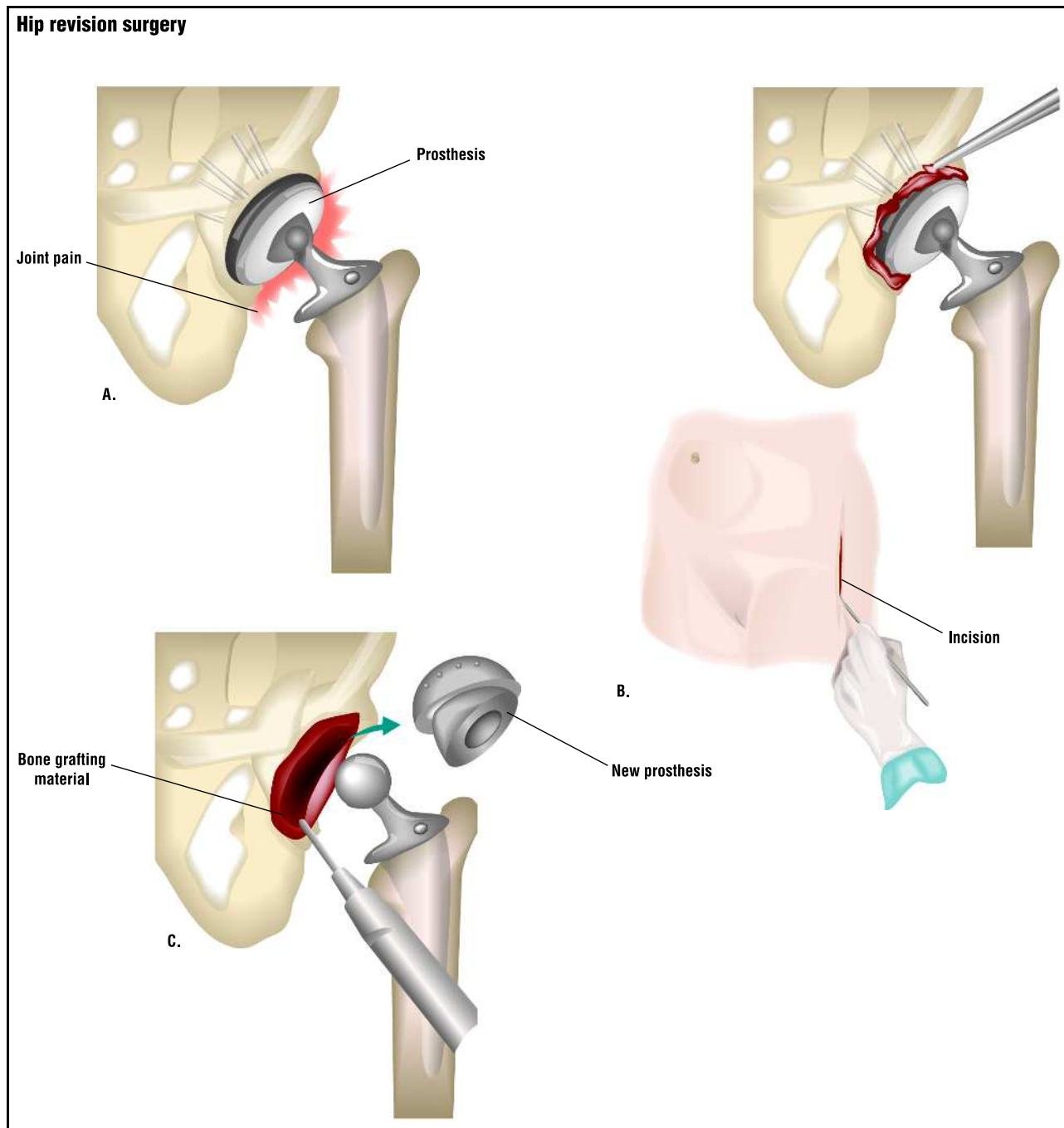
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## Hip revision surgery

### Definition

Hip revision surgery, which is also known as revision total hip **arthroplasty**, is a procedure in which the surgeon removes a previously implanted artificial hip joint, or prosthesis, and replaces it with a new prosthesis. Hip revision surgery may also involve



Degeneration of the joint around the prosthesis causes pain for some patients who have undergone hip replacement (A). To repair it, an incision is made in the hip and the old prosthesis is removed (B). Bone grafts may be planted in the hip, and a new prosthesis is attached (C). (Illustration by GGS Information Services. Cengage Learning, Gale.)

the use of bone grafts. The bone graft may be an autograft, which means that the bone is taken from another site in the patient's own body; or an allograft, which means that the bone tissue comes from another donor.

### Purpose

Hip revision surgery has three major purposes: relieving pain in the affected hip; restoring the patient's mobility; and removing a loose or damaged



## KEY TERMS

**Acetabulum**—The socket-shaped part of the pelvis that forms part of the hip joint.

**Allograft**—A graft of bone or other tissue taken from a donor.

**Analgesic**—A medication given to relieve pain.

**Arthroscope**—An instrument that contains a miniature camera and light source mounted on a flexible tube. It allows a surgeon to see the inside of a joint or bone during surgery.

**Autograft**—A graft of bone or other tissue taken from the body of the patient undergoing surgery.

**Femur**—The medical name for the thighbone. The femur is the largest bone in the human body.

**Impaction grafting**—The use of crushed bone from a donor to fill in the central canal of the femur during hip revision surgery.

**Metaphysis**—The widened end of the shaft of a long tubular bone such as the femur.

**Orthopedics (sometimes spelled orthopaedics)**—The branch of surgery that treats deformities or disorders affecting the musculoskeletal system.

**Osteolysis**—Dissolution and loss of bone resulting from inflammation caused by particles of polyethylene debris from a prosthesis.

**Osteotomy**—The cutting apart of a bone or removal of bone by cutting. An osteotomy is often necessary during hip revision surgery in order to remove the femoral part of the old prosthesis from the femur.

**Prosthesis (plural, prostheses)**—An artificial device that substitutes for or supplements a missing or damaged body part. Prostheses may be either external or implanted inside the body.

**Quadriceps muscles**—A set of four muscles on each leg located at the front of the thigh. The quadriceps straighten the knee and are used every time a person takes a step.

**Templating**—A term that refers to the surgeon's use of x-ray images of an old prosthesis as a template or pattern guide for a new implant.

prosthesis before irreversible harm is done to the joint. Hip prostheses that contain parts made of polyethylene typically become loose because wear and tear on the prosthesis gradually produces tiny particles from the plastic that irritate the soft tissue around the prosthesis. The inflamed tissue begins to dissolve the underlying bone in a process known as osteolysis. Eventually, the soft tissue expands around the prosthesis to the point at which the prosthesis loses contact with the bone.

In general, a surgeon will consider revision surgery for pain relief only when more conservative measures, such as medication and changes in the patient's lifestyle, have not helped. In some cases, revision surgery is performed when x-ray studies show loosening of the prosthesis, wearing of the surfaces of the hip joint, or loss of bone tissue even though the patient may not have experienced any discomfort. In most cases, however, increasing pain in the affected hip is one of the first indications that revision surgery is necessary.

Other less common reasons for hip revision surgery include fracture of the hip, the presence of infection, or dislocation of the prosthesis. In these cases, the prosthesis must be removed in order to prevent long-term damage to the hip itself.

## Demographics

The demographics of hip revision surgery are likely to change significantly over the next few decades as the proportion of people over 65 in the world's population continues to increase. However, demographic information about this procedure is difficult to evaluate. This difficulty is due in part to the fact that total **hip replacement (THR)** itself is a relatively new procedure dating back only to the early 1960s. Since the design of hip prostheses and the materials used in their manufacture have changed over the last 40 years, it is difficult to predict whether prostheses implanted in the early 2000s will last longer than those used in the past and, if so, whether improved durability will affect the need for revision surgery. On the other hand, more THRs are being performed in younger patients who are more likely to wear out their hip prostheses relatively quickly because they are more active and living longer than the previous generation of THR recipients. In addition, recent improvements in surgical technique as well as in prosthesis design have made hip revision surgery a less risky procedure than it was even a decade ago. One Scottish surgeon has reported performing as many as four hip revisions on selected patients, with highly successful outcomes.

While information on the epidemiology of both THR and hip revision surgery is limited, one study found that three to six times as many THRs were performed as revision surgeries. Women had higher rates of both procedures than men, and Caucasians had higher rates than African Americans. Other researchers have reported that one reason for the lower rate of hip replacement and revision procedures among African Americans is the difference in social networks. African Americans are less likely than Caucasians to know someone who has had hip surgery, and they are therefore less likely to consider it as a treatment option.

## Description

Hip revision surgery is hard to describe in general terms because the procedure depends on a set of factors unique to each patient. These factors include the condition of the patient's hip and leg bones; the type of prosthesis originally used; whether the original prosthesis was cemented or held in place without cement; and the patient's age and overall health. Unlike standard THR, however, hip revision surgery is a much longer and more complicated procedure. It is not unusual for a hip revision operation to take from five to eight hours.

The most critical factor affecting the length of the operation and some of the specific steps in hip revision surgery is the condition of the bone tissue in the femur. Defects in the bone are classified in four stages, including:

- Type I. Minimal bone defects.
- Type II. Most of the damage lies at the metaphysis (the flared end of the femur), with minimal damage to the shaft of the bone.
- Type III. All of the damage lies at the metaphysis.
- Type IV. There is extensive bone loss in the femoral shaft as well as at the metaphysis.

The first stage in all hip revision surgery is the removal of the old prosthesis. The part attached to the acetabulum is removed first. The hip socket is cleaned and filled with morselized bone, which is bone in particle form. The new shell and liner are then pressed into the acetabulum.

Revision of the femoral component is the most complicated part of hip revision surgery. If the first prosthesis was held in place by pressure rather than cement, the surgeon usually cuts the top of the femur into several pieces to remove the implant. This cutting apart of the bone is known as osteotomy. The segments of bone are cleaned and the new femoral implant is pressed or cemented in place. If the patient's bone has

been classified as Type IV, bone grafts may be added to strengthen the femur. These grafts consist of morselized bone from a donor (allograft bone) that is packed into the empty canal inside the femur. This technique is called impaction grafting. The segments of the femur are then reassembled around the new implant and bone grafts, and held in place with surgical wire.

A newer technique that was originally designed to help surgeons remove old cement from prostheses that were cemented in place can sometimes be used instead of osteotomy. This method involves the use of a ballistic chisel powered by controlled bursts of pressurized nitrogen. The ballistic chisel is used most often to break up pieces of cement from a cemented prosthesis, but it can also be used to loosen a prosthesis that was held in place only by tightness of fit. In addition to avoiding the need for an osteotomy, the ballistic chisel takes much less time. The surgeon uses an arthroscope in order to view the progress of the chisel while he or she is working inside the femur itself.

After all the cement has been removed from the inner canal of the femur, the surgeon washes out the canal with saline solution, inserts morselized bone if necessary, and implants the new femoral component of the prosthesis. After both parts of the prosthesis have been checked for correct positioning, the head of the femoral component is fitted into the new acetabular component and the incision is closed.

## Diagnosis/Preparation

### Diagnosis

In most cases, increasing pain, greater difficulty in placing weight on the hip, and loss of mobility in the hip joint are early indications that revision surgery is necessary. The location of the pain may point to the part of the prosthesis that has been affected by osteolysis. The pain is felt in both the hip area and the thigh when both parts of the prosthesis have become loose; if only the femoral component has been affected, the patient usually feels pain only in the thigh. However, some patients do not experience any discomfort even though their prosthesis is loosening or wearing against surrounding structures. In addition, a minority of patients who have had THR have always had pain from their artificial joints, and these patients may not consider their discomfort new or significant.

In general, diagnostic imaging that shows bone loss, loosening of the prosthesis, or wearing away of the joint tissues is an essential aspect of hip revision surgery—many orthopedic surgeons will not consider the procedure unless the x-ray studies reveal one or more of these signs. X-ray studies are also

used to diagnose fractures of the hip or dislocated prostheses. In some cases, the doctor may order a computed tomography (CT) scan to confirm the extent and location of suspected osteolysis; recent research indicates that **CT scans** can detect bone loss around a hip prosthesis at earlier stages than radiography.

Infections related to a hip prosthesis are a potentially serious matter. Estimated rates of infection following THR range between one in 300 operations and one in 100. Infections can develop at any time following THR, ranging from the immediate postoperative period to 10 or more years later. The symptoms of superficial infections include swelling, pain, and redness in the skin around the incision, but are usually treatable with **antibiotics**. With deep infections, antibiotics may not work and the new joint is likely to require revision surgery.

### *Preoperative preparation*

Certain health conditions or disorders are considered contraindications for hip revision surgery, including:

- a current hip infection
- dementia or other severe mental disorder
- severe vascular disease
- poor condition of the skin covering the hip
- extreme obesity
- paralysis of the quadriceps muscles
- terminal illness

Patients who are considered appropriate candidates for hip revision surgery are asked to come to the hospital about a week before the operation. X rays and other diagnostic images of the hip are reviewed in order to select the new prosthesis. This review is called templating because the diagnostic images serve as a template for the new implant. The surgeon will also decide whether special procedures or instruments will be needed to remove the old prosthesis.

### **Aftercare**

Aftercare for hip revision surgery is essentially the same as for hip replacement surgery. The major difference is that some patients with very weak bones are asked to use canes or walkers all the time following revision surgery rather than trying to walk without assistive devices.

## **Risks**

### *Risk factors*

Factors that lower a patient's chances for a good outcome from hip revision surgery include the following:

- Sex. Men are more likely to have poor outcomes from revision surgery than women.
- Age. Older patients, particularly those over 75, are more likely to have complications following revision surgery.
- Race. African Americans have a higher rate of complications than Caucasian or Asian Americans.
- Socioeconomic status (SES). Patients with lower incomes do not do as well as patients in higher income brackets.
- Presence of other chronic diseases or disorders.
- Obesity. Many surgeons will not perform hip revision surgery on patients weighing 300 pounds or more.
- Genetic factors. Recent British research indicates that patients who carry an inflammation control gene known as TNF-238A are twice as likely to require replacement of a hip prosthesis as those who lack this gene.

### *Specific risks of hip revision surgery*

Risks following hip revision surgery are similar to those following hip replacement surgery, including deep venous thrombosis and infection. The length of the patient's leg, however, is more likely to be affected following revision surgery. Dislocation is considerably more common because the tissues surrounding the bone are weaker as well as the bone itself usually being more fragile. One group of researchers found that the long-term rate of dislocation following revision surgery may be as high as 7.4%.

## **Normal results**

In general, hip revision surgery has less favorable outcomes than first-time replacement surgery. The greater length and complexity of the procedure often require a longer hospital stay as well as a longer period of **recovery at home**. The range of motion in the new joint is usually smaller than in the first prosthesis, and the patient may experience greater long-term discomfort. In addition, the new prosthesis is not expected to last as long. The life expectancy of implants used in first-time hip replacement surgery is usually given as 10–15 years, whereas revision implants may need to be removed after between eight and 10 years.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Hip revision surgery is performed by an orthopedic surgeon, who has received advanced training in surgical treatment of disorders of the musculoskeletal system. Qualification for this specialty in the United States requires a minimum of five years of training after medical school. Most orthopedic surgeons who perform joint replacements and revision surgery have had additional specialized training in these specific procedures. It is a good idea to find out how many hip revisions the surgeon performs each year; those who perform 200 or more have had more opportunities to refine their technique.

In many cases, hip revision surgery is done by the surgeon who performed the first replacement operation. Some surgeons, however, refer patients to colleagues who specialize in hip revision procedures.

Hip revision surgery can be performed in a hospital with a department of orthopedic surgery, but is also performed in specialized clinics or institutes for joint disorders.

## Morbidity and mortality rates

There are relatively few analyses of mortality and morbidity following hip revision surgery in comparison to studies of complications following THR.

## Alternatives

### Nonsurgical alternatives

In some cases, medications can be used to control the patient's pain, or the patient may prefer to use assistive devices rather than undergo revision surgery. If infection is present, however, surgery is necessary in order to remove the old prosthesis and any areas of surrounding bone that may be infected.

### Alternative and complementary treatments

Alternative and complementary approaches that have been shown to control discomfort after hip revision surgery include mindfulness meditation, **biofeedback**, acupuncture, and relaxation techniques. Music therapy, humor therapy, and aromatherapy are helpful

## QUESTIONS TO ASK THE DOCTOR

- How much improvement can I expect from hip revision surgery?
- How long is the new prosthesis likely to last?
- How many hip revision procedures have you performed?
- What are the alternatives to this procedure in my specific situation?

to some patients in maintaining a positive mental attitude and relieving emotional stress before surgery or during recovery at home.

## Resources

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Histocompatibility testing see **Human leukocyte antigen test**

HLA test see **Human leukocyte antigen test**

HMOs see **Managed care plans**

## Description

The goal of home care is to allow the patient to remain living at home, regardless of age or disability. After surgery, a patient may require home care services that may range from such homemaking services as cooking or cleaning to skilled medical care. In the United States, most home care (about 80%) is still provided by members of patients' families; however, some patients also require home health aides or personal care attendants to help them with activities of daily living (ADLs), which are usually defined as activities necessary for adequate self-care, such as bathing, dressing, going to the toilet, and the like. A second category, instrumental activities of daily living (IADLs), refers to tasks that a person must be capable of carrying out in order to live independently. IADLs include being able to perform light housework, prepare meals, take medications, go shopping for groceries or clothes, use the telephone, and manage money.

Medical, dental, and nursing care may all be delivered in patients' homes, which allows them to feel more comfortable and less anxious. The professionals most often involved in home care in the United States are nurses, followed by physical therapists and home health aides. Therapists from speech-language pathology, physical therapy, and respiratory therapy departments often make regular home visits, depending on a patient's specific needs. General nursing care is provided by both registered and licensed practical nurses; however, there are also nurses who are clinical specialists in psychiatry, obstetrics, and cardiology who may provide care when necessary. Home health aides provide what is called custodial care in domestic settings; their duties are similar to those of nurses' aides in the hospital. Professionals who deliver care to patients in their homes are employed either by independent for-profit home-care agencies, hospital agencies, or hospital departments. Personal care attendants can also be hired privately by patients; however, not only is it more difficult to evaluate an employee's specific background and credentials when he or she is not associated with a certified agency or hospital, but medical insurance may not cover the expense of an employee who does not come from an approved source.

Home care nurses provide care for patients of every age, economic class, and level of disability. Some nurses provide specialized **hospice**, mental health, or pediatric care. Home care nursing often involves more than biomedical-based care, depending on a patient's religious or spiritual background.

The NCHS reported that 76% of the 1.3 million persons receiving home care in the United States lived

## Home care

### Definition

Home care is a form of skilled health care service provided where a patient lives. It is sometimes called domiciliary care. Patients can receive home care services whether they live in their own homes, with or without family members, or in an assisted living facility. According to the National Center for Health Statistics (NCHS), about 1.3 million persons in the United States receive home care.

with a primary caregiver, usually a spouse, adult son or daughter, another relative, or a parent (in that order). Of adults aged 65, 6–7% needed assistance with ADLs, compared to 20.6% of persons over 85. Women were more likely to need assistance with ADLs than men. With regard to payment, 710,000 persons paid through **Medicare** and 277,000 through **Medicaid**.

### *Viewpoints*

Most patients are more comfortable in their own homes, rather than in a hospital setting. Depending on the patient's living status and relationships with others in the home, however, the home is not always the best place for caregiving. Consequently, home care continues to grow in popularity. Hospital stays have been shortened considerably, starting in the 1980s with the advent of the diagnosis-related group (DRG) reimbursement system as part of a continuing effort to reduce healthcare costs. But as a result, many patients come home "quicker and sicker," and in need of some form of care or help that family or friends may not be able to offer. Community-based healthcare services are expanding, giving patients more options for assistance at home.

### *History*

It is helpful to have some basic information about the evolution of home care in order to understand the public's demand for quality healthcare, cost containment, and the benefits of advances in both medical and communication technologies. Members of Roman Catholic religious orders in Europe first delivered home care in the late seventeenth century. Today, there are many home care agencies and visiting nurse associations (VNAs) that continue to deliver a wide range of home care services to meet the specific needs of patients throughout the United States and Canada.

Social factors have historically influenced home care delivery, and continue to do so today. Before the 1960s, home care was a community-based delivery system that provided care to patients whether they could pay for the services or not. Agencies relied on charitable contributions from private citizens or charitable organizations, as well as some limited government funding. Life expectancy of the United States population began to rise as advances in medical science saved patients who might have died in years past. As a result, more and more elderly or disabled people required medical care in their homes, as well as in institutions. In response, the federal government put Medicare and Medicaid programs into place in 1965 to help fund and regulate healthcare delivery for this population.

## KEY TERMS

**Activities of daily living (ADLs)**—Self-care activities performed during the course of a normal day such as eating, bathing, dressing, toileting, etc.

**Home health aide**—An employee of a home care agency who provides the same services to a patient in the home as nurses aides perform in hospitals and nursing homes.

**Instrumental activities of daily living (IADLs)**—Daily tasks that enable a person to live independently.

**Licensed practical nurse (LPN)**—A person who is licensed to provide basic nursing care under the supervision of a physician or a registered nurse.

**Medicaid**—The federally funded program in the United States for state-operated programs that provide medical assistance to permanently disabled patients and to low-income people. Medicaid is the medical assistance provided in Title XIX of the Social Security Act.

**Medicare**—The federally funded national health insurance program, provided for by Title XVIII of the Social Security Act in the United States for all people over the age of 65.

**Personal care attendant**—An employee hired either through a healthcare facility, home care agency, or private agency to assist a patient in performing ADLs.

**Psychiatric nursing**—The nursing specialty concerned with the prevention and treatment of mental disorders and their consequences.

**Registered nurse**—A graduate nurse who has passed a state nursing board examination and been registered and licensed to practice nursing.

**Respiratory therapy**—The department of any health care facility or agency that provides treatment to patients to maintain or improve their breathing function.

**Speech-language pathology**—Formerly known as speech therapy, it includes the study and treatment of human communication its development and disorders.

### *Funding and regulation*

Government involvement resulted in regulations that changed the focus of home care from a nursing care delivery service to care delivery under the direction of a physician. Home care delivery is paid for

either by the government through Medicare and/or Medicaid; by private insurance or health maintenance organizations (HMOs); by patients themselves; or by certain non-profit community, charitable disease advocacy organizations (e.g., ACS), or faith-based organizations.

Home care delivery services provided by Medicare-certified agencies are tightly regulated. For example, a patient must be homebound in order to receive Medicare-reimbursed home care services. The homebound requirement—one of many—means that the patient must be physically unable to leave home (other than for infrequent trips to the doctor or hospital), thereby restricting the number of persons eligible for home care services. Private insurance companies and HMOs also have certain criteria for the number of visits that will be covered for specific conditions and services. Restrictions on the payment source, the physician's orders, and the patient's specific needs determine the length and scope of services.

### *Assessment and implementation*

Since home care nursing services are provided on a part-time basis, patients, family members, or other caregivers are encouraged and taught to do as much of the care as possible. This approach goes beyond payment boundaries; it extends to the amount of responsibility the patient and his or her family or caregivers are willing or able to assume in order to reach expected outcomes. Nurses who have received special training as case managers visit the patient's home and draw up a plan of care based on assessing the patient, listing the diagnoses, planning the care delivery, implementing specific interventions, and evaluating outcomes or the efficacy of the implementation phase. Planning the care delivery includes assessing the care resources within the circle of the patient's caregivers.

At the time of the initial assessment, the visiting nurse, who is working under a physician's orders, enlists professionals in other disciplines who might be involved in achieving expected outcomes, whether those outcomes include helping the patient return to a certain level of health and independence or maintaining the existing level of health and mobility. The nurse provides instruction to the patient and caregiver(s) regarding the patient's particular disease(s) or condition(s) in order to help the patient achieve an agreed-upon level of independence. Home care nurses are committed to helping patients make good decisions about their care by providing them with reliable information about their conditions. Since home care relies heavily on a holistic approach, care delivery includes teaching coping mechanisms and promoting a positive

attitude to motivate patients to help themselves to the extent that they are able. Unless the patient is paying for home care services out-of-pocket and has unlimited resources or a specific private **long-term care insurance** policy, home care services are scheduled to end at some point. Therefore, the goal of most home care delivery is to move both the patient and the caregivers toward becoming as independent as possible during that time.

### *Professional implications*

Home care delivery is influenced by a number of variables. Political, social, and economic factors place significant constraints on care delivery. Differences among nurses, including their level of education, years of work experience, type of work experience, and level of cultural competence (cross-cultural sensitivity) all influence care delivery to some extent.

Some of the professional issues confronting home care nurses include:

- legal issues
- ethical concerns
- safety issues
- nursing skills and professional education

### *Legal issues*

The legal considerations connected with delivering care in a patient's private residence are similar to those of care delivered in healthcare facilities, but have additional aspects. For example, what would a home care nurse do if she or he had heard the patient repeatedly express the desire not to be resuscitated in case of a heart attack or other catastrophic event, and, during a home visit, the nurse finds the patient unresponsive and cannot find the orders not to resuscitate in the patient's chart? What happens if the patient falls during home care delivery? While processes, protocols, and standards of practice cannot be written to address every situation that may arise in a domestic setting, timely communication and strong policy are essential to keep both patients and home care staff free of legal liability.

### *Ethical concerns*

Ethical implications are closely tied to legal implications in home care—as in the case of missing do-not-resuscitate (DNR) orders. For example, what measures are appropriate if a home care nurse finds a severe diabetic and recovered alcoholic washing down a candy bar with a glass of bourbon? The patient is in his or her own residence and has the legal right to do as he or she chooses. Or, what about the family member

who has a bad fall while the nurse is in the home providing care? Should the nurse care for that family member as well? What is the nurse's responsibility to the patient when he or she notices that a family member is taking money from an unsuspecting patient? Complex ethical issues are not always addressed in policy statements. Ongoing communication between the home care agency and the nurse in the field is essential to address problematic situations.

### *Safety issues*

Safety issues in home care require attention and vigilance. The home care nurse does not have security officers readily available if a family member becomes violent either toward the healthcare worker or the patient. Sometimes, home care staff is required to visit patients in high-crime areas or after dark. All agencies should have some type of supervisory personnel available 24 hours a day, seven days a week, so that field staff can reach them with any concerns. Also, clear policy statements that cover issues of personal safety must be documented and communicated regularly and effectively.

### *Technological advances*

With advances in technology and the increased effort to control cost, home care delivery services are using "telecare," which uses communications technology to transmit medical information between the patient and the healthcare provider. Providing care to patients without being in their immediate presence is a relatively new form of home nursing, and is not without its problems. While some uncertainty exists regarding legal responsibilities and the potential for liability, much has been done to make telecare an effective way to hold costs down for some patients. Home care nurses who are required to make telecare visits should know what regulations exist in the particular state before providing care. The chief problem lies in diagnosing and prescribing over the phone. Technological advances have enabled patients to access telecare through the Internet using personal computers or using televisions. With the most recent advances in telecare, the following services may now be offered:

- instant access to patient records
- prescriptions for treatment
- assessment of possible dangers to the patient
- evaluation of the patient's treatment and medication
- follow-up care

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Homocysteine test see **Cardiac marker tests**

## Hospice

### Definition

The term hospice refers to an approach to end-of-life care as well as to a type of facility for supportive care of terminally ill patients. Hospice programs provide palliative (care that relieves discomfort but does not improve the patient's condition or cure the disease) patient-centered care, and other services. The goal of hospice care, whether delivered in the patient's home or in a healthcare facility, is the provision of humane and compassionate medical, emotional, and spiritual care to the **dying**.

### Description

#### Early history

The English word "hospice" is derived from the Latin *hospitium*, which originally referred to the guest-house of a monastery or convent. The first hospices date back to the Middle Ages, when members of religious orders frequently took in dying people and nursed them during their last illness. Other hospices were built along the routes to major pilgrimage shrines in medieval Europe, such as Rome, Compostela, and Canterbury. Pilgrims who died during their journey were cared for in these hospices. The modern hospice movement, however, may be said to have begun in the United Kingdom during the middle of the nineteenth century. In Dublin, the Roman Catholic Sisters of Charity undertook to provide a clean, supportive environment for care for the terminally ill. Their approach spread throughout England and as far as Asia, Australia, and



A nurse cares for a 95-year-old woman in a hospice. (Jim West/Alamy)

Africa; but until the early 1970s, it had not been accepted on any large scale in the United States.

Two physicians, Drs. Cicely Saunders and Elisabeth Kübler-Ross, are credited with introducing the hospice concept in the United States. Dame Saunders had originally trained as a nurse in England and afterward attended medical school. She founded St. Christopher's Hospice just outside London in 1962. St. Christopher's pioneered an interdisciplinary team approach to the care of the dying. This approach made great strides in **pain management** and symptom control. Dr. Saunders also developed the basic tenets of hospice philosophy, including:

- acceptance of death as the natural conclusion of life
- delivery of care by a highly trained, interdisciplinary team of health professionals who communicate among themselves regularly
- an emphasis on effective pain management and comprehensive home care services
- counseling for the patient and bereavement counseling for the family after the patient's death
- ongoing research and education as essential features of hospice programs

During this same period, Dr. Kübler-Ross, a psychiatrist working in Illinois, published results from her groundbreaking studies of dying patients. Her books about the psychological stages of response to catastrophe and her lectures to health professionals helped to pave the way for the development and acceptance of hospice programs in the United States. The merit of the five stages of acceptance that Dr. Kübler-Ross outlines is that they are not limited to use in counseling the dying. Many patients who become disabled—especially those whose disability and physical impairment are

## KEY TERMS

**Analgesic**—A type of medication given to relieve pain.

**Hospice**—An approach for providing compassionate, palliative care to terminally ill patients and counseling or assistance for their families. The term may also refer to a hospital unit or freestanding facility devoted to the care of terminally ill patients.

**Palliative**—A type of care that is intended to relieve pain and suffering, but not to cure.

**Patient-controlled analgesia (PCA)**—An approach to pain management that allows the patient to control the timing of intravenous doses of analgesic drugs.

sudden occurrences—go through the same stages of “grieving” for the loss of their previous physical health or quality of life. Paraplegics, quadriplegics, amputees, and patients with brain-stem injuries all progress through these same stages of acceptance—and they are not dying.

The first hospice programs in North America opened during the 1970s. In New Haven, Connecticut, the Yale University School of Medicine started a hospice **home care** program in 1974, adding inpatient facilities in 1979. In 1976, another hospice/home-care program, the Hospice of Marin, began in northern California. After a slow start, interest in and enthusiasm for the hospice concept grew. Health professionals as well as the public at large embraced the idea of **death** with dignity. The notion of quality care at the end of life combined with grief counseling and bereavement care (counseling and support for families and friends of dying persons) gained widespread acceptance. The hospice movement also benefited from government efforts to contain healthcare costs when reimbursement for inpatient **hospital services** was sharply reduced. Home-based hospice care is a cost-effective alternative to end-of-life care in a hospital or skilled nursing facility.

### *Acceptance by mainstream medical professionals*

The hospice approach emphasizes caring instead of curing, and some health professionals initially found that this orientation was inconsistent with their previous education, experiences, beliefs, and traditions. Moreover, the involvement of complementary and alternative medicine practitioners was sometimes

unsettling for health professionals unaccustomed to interacting with these persons. As a result of this early period of tension, the Academy of Hospice Physicians was established in 1988 to bring together doctors from a variety of specialties to awaken interest in hospice care among their colleagues and answer their concerns.

In the 1990s, the Academy changed its name to the American Academy of Hospice and Palliative Medicine (AAHPM). Its present purposes include the recognition of palliative care and the management of terminal illness as a distinctive medical discipline; the accreditation of training programs in hospice care; and the support of further research in the field. Most members of the AAHPM believe that more work needs to be done to encourage primary care practitioners and other physicians to refer patients to hospices. A study found that a significant minority of family practitioners and internists have problems interacting with hospices and hospice staff. In the late 1990s, however, the American Board of Medical Specialties (ABMS) recognized hospice and palliative medicine as a board-certified subspecialty. As of 2006, there were 2,883 physicians in the United States who were certified in this subspecialty.

### *Models of hospice care*

#### **HOSPITAL- AND HOME-BASED HOSPICE CARE.**

According to the National Hospice and Palliative Care Organization (NHPCO), there were 3,650 hospice programs operating in the United States in 2004, including Puerto Rico and Guam. In 1999, hospice programs in the United States cared for over 600,000 people, or 29% of those who died that year. By 2004, this number had increased to 1,060,000 patients.

There are several successful hospice models. As of 2007, over 95% of hospice care is delivered in patients' homes, although the hospice programs that direct the care may be based in medical facilities. Home health agency programs care for patients at home, while hospital-based programs may devote a special wing, unit, or floor to hospice patients. Freestanding independent for-profit hospices devoted exclusively to care of the terminally ill also exist. Most hospice programs offer a combination of services, both inpatient and home-care programs, allowing patients and families to make use of either or both as needed.

One limitation of present hospice models is that most require physicians to estimate that the patient is not likely to live longer than six months. This requirement is related to criteria for **Medicare** eligibility, which has covered hospice care since 1982. Unfortunately,

Medicare eligibility means that terminal patients with uncertain prognoses are often excluded from hospice care, as well as homeless and isolated patients. In addition, pressures to contain healthcare costs have continued to shorten the length of patients' stays in hospices. The shortened time span in turn has made it more difficult for pastoral and psychological counselors to help patients and their families deal effectively with the complex issues of terminal illness.

Another present issue for hospice care in the United States and Western Europe is the need for greater understanding of concepts of death in Eastern cultures. For example, the Chinese notion of a "good death" differs from Western perspectives in several significant ways. As more people from non-Western cultures emigrate to North America and eventually seek hospice care, their concepts of **death and dying** will need to be incorporated in hospice care programs.

One challenge that confronts the hospice movement in the United States as of the early 2000s is the need to accommodate the rapid increase in the size of the elderly population (defined as people over the age of 65), which is expected to double between 2000 and 2030. The group of those over 85 is expected to increase from 4.2 million in 2000 to 8.9 million by 2030. In addition to the sheer number of elderly patients who will need hospice care, hospices must also care for people with a wider range of terminal conditions. In the 1970s, most hospice patients were people diagnosed with end-stage cancer. In 2002, however, people with cancer accounted for only 51% of hospice patients; the others were diagnosed with end-stage heart, kidney, or liver disorders; dementia; lung disease; or AIDS.

The demographics of hospice patients has also changed since the 1970s. In the early years of the hospice movement, almost all patients were middle-class Caucasians. In the early 2000s, 9.2% of hospice patients were African American, 4.3% were Hispanic, 8% were Asian, and 3.7% were multiracial. African Americans, however, appear to be more reluctant than members of other racial groups to consider hospice at the end of life even when their doctor strongly recommends it.

**SPECIALIZED HOSPICES.** The first hospices in the United States and the United Kingdom were established to meet the needs of adult patients; in the early 1970s, only four hospice programs in the United States accepted children. In 1977, a dying eight-year-old boy was denied admission to a hospice because of his age. This incident prompted the foundation of hospices just for children beginning in 1983, as well as the

admission of children to other hospices. As of 2007, almost all hospices in the United States and Canada will accept children as patients.

In 1995, the National Prison Hospice Association (NPHA) was founded to meet the needs of prison inmates with terminal illness. Prisoners are much more resistant than most people to accept the fact that they are dying because death in prison feels like the ultimate defeat. Many are also very suspicious of medical care given within the prison, and are afraid to appear weak and vulnerable in the eyes of other inmates. A surprisingly high number refuse to take pain medications for this reason. The NPHA trains medical professionals and volunteers to understand the special needs of terminally ill prison inmates and their families.

Hospices in the United States and Canada accept patients from all religious backgrounds and faith traditions. Hospices that are related to a specific religion or spiritual tradition, however, often offer special facilities or programs to meet the needs of patients from that tradition. For example, there are Jewish hospices that observe the dietary regulations, Sabbath rituals, and other parts of *Halakhah* (Jewish religious law). The National Institute for Jewish Hospice (NIJH), founded in 1985, has accredited 40 hospice programs for Jewish patients as of 2007. Hospices related to the various branches of Christianity have a priest or pastor on call for prayer, administration of the sacraments, and similar Christian religious observances. The Zen Hospice Project, founded in 1987, sponsors programs reflecting the Buddhist tradition of compassionate service and maintains a 25-bed unit within the Laguna Honda Hospice in San Francisco, California.

### *Aspects of hospice care*

**GENERAL ENVIRONMENT.** The goal of freestanding hospices and even hospital-based programs is the creation and maintenance of warm, comfortable, home-like environments. Rather than the direct overhead lights found in hospitals, these hospices use floor and table lamps along with natural light to convey a sense of brightness and uplift. Some hospices offer music or art programs and fill patient rooms with original artwork and fresh flowers.

**PAIN MANAGEMENT AND PSYCHOSPIRITUAL SUPPORT.** Along with acceptance of death as a natural part of the life cycle, health professionals who refer patients to or work in hospice programs must become especially well informed about pain management and symptom control. This knowledge is necessary because about 80% of hospice patients are dying of end-stage cancer. In traditional medical settings, pain medication is often



administered when the patient requests it. Hospice care approaches pain control quite differently. By administering pain medication regularly, before it is needed, hospice caregivers hope to prevent pain from recurring. Since addiction and other long-term consequences of narcotic **analgesics** are not a concern for the terminally ill, hospice caregivers focus on relieving pain as completely and effectively as possible. Hospice patients often have **patient-controlled analgesia** (PCA) pumps that allow them to control their pain medication.

Symptom relief often requires more than simply using narcotic analgesia. Hospices consider the patient and family as the unit of care; family is broadly defined as embracing all persons who are close to the patient, not just blood relatives. Seeking to relieve physical, psychological, emotional, and spiritual discomfort, hospice teams rely on members of the clergy, pastoral counselors, social workers, psychiatrists, massage therapists, and trained volunteers to comfort patients and family members, in addition to the solace offered by nurses and physicians. A study published in early 2008 reported that patients and family members who received spiritual care while they were in a hospice setting thought that they received better overall care than those who did not. The single most important spiritual need mentioned by patients was individual devotional activities.

Since the patient and his or her family members are considered the unit of care, hospice programs continue to support families and loved ones after the patient's death. Grief and bereavement counseling as well as support groups offer opportunities to express and resolve emotional concerns and share them with others.

**COMPLEMENTARY AND ALTERNATIVE THERAPIES.** In addition to mainstream medicine, many hospices offer patients and families the opportunity to use complementary and alternative approaches to control symptoms and improve well being. Acupuncture, music therapy, pet therapy, bodywork, massage therapy, aromatherapy, Reiki (energy healing), Native American ceremonies, herbal treatments, and other non-Western practices may be used to calm and soothe patients and their families. A study of complementary and alternative therapies within hospice programs found that patients who received these treatments reported greater overall satisfaction with hospice care than those who did not.

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## Hospital-acquired infections

### Definition

A hospital-acquired infection, also called a nosocomial infection, is an infection that first appears between 48 hours and four days after a patient is admitted to a hospital or other healthcare facility.

### Description

About 10% of patients admitted to acute care hospitals and long-term care facilities in the United States develop a hospital-acquired, or nosocomial, infection, with an annual total of 1.7 million infections and 99,000 deaths as of 2007. The annual cost of treating these infections is estimated to run between \$4.5 billion and \$11 billion. Hospital-acquired infections are usually related to a device, procedure, or treatment used to diagnose or treat the patient's initial illness or injury. The Centers for Disease Control (CDC) of the U.S. Department of Health and Human Services has shown that many of these infections are preventable through the adherence to strict guidelines by healthcare workers when caring for patients. What can make these infections so troublesome is that they occur in people whose health is already compromised by the condition for which they were first hospitalized.

Hospital-acquired infections may be caused by bacteria, viruses, fungi, or parasites. These microorganisms may already be present in the patient's body or may come from the environment, contaminated hospital equipment, healthcare workers, or other patients. There are three basic routes of infection transmission: direct contact (diseases are spread by touching infected objects or persons); droplet (diseases are spread by coughing and sneezing); and airborne (diseases are spread by microorganisms that remain suspended in the air for long periods of time).

Depending on the causal agents involved, an infection may start in any part of the body. A localized infection is limited to a specific part of the body and has local symptoms. For example, if a surgical wound in the abdomen becomes infected, the area around the

wound becomes red, hot, and painful. A generalized infection is one that enters the bloodstream and causes systemic symptoms such as fever, chills, low blood pressure, or mental confusion. This can lead to sepsis, a serious, rapidly progressive multi-organ infection, sometimes called blood poisoning, that can result in death.

Hospital-acquired infections may develop from the performance of surgical procedures; from the insertion of catheters (tubes) into the urinary tract, nose, mouth, or blood vessels; or from material from the nose or mouth that is aspirated (inhaled) into the lungs. According to the CDC, the most common types of hospital-acquired infections are urinary tract infections (UTIs) (32%), surgical wound infections (22%), pneumonia (15%), and bloodstream infections (14%). The University of Michigan Health System reports that the most common sources of infection in their hospital are urinary catheters, central venous (in the vein) catheters, and endotracheal tubes (tubes going through the mouth into the stomach). Catheters going into the body allow bacteria to move along the outside of the tube into the body where they find their way into the bloodstream. A study in the journal *Infection Control and Hospital Epidemiology* shows that about 24% of patients with catheters will develop catheter-related infections, of which 5.2% will become bloodstream infections. Death has been shown to occur in 4–20% of catheter-related infections.

Hospital-acquired infections in the United States are monitored by the National Healthcare Safety Network (NHSN), formed in 2005 by a merger of three health surveillance systems previously established by the CDC. The NHSN monitors healthcare personnel safety as well as patient safety.

### Causes

All hospitalized patients are at risk of acquiring an infection from their treatment or surgery. Some patients are at greater risk than others, especially young children, the elderly, and persons with compromised immune systems. The surveillance database compiled by the CDC shows that the overall infection rate among children in intensive care is 6.1%, with the primary causes being venous catheters and ventilator-associated pneumonia. The risk factors for hospital-acquired infections in children include parenteral nutrition (tube or intravenous feeding), the use of **antibiotics** for more than 10 days, use of invasive devices, poor postoperative status, and immune system dysfunction. Other risk factors that increase the opportunity for hospitalized adults and children to acquire infections are:

## KEY TERMS

**Abscess**—A localized pocket of pus at a site of infection.

**Aseptic**—Sterile conditions with no harmful microorganisms present.

**Catheter**—A thin, hollow tube inserted into the body at specific points in order to infuse medications, blood components, or nutritional fluids into the body, or to withdraw fluids from the body such as gastric fluid or urine.

**Culture**—A swab of blood, sputum, pus, urine, or other body fluid planted in a special medium, incubated, and allowed to grow for identification of infection-causing organisms.

**Generalized infection**—An infection that has entered the bloodstream and has general systemic symptoms such as fever, chills, and low blood pressure.

**Localized infection**—An infection that is limited to a specific part of the body and has local symptoms.

**Nosocomial infection**—An infection acquired in the hospital.

**Sepsis**—A rapidly spreading state of poisoning in the body, usually involving the whole body.

- a prolonged hospital stay
- severity of underlying illness
- compromised nutritional or immune status
- use of indwelling catheters
- failure of health care workers to wash their hands between patients or before procedures
- prevalence of antibiotic-resistant bacteria from the overuse of antibiotics

Any type of invasive (enters the body) procedure can expose a patient to the possibility of infection. Some common procedures that increase the risk of hospital-acquired infections include:

- urinary bladder catheterization
- respiratory procedures such as intubation or mechanical ventilation
- surgery and the dressing or drainage of surgical wounds
- gastric drainage tubes into the stomach through the nose or mouth
- intravenous (IV) procedures for delivery of medication, transfusion, or nutrition

Urinary tract infection (UTI) is the most common type of hospital-acquired infection and has been shown to occur after urinary catheterization. Catheterization is the placement of a catheter through the urethra into the urinary bladder to empty urine from the bladder; or to deliver medication, relieve pressure, or measure urine in the bladder; or for other medical reasons. Normally, a healthy urinary bladder is sterile, with no harmful bacteria or other microorganisms present. Although bacteria may be in or around the urethra, they normally cannot enter the bladder. A catheter, however, can pick up bacteria from the urethra and give them an easy route into the bladder, causing infection. Bacteria from the intestinal tract are the most common type to cause UTIs. Patients with poorly functioning immune systems or who are taking antibiotics are also at increased risk for UTI caused by a fungus called *Candida*. The prolonged use of antibiotics, which may reduce the effectiveness of the patient's own immune system, has been shown to create favorable conditions for the growth of this fungal organism.

Invasive surgical procedures, the second most common cause of nosocomial infections, increase a patient's risk of getting an infection by giving bacteria a route into normally sterile areas of the body. An infection can be acquired from contaminated surgical equipment or from the hands of healthcare workers. Following surgery, the surgical wound can become infected from contaminated **dressings** or the hands of healthcare workers who change the dressing. Other wounds can also become easily infected, such as those caused by trauma, burns, or pressure sores that result from prolonged bed rest or wheel chair use.

Pneumonia is the third most common type of hospital-acquired infection. Bacteria and other microorganisms are easily introduced into the throat by treatment procedures performed to treat respiratory illnesses. Patients with chronic obstructive lung disease, for example, are especially susceptible to infection because of frequent and prolonged antibiotic therapy and long-term **mechanical ventilation** used in their treatment. The infecting microorganisms can come from contaminated equipment or the hands of healthcare workers as procedures are conducted such as respiratory intubation, suctioning of material from the throat and mouth, and mechanical ventilation. Once introduced through the nose and mouth, microorganisms quickly colonize the throat area. This means that they grow and form a colony, but have not yet caused an infection. Once the throat is colonized, it is easy for a patient to aspirate the microorganisms into the lungs, where infection develops that leads to pneumonia.

Bloodstream infections are the fourth most common type of hospital-acquired infections. Many hospitalized patients need continuous medications, transfusions, or nutrients delivered into their bloodstream. An intravenous (IV) catheter is placed in a vein and the medications, blood components, or liquid nutritional components are infused into the vein. Bacteria from the surroundings, contaminated equipment, or healthcare workers' hands can enter the body at the site of catheter insertion. A local infection may develop in the skin around the catheter. The bacteria can also enter the blood through the vein and cause a generalized infection. The longer a catheter is in place, the greater the risk of infection.

Other hospital procedures that may put patients at risk for nosocomial infection are gastrointestinal procedures, obstetric procedures, and **kidney dialysis**.

### Symptoms

Fever is often the first sign of infection. Other symptoms and signs of infection are rapid breathing, mental confusion, low blood pressure, reduced urine output, and a high **white blood cell count**. Patients with a UTI may have pain when urinating and blood in the urine. Symptoms of pneumonia may include difficulty breathing and inability to cough. A localized infection begins with swelling, redness, and tenderness on the skin or around a surgical wound or other open wound, which can progress rapidly to the destruction of deeper layers of muscle tissue, and eventually sepsis.

### Diagnosis

An infection is suspected any time a hospitalized patient develops a fever that cannot be explained by the underlying illness. Some patients, especially the elderly, may not develop a fever. In these patients, the first signs of infection may be rapid breathing or mental confusion.

Diagnosis of a hospital-acquired infection is determined by any of the following:

- evaluation of symptoms and signs of infection
- examination of wounds and catheter entry sites for redness, swelling, or the presence of pus or an abscess
- a complete physical examination and review of underlying illness
- laboratory tests, including complete blood count (CBC), especially to look for an increase in infection-fighting white cells; urinalysis, looking for white cells or evidence of blood in the urinary tract; cultures of the infected area, blood, sputum, urine, or

other body fluids or tissue to find the causative organism

- chest x ray may be done when pneumonia is suspected to look for the presence of white blood cells and other inflammatory substances in lung tissue
- review of all procedures performed that might have led to infection

### Treatment

Cultures of blood, urine, sputum, other body fluids, or tissue are especially important in order to identify the bacteria, fungi, virus, or other microorganism causing the infection. Once the organism has been identified, it will be tested again for sensitivity to a range of antibiotics so that the patient can be treated quickly and effectively with an appropriate medicine to which the causative organism will respond. While waiting for these test results, treatment may begin with common broad-spectrum antibiotics such as penicillin, **cephalosporins**, **tetracyclines**, or erythromycin.

More and more often, however, some types of bacteria are becoming resistant to these standard antibiotic treatments, especially when patients with chronic illnesses are frequently given antibiotic therapy for long periods of time. When resistance develops, a different, more powerful, and more specific antibiotic must be used to which the specific organism has been shown to respond. Two strong antibiotics that have been effective against resistant bacteria are vancomycin and imipenem, although some bacteria are developing resistance to these antibiotics as well. A newer generation of tetracycline antibiotics known as glycylcyclines was introduced in 2005; the first of these, tigecycline, was developed specifically to target drug-resistant microorganisms. The prolonged use of antibiotics is also known to reduce the effectiveness of the patient's own immune system, sometimes becoming a factor in the development of infection.

Fungal infections are treated with antifungal medications. Examples of these are amphotericin B, nystatin, ketoconazole, itraconazole, and fluconazole.

Viruses do not respond to antibiotics. A number of antiviral drugs have been developed that slow the growth or reproduction of viruses, such as acyclovir, ganciclovir, foscarnet, and amantadine.

### Prevention

Hospitals take a variety of steps to prevent nosocomial infections, including:

- Adoption of an infection control program such as the one sponsored by the Centers for Disease Control

(CDC), which includes quality control of procedures known to lead to infection, and a monitoring program to track infection rates to see if they go up or down.

- Employment of an infection control practitioner for every 200 beds.
- Identification of high-risk procedures and other possible sources of infection.
- Strict adherence to hand-washing rules by healthcare workers and visitors to avoid passing infectious microorganisms to or between hospitalized patients.
- Strict attention to aseptic (sterile) technique in the performance of procedures, including use of sterile gowns, gloves, masks, and barriers.
- Sterilization of all reusable equipment such as ventilators, humidifiers, and any devices that come in contact with the respiratory tract.
- Frequent changing of dressings for wounds and use of antibacterial ointments under dressings.
- Removal of nasogastric (nose to stomach) and endotracheal (mouth to stomach) tubes as soon as possible.
- Use of an antibacterial-coated venous catheter that destroys bacteria before they can get into the bloodstream.
- Preventing contact between respiratory secretions and health care providers by using barriers and masks as needed.
- Use of silver alloy-coated urinary catheters that destroy bacteria before they can migrate up into the bladder.
- Limitations on the use and duration of high-risk procedures such as urinary catheterization.
- Isolation of patients with known infections.
- Sterilization of medical instruments and equipment to prevent contamination.
- Reductions in the general use of antibiotics to encourage better immune response in patients and reduce the cultivation of resistant bacteria.

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## Hospital services

### Definition

Hospital services is a term that refers to medical and surgical services and the supporting laboratories, equipment and personnel that make up the medical and surgical mission of a hospital or hospital system.

### Purpose

Hospital services make up the core of a hospital's offerings. They are often shaped by the needs or wishes of its major users to make the hospital a one-stop or core institution of its local community or medical network. Hospitals are institutions comprising basic services and personnel—usually departments of medicine



and surgery—that administer clinical and other services for specific diseases and conditions, as well as emergency services. Hospital services cover a range of medical offerings from basic health care necessities or training and research for major medical school centers to services designed by an industry-owned network of such institutions as health maintenance organizations (HMOs). The mix of services that a hospital may offer depends almost entirely upon its basic mission(s) or objective(s).

There are three basic types of hospitals in the United States: proprietary (for-profit) hospitals; non-profit hospitals; and charity- or government-supported hospitals. The services within these institutions vary considerably, but are usually organized around the basic mission(s) or objective (s) of the institution:

- **Proprietary hospitals.** For-profit hospitals include both general and specialized hospitals, usually as part of a healthcare network like Humana or HCA, which may be corporately owned. The main objective of proprietary hospitals is to make a profit from the services provided.
- **Teaching or community hospitals.** These are hospitals that serve several purposes: they provide patients for the training or research of interns and residents; they also offer services to patients who are unable to pay for services, while attempting to maintain profitability. Nonprofit centers like the University of California at San Francisco (UCSF) or the Mayo Clinics combine service, teaching, and profitability without being owned by a corporation or private owner.
- **Government-supported hospitals.** This group includes tax-supported hospitals for counties, communities and cities with voluntary hospitals (community or charity hospitals) run by a board of citizen administrators who serve without pay. The main objective of this type of hospital is to provide health care for a community or geographic region.

### Demographics

As of 2006, the total number of hospitals in the United States, including military and prison hospitals, is over 7,569. Of this total, approximately 3,000 are non-government-related nonprofit hospitals; almost 800 are investor-owned; and 1,156 are government (state, county, or local) hospitals.

### Description

Over the past two decades, hospital services in the United States have declined markedly as a percentage of health care costs, from 43.5% in 1980 to about 31% in 2005. This decline was due to shortened lengths of

## KEY TERMS

**Auxiliary hospital services**—A term used broadly to designate such nonmedical services as financial services, birthing classes, support groups, etc. that are instituted in response to consumer demand.

**Health maintenance organization (HMO)**—A broad term that covers a variety of prepaid systems providing health care within a certain geographic area to all persons covered by the HMO's contract.

**Intensivist**—A physician who specializes in caring for patients in intensive care units.

**Nonprofit hospitals**—Hospitals that combine a teaching function with providing for uninsured within large, complex networks technically designated as nonprofit institutions. While the institution may be nonprofit, however, its services are allowed to make a profit.

**Proprietary hospitals**—Hospitals owned by private entities, mostly corporations, that are intended to make a profit as well as provide medical services. Most hospitals in health maintenance organizations and health networks are proprietary institutions.

**Teaching hospitals**—Hospitals whose primary mission is training medical personnel in collaboration with (or ownership by) a medical school or research center.

hospital stay, the move from inpatient to outpatient facilities for surgery, and a wave of hospital mergers in the 1990s that consolidated services and staff. Since 2001, however, spending on hospital care in the United States has been growing faster than other sectors of the economy as a result of increasing demand for hospital services. Forty percent of the rise in spending on hospital care is due to escalating costs for hospital services attributed to population growth, the aging of the general population, and growing discontent with the limitations imposed by managed care. In addition, new medical technologies have allowed hospitals to provide life-saving diagnostic and therapeutic alternatives that were unavailable in the 1990s.

At the same time that the use of hospital services is increasing nationwide, government support of hospital services with **Medicaid** and **Medicare** has been decreasing, putting pressure upon hospitals to treat the uninsured and make up for \$21.6 billion in uncompensated care (year 2002). This trend has put pressure on for-profit, not-for-profit and teaching hospitals to

provide a broader range of community services or such “low-end” services as mental health care, preventive health services, and general pediatric care. In addition, very recent changes in Federal laws governing the entry of hospitals into new markets—Certificate of Need laws—allow health care providers to offer new hospital services, resulting in the growth of ambulatory surgical centers, special tertiary surgery centers and specialty hospitals that treat a single major disease category. These legislative changes encourage the offering of “high-end” services that are increasingly demanded by consumers.

Hospital services define the core features of a hospital’s organization. The range of services may be limited in such specialty hospitals as cardiovascular centers or cancer treatment centers, or very broad to meet the needs of the community or patient base, as in full service health maintenance organizations (HMOs), rural charity centers, urban health centers, or medical research centers. Hospital services are usually the most general in large urban areas or underserved rural areas, broadly encompassing many services ordinarily offered by other medical providers. The basic services that hospitals offer include:

- short-term hospitalization
- emergency room services
- general and specialty surgical services
- x ray/radiology services
- laboratory services
- blood services

**HMO** hospitals add a number of special and auxiliary services to the basic list, including:

- pediatric specialty care
- greater access to surgical specialists
- physical therapy and rehabilitation services
- prescription services
- home nursing services
- nutritional counseling
- mental health care
- family support services
- genetic counseling and testing
- social work or case management services
- financial services

Hospitals funded by state, regional, or local government, as well as charity hospitals and hospitals within research and teaching centers, are pressed by community needs to provide for the uninsured or underinsured with more basic services:

- primary care services
- mental health and drug treatment

- infectious disease clinics
- hospice care
- dental services
- translation and interpreter services

## Diagnosis/Preparation

Most hospitals have extensive surgical services that include preoperative testing, which may include x rays, **CT scans**, ultrasonography, blood tests, **urinalysis**, and/or an EKG. Medication counseling is offered for current patient prescriptions and how they should be taken during and after surgery. **Informed consent** forms are made available to patients, as well as patient advocate services for questions and assistance in understanding the consent form and similar documents. An anesthesiologist or an assistant discuss with the patient the patient’s history of allergies, previous reactions to anesthesia and special precautions that will be taken. Intravenous medications are usually begun in the patient’s room before surgery to relax the patient, with **general anesthesia** administered in the **operating room**.

## Aftercare

According to the National Center for Health Statistics of the Centers for Disease Control and Prevention (CDC), 44.9 million inpatient surgical procedures were performed in the United States in 2005, followed closely by 31.5 million outpatient surgeries. The procedures that were performed most frequently included:

- appendectomy
- breast biopsy
- carotid endarterectomy
- cataract surgery
- cesarian section
- gall bladder surgery
- debridement of wound, infection, burn
- dilatation and curettage or d & c
- hemorrhoidectomy
- hysterectomy
- hysteroscopy
- inguinal hernia repair
- lower back surgery
- mastectomy
- colectomy
- revision of peritoneal adhesions
- tonsillectomy

### *Inpatient aftercare*

After inpatient surgery, most patients are taken to a **recovery room** and monitored by nursing staff until they regain full consciousness. If there are complications or if the patient develops respiratory or cardiac problems, he or she is transferred to a surgical **intensive care unit** equipped to deal with acute needs. Intensive care units (ICU) are highly advanced facilities in which patients are monitored by special equipment that measures their heart rate, breathing, blood pressure, and blood oxygen level. Some patients require a respirator to breathe for them and additional intravenous lines to deliver medication and fluids. Once stabilized, patients are transferred to their hospital room.

After returning to the room, the patient is encouraged to sit up, start walking, and do as much as possible to return to a normal level of activity. Special diets may be provided, as well as pain-killing medications and **antibiotics** if needed. A respiratory therapist will usually visit the patient with breathing equipment intended to help the patient's lung function return to normal. A physical therapist may introduce the patient to an **exercise** program or to skills needed to manage with temporary or permanent physical limitations.

Discharge personnel help the patient plan to go home. Some hospitals follow up with an outpatient nurse or social worker service. Pharmaceutical services may be offered to fill take-home prescriptions without the requirement of visiting an outside pharmacy. Medical equipment, like wheelchairs or crutches and other durable equipment, may be provided by the hospital and then purchased by the patient for use at home.

### *Outpatient aftercare*

Outpatient or ambulatory surgery services make up almost half of all surgeries in the United States as a result of advances in surgical equipment and technique that allow for laser treatments and other minimally invasive procedures. Outpatient procedures require comparatively little aftercare for the patient due to both the nature of the surgical procedure and the advantages of being able to use regional or **local anesthesia**. Aftercare in hospital outpatient clinics, **ambulatory surgery centers**, or office-based practices requires that patients recover from anesthetics in the facility. After the anesthetic has worn off, the patient is briefly monitored for complications and released to go home. Many surgical procedures now allow patients to go home after a short recovery period on the same day as the surgery, and benefit from minimal pain and a speedier recovery.

## Morbidity and mortality rates

According to a health consumer organization, 195,000 people die each year in America's hospitals as a result of **medical errors**. In recent years, many hospitals have introduced special safeguards to cut down on the number of mistakes in medication and surgical services. Two new practices have been adopted by quality hospitals. Computerized order entries for medications cut down drastically on the number of misread prescriptions. The other innovation reduces the number of medical errors in intensive care units by using specially trained physicians—intensivists—in the unit. Hospitals that have introduced these patient safety features can be found on the Internet at consumer health sites.

Proprietary hospitals generally offer more services and “high end” care than government or community hospitals, with teaching hospitals offering the most highly developed new procedures and techniques along with services for the poor and special populations. For-profit hospitals, however, do not have lower rates of morbidity or mortality in their delivery of hospital services. One study in 2000 published by General Internal Medicine found that patients at for-profit hospitals suffered two to four times more complications from surgery as well as delays in diagnosing and treating illness than did patients in nonprofit hospitals. Previous research has shown that **death** rates are 25% higher in proprietary hospitals than in teaching hospitals, and 6–7% higher in proprietary hospitals than in nonprofit institutions.

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## Human leukocyte antigen test

### Definition

The human leukocyte antigen (HLA) test, also known as HLA typing or tissue typing, identifies antigens on the white blood cells (WBCs) that determine tissue compatibility for organ transplantation (that is, histocompatibility testing). There are six loci on chromosome 6, where the genes that produce HLA antigens are inherited: HLA-A, HLA-B, HLA-C, HLA-DR, HLA-DQ, and HLA-DP.

Unlike most blood group antigens, which are inherited as products of two alleles (types of gene that occupy the same site on a chromosome), many different alleles can be inherited at each of the HLA loci. These are defined by antibodies (antisera) that recognize specific HLA antigens, or by DNA probes that recognize the HLA allele. Using specific antibodies, 26 HLA-A alleles, 59 HLA-B alleles, 10 HLA-C alleles, 26 HLA-D alleles, 22 HLA-DR alleles, nine HLA-DQ alleles, and six HLA-DP alleles can be recognized. This high degree of genetic variability (polymorphism) makes finding compatible organs more difficult than finding compatible blood for **transfusion**.

### Purpose

HLA typing, along with ABO (blood type) grouping, is used to provide evidence of tissue compatibility. The HLA antigens expressed on the surface of the lymphocytes of the recipient are matched against those from various donors. Human leukocyte antigen typing is performed for kidney, bone marrow, liver, pancreas, and heart transplants. The probability that a transplant will be successful increases with the number of identical HLA antigens.

Graft rejection occurs when the immune cells (T-lymphocytes) of the recipient recognize specific HLA antigens on the donor's organ as foreign. The T-lymphocytes initiate a cellular immune response that result in graft rejection. Alternatively, T-lymphocytes

## KEY TERMS

**Allele**—Types of genes that occupy the same site on a chromosome.

**Ankylosing spondylitis**—An inflammatory arthropathy (arthritis-like) of the vertebral column and sacroiliac joints.

**Antibody**—A protein (immunoglobulin) produced by B-lymphocytes in response to stimulation by a specific antigen.

**Antigen**—A molecule, usually a protein, that elicits the production of a specific antibody or immune response.

**Autoimmune disorders**—A disorder caused by a reaction of an individual's immune system against the organs or tissues of one's own body.

**B-lymphocyte**—A type of blood cell that is active in immune response.

**Cornea**—The transparent outer layer of the eye. It covers the iris and lens.

**Histocompatibility testing**—Testing of genotypes of a recipient and potential donor to see if rejection would occur when tissues are transplanted.

**Lymphocyte**—A class of white blood cell that is responsible for the immune response to antigens.

**Macrophage**—A type of blood cell derived from monocytes that are stimulated by inflammation and stimulate antibody production.

**Monocyte**—A type of white blood cell produced in bone marrow.

**Phenotype**—A trait produced by a gene. For example, the specific HLA antigen(s) inherited for the HLA-A locus is the phenotype for that gene.

present in the grafted tissue may recognize the host tissues as foreign and produce a cell-mediated immune response against the recipient. This is called graft versus host disease (GVHD), and it can lead to life-threatening systemic damage in the recipient. Human leukocyte antigen testing is performed to reduce the probability of both rejection and GVHD.

Typing is also used along with blood typing and DNA tests to determine the parentage (that is, for paternity testing). The HLA antigens of the mother, child, and alleged father can be compared. When an HLA antigen of the child cannot be attributed to the mother or the alleged father, then the latter is excluded as the father of the child.



A third use of HLA testing called linkage analysis is based on the region where the HLA loci are positioned, the major histocompatibility complex (MHC), which contains many other genes located very close to the HLA loci. The incidence of crossing-over between HLA genes during fertilization of the egg by sperm is generally less than 1%. Consequently, the HLA antigens from all six loci are inherited together and segregate with many other genes located within the same region of chromosome 6. Many of the MHC-region genes are involved in immunological processes. As a result, alleles that are known to increase the chance of developing various autoimmune diseases have remained associated with specific HLA alleles. For example, 2% of people who have the HLA-B27 allele develop an arthritic condition of the vertebrae called ankylosing spondylitis. However, approximately nine out of ten white persons who have ankylosing spondylitis are positive for HLA-B27. Because of this association, the disease and this HLA type are linked. Thus, a person with ankylosing spondylitis who is also HLA-B27 positive would have family with a much higher likelihood of developing ankylosing spondylitis than those who are not. Some notable autoimmune diseases that have a strong association with HLA antigens include Hashimoto's thyroiditis (an autoimmune disorder involving underproduction by the thyroid gland) associated with HLA-DR5; Graves' disease (an autoimmune disorder associated with overproduction by the thyroid gland), associated with HLA-B8 and Dw3; and hereditary hemochromatosis (excess iron stores), associated with HLA-A3, B7, and B14.

### Precautions

HLA testing is performed using WBCs. If possible, this test should be postponed if the patient has recently undergone a transfusion, because any WBCs from the transfusion may interfere with the tissue typing of the patient's lymphocytes.

### Description

The HLA gene products can be grouped into three classes. Class I consists of the products of the genes located on the HLA-A, HLA-B, and HLA-C loci. These HLA antigens are found on all nucleated cells. Class II molecules consist of antigens inherited as genes from the HLA-DR, HLA-DQ, and HLA-DP loci. These HLA antigens are normally found only on B-lymphocytes, macrophages, monocytes, dendritic cells, endothelial cells, and activated T-lymphocytes. Class III molecules are not evaluated in histocompatibility testing.

Because the HLA loci are closely linked, the HLA antigens are inherited as a group of six antigens is called a haplotype. The probability of siblings having identical haplotypes is one in four. Therefore, siblings provide the opportunity for the best matches. They can donate bone marrow, a kidney, and a section of their livers, but they cannot donate other solid organs. Approximately 85% of transplants are organs from cadavers, and because the HLA antigens are so highly polymorphic, the chance of identical haplotypes decreases quickly.

Histocompatibility testing consists of three tests, HLA antigen typing (tissue typing), screening of the recipient for anti-HLA antibodies (antibody screen), and the lymphocyte crossmatch (compatibility test). HLA antigen typing may be performed by serological (blood fluid) or DNA methods. In either case, HLA typing of HLA-A, HLA-B, HLA-DR, and HLA-DQ antigens is performed for solid organ transplants. HLA typing of HLA-C antigens is also included when tissue typing is performed for bone marrow transplants.

The antibody screen is performed in order to detect antibodies in the recipient's serum that react with HLA antigens. The most commonly used method of HLA antibody screening is the microcytotoxicity test. If an antibody against an HLA antigen is present, it will bind to the cells. The higher the number of different HLA antibodies, the lower the probability of finding a compatible match.

The third component of a histocompatibility study is the crossmatch test. In this test peripheral blood lymphocytes from the donor are separated into B and T lymphocyte populations. In the crossmatch, serum from the recipient is mixed with T-cells or B-cells from the donor. A positive finding indicates the presence of preformed antibodies in the recipient that are reactive against the donor tissues. An incompatible T-cell crossmatch contraindicates transplantation of a tissue from the T-cell donor.

### Preparation

The HLA test requires a blood sample. There is no need for the patient to fast before the test.

### Aftercare

The patient may feel discomfort when blood is drawn from a vein. Bruising may occur at the puncture site, or the person may feel dizzy or faint. Pressure should be applied to the puncture site until the bleeding stops to reduce bruising. Warm packs can also be placed over the puncture site to relieve discomfort.

## Risks

Risks for this test are minimal, but may include slight bleeding from the puncture site, fainting or feeling lightheaded after having blood taken, or hematoma (blood accumulating under the puncture site).

## Normal results

HLA typing either by serologic (blood fluid) or DNA methods is reported as the phenotype for each HLA loci tested. The antibody screen test is reported as the percentage of panel reactive antibodies (PRA). The percent PRA is the number of wells reactive with the patient's serum expressed in percent. The cross-match is reported as compatible or incompatible.

Tissue typing results for both donors and recipients and antibody screen results for recipients are submitted to the United Network for Organ Sharing (UNOS) database. The database searches all regional donors that are ABO-compatible for an HLA-identical match. If none is found, the database searches the national database for ABO compatible donors and scores the match. A point system is used based upon several parameters, including the number of matching HLA loci, the length of time the recipient has been waiting, the recipient's age, and the PRA score.

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Hydrocele repair see **Hydrocelectomy**

## Hydrocelectomy

### Definition

Hydrocelectomy, also known as hydrocele repair, is a surgical procedure performed to correct a hydrocele. A hydrocele is an accumulation of peritoneal fluid in a membrane called the tunica vaginalis, which covers the front and sides of the male testes. Hydroceles occur because of defective absorption of tissue fluid or irritation of the membrane leading to overproduction of fluid. In addition to filling the tunica vaginalis, the fluid may also fill a portion of the spermatic duct (epididymis) in the scrotum.

### Purpose

A hydrocelectomy is performed to correct a hydrocele and prevent its recurrence.

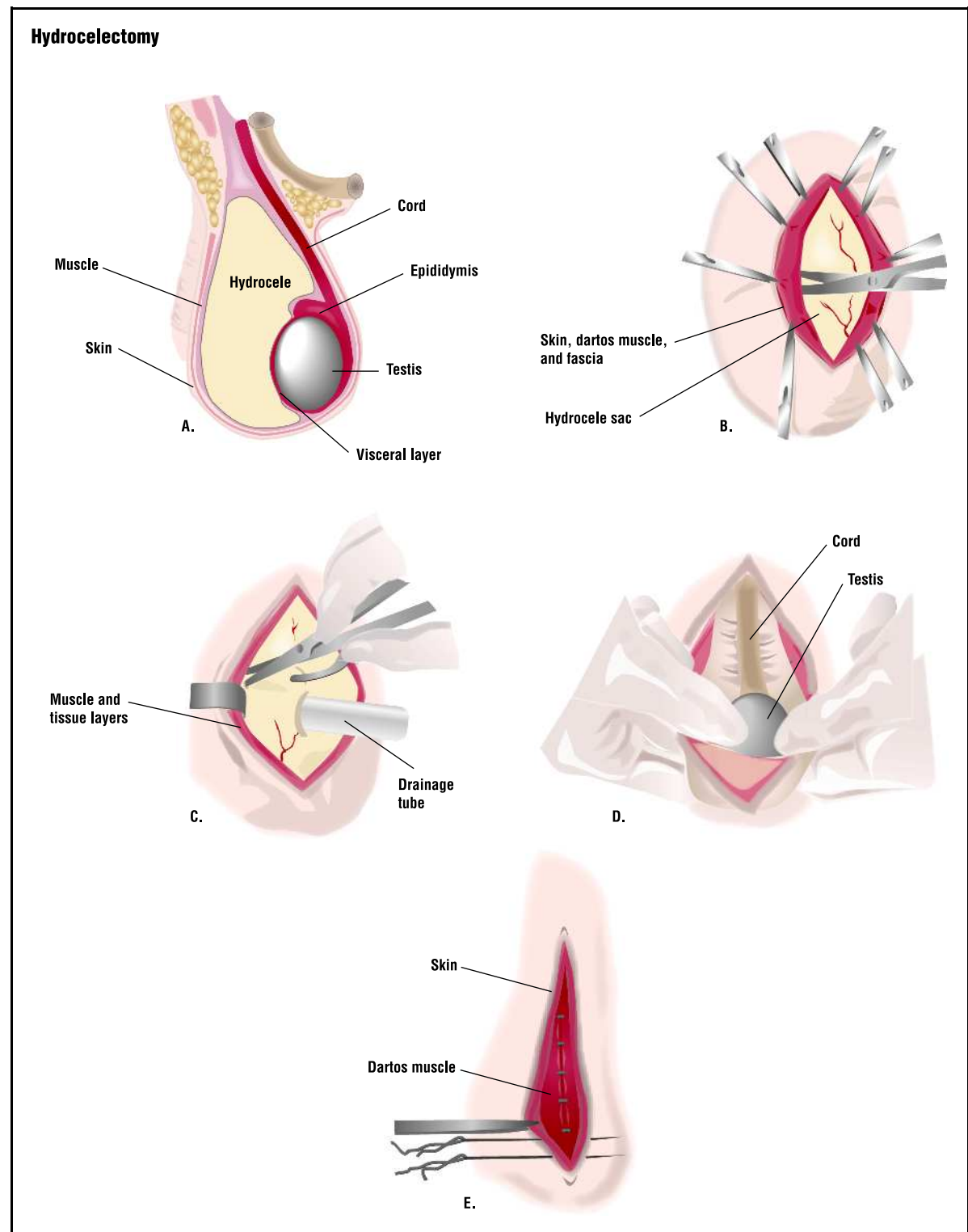
### Demographics

Hydroceles are found in male children or adult males (usually over 40). They have no known association with a man's ethnic background or lifestyle factors.

### Description

A hydrocele usually appears as a soft swelling in the membrane surrounding the testes. It is not usually painful and does not damage the testes. It typically occurs on one side only; only 7–10% occur on both sides of the scrotum. Inflammation is not usually present, although if the hydrocele occurs in conjunction with epididymitis (inflammation of the epididymis), the testes may be inflamed and painful. The main symptom of a hydrocele that occurs without epididymitis is scrotal swelling. As the hydrocele fills with fluid and grows, the scrotum itself gets larger. Some men may have pain or discomfort from the increased size of the scrotal mass. Hydroceles are usually congenital, found in a large percentage (80% or more) of male children and in 1% of adult males over 40.

The most common congenital hydrocele is caused by a failure of a portion of the testicular membrane (processus vaginalis, a membrane that descends with the testicles in the fetus) to close normally. This failure to close allows peritoneal (abdominal) fluid to flow into the scrotum. Although surgery is the usual treatment, it is not performed until the child is at least two years of age, giving the processus vaginalis sufficient time to close by itself. More than 80% of newborn boys are reported to have a patent (open) processus vaginalis, but it closes spontaneously in the majority



A hydrocele is a pocket of fluid inside a man's testicle (A). To remove it, the surgeon cuts through the skin and tissue layers (B), then drains the hydrocele with a tube (C). The hydrocele is opened completely (D), and skin and tissue layers are stitched (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Aspiration**—The process of removing fluids or gases from the body by suction.

**Epididymis**—A coiled segment of spermatic duct within the scrotum, attached to the back of the testis.

**Epididymitis**—Inflammation of the epididymis.

**Inguinal hernia**—An opening, weakness, or bulge in the lining tissue of the abdominal wall in the groin area, with protrusion of the large intestine.

**Hydrocele**—An accumulation of fluid in the membrane that surrounds the testes.

**Scrotum**—A pouch of skin containing the testes, epididymis, and portions of the spermatic cords.

**Testis (plural, testes)**—The male sex gland, held within the scrotum.

**Transillumination**—A technique in which the doctor shines a strong light through body tissues in order to examine an organ or structure.

**Tunica vaginalis**—A sac-like membrane covering the outer surface of the testes.

of children before they are 12 months old. The process is not expected to close spontaneously in children over 18 months.

In adults, hydroceles develop slowly, usually as a result either of a defect in the tunica vaginalis that causes overproduction of fluid, or as a result of blocked lymphatic flow that may be related to an obstruction in the spermatic cord. Hydroceles may also develop as a result of inflammation or infection of the epididymis; trauma to the scrotal area; or in association with cancerous tumors in the groin area. A hydrocele can occur at the same time as an inguinal hernia.

Hydroceles can be treated with aspiration or surgery. To aspirate the collected fluid, the doctor inserts a needle into the scrotum and directs it toward the hydrocele. Suction is applied to remove (aspirate) as much fluid as possible. While aspiration is usually successful, it is a temporary correction with a high potential for recurrence of the hydrocele. Aspiration may have longer-term success when certain medications are injected during the procedure (sclerotherapy). There is a higher risk of infection with aspiration than with surgery.

Generally, surgical repair of a hydrocele will eliminate the hydrocele and prevent recurrence. In adults, surgery is used to remove large or painful hydroceles.

It is the preferred method of treatment for children over two years of age. It is also standard practice to remove hydroceles that reoccur after aspiration.

Patients are given **general anesthesia** for hydrocele repair surgery. A hydrocelectomy is typically performed on an outpatient basis with no special precautions required. The extent of the surgery depends on whether other problems are present. If the hydrocele is uncomplicated, the doctor makes an incision directly into the scrotum. After the canal between the abdominal cavity and the scrotum is repaired, the hydrocele sac is removed, fluid is removed from the scrotum, and the incision is closed with sutures. If there are complications, such as the presence of an inguinal hernia, an incision is made in the groin area. This approach allows the doctor to repair the hernia or other complicating factors at the same time as correcting the hydrocele. Some surgeons use a minimally invasive laparoscopic approach to repair a hydrocele. The operation is performed through a tiny incision using a lighted, camera-tipped, tube-like instrument (laparoscope) that allows the passage of instruments for the repair while displaying images of the procedure on a monitor in the **operating room**.

## Diagnosis

Diagnosis will begin with taking a careful history, including sexual history, recent injury, or illnesses, and observing signs and symptoms. Hydroceles can sometimes be diagnosed in the doctor's office by visual examination and palpation (touch). Hydroceles are distinguished from other testicular problems by transillumination (shining a light source through the hydrocele so that the tissue lights up) and **ultrasound** examinations of the area around the groin and scrotum.

## Preparation

The patient will be given standard pre-operative blood and urine tests at some time prior to surgery. Before the operation, the physician or nurse will explain the procedure, the type of anesthesia to be used, and, in some cases, the need for a temporary drain to be inserted. The drain will be placed during surgery to reduce the chances of postoperative infection and fluid accumulation.

## Aftercare

Immediately following surgery, the patient will be taken to a recovery area and checked for any undue



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A hydrocelectomy is performed in a hospital operating room or a one-day surgery center by a general surgeon or urologist.

bleeding from the incision. **Body temperature** and blood pressure will be monitored. Patients will usually go home the same day for a brief recovery period at home. Follow-up appointments are usually scheduled for several weeks after surgery so that the doctor can check the incision for healing and to be sure there is no infection. The patient may notice swelling for several months after the procedure; however, prolonged swelling, fever, or redness in the incision area should be reported to the surgeon immediately.

### Risks

Hydrocelectomy is considered a safe surgery, with only a 2% risk of infection or complications. Injury to spermatic vessels can occur, however, and affect the man's fertility. As with all surgical procedures, reactions to anesthesia, bleeding from the surgical incision, and internal bleeding can also occur.

### Normal results

Surgery usually corrects the hydrocele and the underlying defect completely; recurrence is rare. The long-term outlook is excellent. There may be swelling of the scrotum for up to a month. The adult patient is able to resume most activities within seven to 10 days, although heavy lifting and sexual activities may be delayed for up to six weeks. Children will be able to resume normal activities in four to seven days.

### Morbidity and mortality rates

Chronic infection after surgical repair can increase morbidity. There are no instances reported of **death** following a hydrocele repair.

### Alternatives

A hydrocele is most often a congenital defect that is commonly corrected surgically. There are no recommended alternatives and no known measures to prevent the occurrence of congenital hydroceles.

## QUESTIONS TO ASK THE DOCTOR

- Why is this surgery necessary?
- How will it improve my condition (my child's condition)?
- Is surgery the only option for correction of this problem?
- How many times have you performed this surgery? What are the usual results?
- How will I (my child) feel after the surgery?
- How soon can I (my child) resume normal activities?

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L. Lee Culvert

## Hypophysectomy

### Definition

Hypophysectomy, or hypophysis, is the surgical removal of the pituitary gland.

### Purpose

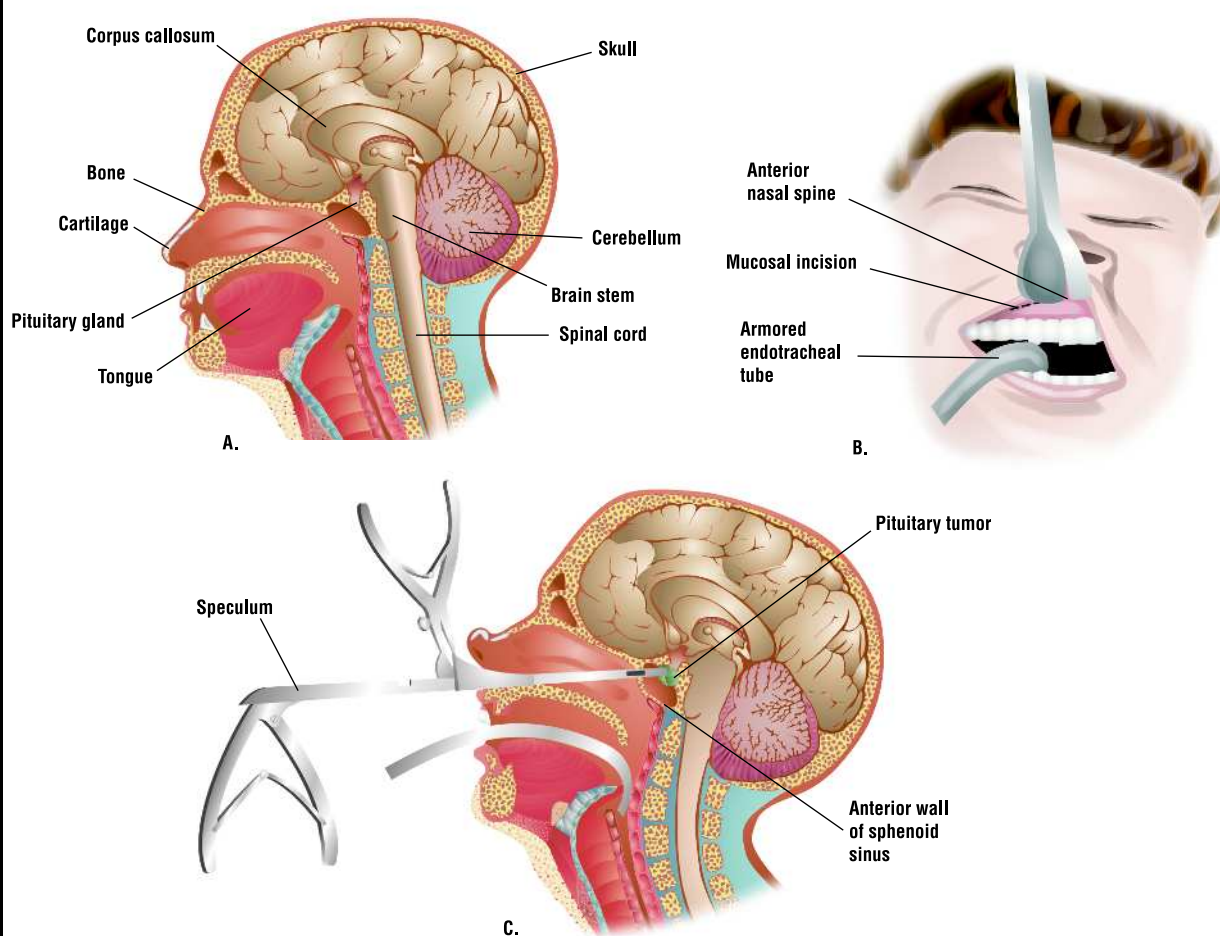
The pituitary gland is a small, oval-shaped endocrine gland about the size of a pea located in the center of the brain above the back of the nose. Its major role is to produce hormones that regulate growth and metabolism in the body. Removing this important gland is a drastic step that is usually taken in the case of cancers or

tumors that resist other forms of treatment, especially craniopharyngioma tumors. Hypophysectomy may also be performed to treat Cushing's syndrome, a hormonal disorder caused by prolonged exposure of the body's tissues to high levels of the hormone cortisol, in most cases associated with benign tumors called pituitary adenomas. The goal of the surgery is to remove the tumor and try to partially preserve the gland.

### Demographics

Craniopharyngiomas account for less than 5% of all brain tumors. Half of all craniopharyngiomas occur in children, with symptoms most often appearing between the ages of five and ten. Cushing's syndrome is relatively

### Hypophysectomy



Hypophysectomy is a procedure to access and remove the pituitary gland (A). To access it, an incision is made beneath the patient's upper lip to enter the nasal cavity (B). A speculum is inserted, and special forceps are used to remove the pituitary tumor (C). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Adenoma**—A benign tumor in which cells form recognizable glandular structures.

**Cerebrospinal fluid (CSF)**—A clear, colorless fluid that contains small quantities of glucose and protein. CSF fills the ventricles of the brain and the central canal of the spinal cord.

**Craniotomy**—A surgical incision into the skull.

**Cushing's disease**—A disease in which too many hormones called glucocorticoids are released into the blood. This causes fat to build up in the face, back, and chest, and the arms and legs to become very thin. Other symptoms include excessive blood sugar levels, weak muscles and bones, a flushed face, and high blood pressure.

**Electrocardiogram**—A recording of the electrical activity of the heart on a moving strip of paper.

**Endocrine system**—Group of glands and parts of glands that control metabolic activity. The pituitary, thyroid, adrenals, ovaries, and testes are all part of the endocrine system.

**Hormone**—A chemical made in one place that has effects in distant places in the body. Hormone

production is usually triggered by the pituitary gland.

**Hypopituitarism**—A medical condition where the pituitary gland produces lower than normal levels of its hormones.

**Magnetic resonance imaging (MRI)**—A special imaging technique used to visualize internal structures of the body, particularly the soft tissues.

**Metabolism**—The sum of all the physical and chemical processes required to maintain life and also the transformation by which energy is made available for the uses of the body.

**Pituitary gland**—A small, oval-shaped endocrine gland situated at the base of the brain in the fossa (depression) of the sphenoid bone. Its overall role is to regulate growth and metabolism. The gland is divided into the posterior and anterior pituitary, each responsible for the production of its own unique hormones.

**Pituitary tumors**—Tumors found in the pituitary gland. Most pituitary tumors are benign, meaning that they grow very slowly and do not spread to other parts of the body.

rare in the United States, most commonly affecting adults aged 20–50. An estimated 10–15 of every million people are affected each year. However, the Pituitary Network Association reports that one out of every five people worldwide has a pituitary tumor. The earliest study was performed in 1936, by Dr. R. T. Costello of the Mayo Foundation who found pituitary tumors in 22.4% of his studied population with statistics not having changed significantly since that time.

### Description

There are several surgical approaches to the pituitary. The surgeon chooses the best one for the specific procedure. The pituitary lies directly behind the nose, and access through the nose or the sinuses is often the best approach. A **craniotomy** (opening the skull) and lifting the frontal lobe of the brain will expose the delicate neck of the pituitary gland. This approach works best if tumors have extended above the pituitary fossa (the cavity in which the gland lies).

Surgical methods using new technology have made other approaches possible. Stereotaxis is a three-dimensional aiming technique using x rays or scans for guidance. Instruments can be placed in the

brain with pinpoint accuracy through tiny holes in the skull. These instruments can then manipulate brain tissue, either to destroy it or remove it. Stereotaxis is also used to direct radiation with similar precision using a gamma knife. Access to some brain lesions can be gained through the blood vessels using tiny tubes and wires guided by x rays.

### Diagnosis/Preparation

A patient best prepares for a hypophysectomy by keeping as healthy and relaxed as possible. Informed surgical consent is always required.

The patient is first seen for evaluation of pituitary functions by the treatment team. An MRI scan of the pituitary gland is performed and the patient is seen by a neurosurgeon in an outpatient clinic or at the hospital to assess whether hypophysectomy is suitable.

The patient checks into the hospital the day before surgery and undergoes blood tests, chest x rays, or an **electrocardiogram** to assess anesthesia fitness. Four to five sticks are attached on buttons on the forehead and marked for a special MRI scan. These buttons and scan help the neurosurgeon to accurately remove the

pituitary tumor using sophisticated visualization computers. The patient is visited by the anesthesiologist (the physician who puts the patient to sleep for the operation) and he is asked to fast (nothing to eat or drink) from midnight before the day of surgery. If the hypophysectomy is performed through the nose, the patient is advised to practice breathing through the mouth as the nose will be packed after the surgery.

### Aftercare

The operation takes about one to two hours, following which the patient is taken to the recovery area for about two hours before returning to the neurosurgical ward. The following postoperative measures are the normally taken:

- The patient's nose is packed to stop bleeding.
- There may be a dressing on a site of incision in the abdominal wall or thigh if a graft was necessary.
- A drip is attached to the hand and foot and other lines are attached to monitor the heart and breathing.
- A urinary catheter is placed to monitor fluid output.
- The patient has an oxygen mask.

Once in the ward, the patient is allowed to eat and drink the same night, after he or she has recovered from the anesthesia. If fluid intake and output are in balance, the drip and urinary catheter are removed the next morning. The nurses continue to monitor the amount of fluid taken and the amount of urine passed by the patient for a few days. The blood is usually tested the day following surgery. The nasal pack stays for about four days. Once the nasal pack is removed, patients commonly experience moisture coming through the nose and blood-stained mucus occurs frequently. If all is well, patients are usually discharged the following day. There are no sutures to be removed. The sutures in the nose are degradable and the graft site is usually glued together. Patients are advised not to blow their nose or insert anything in the nose.

### Risks

The risks associated with hypophysectomy are numerous. Procedures are painstakingly selected to minimize risk and maximize benefit. A special risk associated with surgery on the pituitary is the risk of destroying the entire gland and leaving the entire endocrine system without regulation. Historically, this was the purpose of hypophysectomy, when the procedure was performed to suppress hormone production. After the procedure, the endocrinologist, a physician specializing in the study and care of the endocrine system, would provide the patient with all

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Hypophysectomies are performed by neurosurgeons or surgeons specialized in endocrinology. Endocrinologists are physicians with special education, training, and interest in the practice of clinical endocrinology. These physicians devote a significant part of their career to the evaluation and management of patients with endocrine disease. These physicians are usually members of the American Association of Clinical Endocrinologists and a majority are certified by Boards recognized by the American Board of Medical Specialties.

A hypophysectomy is major surgery and is always performed in a hospital setting.

the hormones needed. Patients with no pituitary function did and still do quite well because of the available hormone replacements.

Other specific risks include;

- **Hypopituitarism.** Following surgery, if the pituitary gland has normal activity, it may become underactive and the patient may require hormone replacement therapy. Diabetes insipidus (DI) (excessive thirst and excessive urine) is not uncommon in the first few days following surgery. The vast majority of cases clear but a small number of individuals need hormone replacement.
- **Cerebrospinal fluid (CSF) leakage.** CSF leakage from the nose can occur following hypophysectomy. If it happens during surgery, the surgeon will repair the leak immediately. If it occurs after the nasal pack is removed, it may require diversion of the CSF away from the site of surgery or repair.
- **Infection.** Infection of the pituitary gland is a serious risk as it may result in abscess formation or meningitis. The risk is very small and the vast majority of cases are treatable by antibiotics. Patients are usually given antibiotics during surgery and until the nasal pack is removed.
- **Bleeding.** Nasal bleeding or bleeding in the cavity of the tumor after removal may occur. If the latter occurs it may lead to deterioration of vision as the visual nerves are very close to the pituitary region.
- **Nasal septal perforation.** This may also occur during surgery, although it is very uncommon.
- **Visual impairment.** A very rare occurrence, but still a risk.



## QUESTIONS TO ASK THE DOCTOR

- Should I stop any medications before surgery?
  - How long will the surgery last?
  - What are the possible risks and complications?
  - How long will it be before I can resume normal activities?
  - How many hypophysectomies do you perform each year?
  - Are there alternatives to surgery?
- Incomplete tumor removal. Tumors may not be completely removed, due to their attachment to vital structures.

### Normal results

In the past, complete removal of the pituitary was the goal for cancer treatment. Nowadays, removal of tumors with preservation of the gland is the goal of the surgery.

### Morbidity and mortality rates

A follow-up study performed at the Massachusetts General Hospital and involving 349 patients who underwent surgery for pituitary adenomas between 1978 and 1985 documented 39 deaths over the 13 year follow-up. The primary cause of **death** was cardiovascular (27.5%) followed by non-pituitary cancer (20%) and pituitary-related deaths (20%). When compared to the population at large, the primary cause of death was also cardiovascular (40%), followed by cancers (at 24%).

### Alternatives

Surgery is a common treatment for pituitary tumors. For patients in whom hypophysectomy has failed or who are not suitable candidates for surgery, radiotherapy is another possible treatment. Radiation therapy uses high-energy x rays to kill cancer cells and shrink tumors. Radiation to the pituitary gland is given over a six-week period, with improvement occurring in 40–50% of adults and up to 80% of children. It may take several months or years before patients feel better from radiation treatment alone. However, the combination of radiation and the drug mitotane (Lysodren) has been shown to help speed recovery. Mitotane suppresses cortisol production and lowers plasma and urine hormone levels. Treatment with mitotane alone

can be successful in 30–40% of patients. Other drugs used alone or in combination to control the production of excess cortisol are aminoglutethimide, metyrapone, trilostane, and ketoconazole.

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#### ORGANIZATIONS

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- American Association of Endocrine Surgeons (AAES). MetroHealth Medical Center, H920, 2500 MetroHealth Drive, Cleveland, OH 44109-1908. (216) 778-4753. <http://www.endocrinesurgeons.org>.

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## Hypospadias repair

### Definition

Hypospadias repair refers to a group of surgical approaches used to correct or reconstruct parts of the external genitalia and urinary tract related to a displaced meatus, or opening of the urethra. The urethra is the passageway that carries urine from the bladder to the outside of the body. Hypospadias is the medical term for a birth defect in which the urethra opens on the underside of the penis (in boys) or into the vagina (in girls). The word hypospadias comes from two Greek words that mean underneath and rip or tear, because severe forms of hypospadias in boys look like large tears in the skin of the penis.

Hypospadias is one of the most common congenital abnormalities in males. It was described in the first and second centuries A.D. by Celsus, a Roman historian of medicine, and Galen, a Greek physician. The first attempt to correct hypospadias by surgery was made in 1874 by Duplay, a French surgeon; as of 2003, more than 200 different procedures for the condition have been reported in the medical literature.

Hypospadias repair is, however, controversial because it is genital surgery. Some people regard it as unnecessary interference with a child's body and a traumatic experience with psychological consequences extending into adult life. Others maintain that boys with untreated hypospadias are far more likely than those who have had surgery to develop fears about intimate relationships and sexuality. There is little information about the emotional aftereffects of hypospadias repair on girls.

### Purpose

Although there are several different surgical procedures used at present to correct hypospadias depending on its severity, all have the following purposes:

- To permit emptying of the bladder standing up. The abnormal location of the urethral meatus on the underside of the penis forces many boys to void urine sitting down, which leads to anxiety about using public restrooms or otherwise being seen undressed by other males.
- To correct a condition associated with hypospadias known as chordee. Chordee, which comes from the French *cordée*, which means tied or corded, is a condition in which the penis bends downward during an erection. This curving or bending makes it difficult to have normal sexual intercourse as an adult.

- To prevent urinary tract infections (UTIs). It is common in hypospadias for the urethral meatus to be stenotic, or abnormally narrowed. A stenotic urethra increases the risk of frequent UTIs.
- To lower the risk of developing testicular cancer. Hypospadias has been identified as a risk factor for developing testicular cancer after adolescence.
- To confirm the boy's sexual identity by improving the outward appearance of the penis. The external genitals of babies with severe hypospadias may look ambiguous at birth, causing stress for the parents about their child's gender identity.

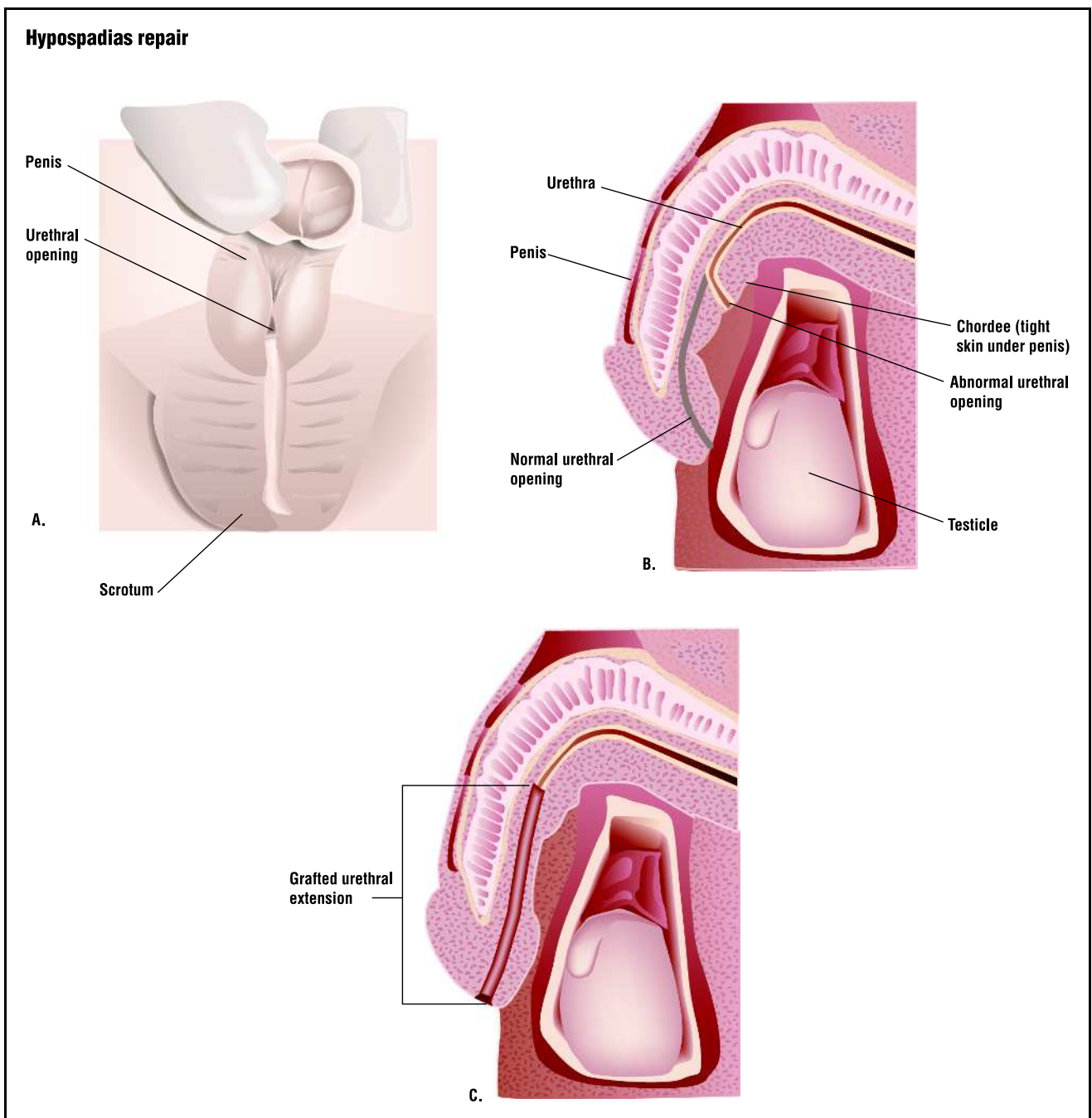
### Demographics

Hypospadias is much more common in males than in females. In Canada and the United States, the incidence of hypospadias in boys is estimated to be 1:250 live births. In girls, the condition is very rare, estimated at 1:500,000 live births. One troubling phenomenon is the reported doubling of cases of hypospadias in both Europe and North America since the 1970s without any obvious explanation. According to a recent press release from the U.S. Centers for Disease Control and Prevention (CDC), data from two surveillance systems monitoring birth defects in the United States show that the rate of hypospadias rose from 36 per 10,000 male births in 1968 to 80 per 10,000 male births in 1993. In addition to the increase in the number of cases reported, the proportion of severe cases has also risen, which means that the numerical increase cannot be explained as the result of better reporting.

The severity of hypospadias is defined according to the distance of the urethral opening from its normal location at the tip of the penis. In mild hypospadias, which is sometimes called coronal/glandular hypospadias, the urethral opening is located on the shaft of the penis just below the glans. In mild to moderate hypospadias, the opening is located further down the shaft of the penis toward the scrotum. In severe hypospadias, which is also called penoscrotal hypospadias, the urethral opening is located on the scrotum. About 80–85% of hypospadias are classified as mild; 10–15% as mild to moderate; and 3–6% as severe.

Although the causes of hypospadias are not yet fully understood, the condition is thought to be the end result of a combination of factors. The following have been associated with an increased risk of hypospadias:

- Genetic inheritance. Hypospadias is known to run in families; a boy with hypospadias has a 28% chance of having a male relative with the condition.



In hypospadias, the urethral opening is at the base of the penis, instead of the tip (A). Tissue grafts are used to create an extension for the urethra (C) and alleviate the tight skin, or chordee, on the underside of the penis. (Illustration by GGS Information Services. Cengage Learning, Gale.)

- Genetic disorders. Hypospadias is found in boys with a deletion on human chromosome 4p, also known as Wolf-Hirschhorn syndrome; and in persons with a variety of intersex conditions related to chromosomal abnormalities. Several different genetic mutations responsible for a deficiency in 5-alpha reductase, an enzyme needed to convert testosterone to a stronger androgen needed for urethral development, have been found in boys with hypospadias.
- Low birth weight. Several studies in the United Kingdom as well as in the United States have shown that male infants with hypospadias weigh less and are

## KEY TERMS

**Androgen**—Any substance that promotes the development of masculine characteristics in a person. Testosterone is one type of androgen; others are produced in the adrenal glands located above the kidneys.

**Chordee**—A condition associated with hypospadias in which the penis bends downward during erections.

**Circumcision**—The removal of the foreskin of the penis.

**Cryptorchidism**—A developmental disorder in which one or both testes fail to descend from the abdomen into the scrotum before birth. It is the most common structural abnormality in the male genital tract.

**Degloving**—Separating the skin of the penis from the shaft temporarily in order to correct chordee.

**Dehiscence**—A separation or splitting apart. In hypospadias repair, dehiscence refers to the reopening of the tip of the penis or the coming apart of the entire repair.

**Fistula (plural, fistulae)**—An abnormal passage between two internal organs or between an internal organ and the surface of the body. The formation of

fistulae is one of the possible complications of hypospadias repair.

**Glans**—The cap-shaped structure at the end of the penis.

**Hernia**—The protrusion of a loop or piece of tissue through an incision or abnormal opening in other tissues.

**Inguinal**—Referring to the groin area.

**Meatus**—The medical term for the opening of the urethra.

**Stenotic**—Abnormally narrowed. The urethral meatus is often stenotic in patients with uncorrected hypospadias.

**Stent**—A thin plastic tube inserted temporarily to hold the urethra open following hypospadias repair.

**Testosterone**—The major male sex hormone, produced in the testes.

**Urethra**—The canal or passageway that carries urine from the bladder to the outside of the body.

**Urology**—The branch of medicine that deals with disorders of the urinary tract in both males and females, and with the genital organs in males.

smaller at birth than controls. It is thought that these low measurements are markers of fetal androgen dysfunction.

- Drugs taken by the mother during pregnancy. Diethylstilbestrol (DES), a synthetic hormone that was prescribed for many women between 1938 and 1971 to prevent miscarriage, has been associated with an increased risk of stenosis of the urethral meatus as well as hypospadias in the sons of women who took the medication. Boys born to mothers addicted to cocaine also have an abnormally high rate of hypospadias.
- Environmental contamination. One proposal for explaining the rising rate of hypospadias and other birth defects in males is the so-called endocrine disruptor hypothesis. Many pesticides, fungicides, and other environmental pollutants contain estrogenic or anti-androgenic substances that interfere with the normal androgen pathways in embryonic tissue development—in birds and other animals as well as in humans.
- Assisted reproduction. A study done in Baltimore of children who were conceived through in vitro fertilization (IVF) between 1988 and 1992 found that the

incidence of hypospadias among the males was five times that of male infants in a control group.

With regard to ethnic and racial differences in the American population, the CDC reports that Caucasians have the highest rates of hypospadias, Hispanics have the lowest, and African Americans have intermediate rates. Other studies have found that hypospadias is more common in males of Jewish or Italian descent than in other ethnic groups.

## Description

### *Correction of hypospadias in boys*

The specific surgical procedure used depends on the severity of the hypospadias. The objectives of surgery always include widening the urethral meatus; correcting chordee, if present; reconstructing the missing part of the urethra; and making the external genitalia look as normal as possible. Most repair procedures take between one-and-a-half and three hours, and are performed under **general anesthesia**. Mild hypospadias can be corrected in a one-step procedure known as a meatal advancement and glanduloplasty, or MAGPI. In a MAGPI procedure, the opening of the urethra is moved forward and the head



of the penis is reshaped. More severe hypospadias can also be corrected in one operation, which involves degloving the penis (separating the skin from the shaft) in order to cut the bands of tissue that cause chordee, and constructing a new urethra that will reach to the tip of the penis. The specific technique of reconstruction is usually decided in the **operating room**, when the surgeon can determine how much tissue will be needed to make the new urethra. In some cases, tissue must be taken from the inner arm or the lining of the mouth. In a few cases, the repair may require two or three stages spaced several months apart.

There is some remaining disagreement among professionals regarding the best age for hypospadias repair in boys. Most surgeons think the surgery should be done between 12 and 18 months of age, on the ground that gender identity is not fully established prior to toilet training and the child is less likely to remember the operation. Some doctors, however, prefer to wait until the child is about three years old, particularly if the repair involves extensive reconstruction of the urethra.

Recent advances in hypospadias repair include the use of tissue glues and other new surgical adhesives that speed healing and reduce the risk of fistula formation. In addition, various synthetic materials are being tested for their suitability in constructing artificial urethras, which would reduce the risk of complications related to **skin grafting**.

#### *Correction of hypospadias in girls*

The most common surgical technique for correcting hypospadias in girls is construction of a new urethra that opens to the outside of the body rather than emptying into the vagina. Tissue is taken from the front wall of the vagina for this purpose.

### Diagnosis/Preparation

#### *Diagnosis*

The diagnosis of hypospadias in boys is often made at the time of delivery during the newborn examination. The condition may also be diagnosed before birth by **ultrasound**; according to a group of Israeli researchers, ultrasound images of severe hypospadias resemble the outline of a tulip flower. Ultrasound is also used prior to surgical repair to check for other abnormalities, as about 18% of boys with hypospadias also have cryptorchidism (undescended testicles), inguinal hernia, or defects of the upper urinary tract.

Hypospadias in girls may not be discovered for several months after birth because of the difficulty of examining the vagina in newborn females.

#### *Preparation*

Male infants with hypospadias should not be circumcised as the foreskin may be needed for tissue grafting during repair of the hypospadias.

Some surgeons prescribe small doses of male hormones to be given to the child in advance to increase the size of the penis and improve blood supply to the area. The child may also be given a mild sedative immediately before surgery to minimize memories of the procedure.

### Aftercare

#### *Short-term aftercare*

Many anesthesiologists provide a penile nerve block to minimize the child's postoperative discomfort. **Dressings** are left in place for about four days. The surgeon places a stent, which is a short plastic tube held in place with temporary **stitches**, or a catheter to keep the urethra open. The patient is usually given a course of **antibiotics** to reduce the risk of infection until the dressings and the stent or catheter are removed, usually 10–14 days after surgery.

The child should be encouraged to drink plenty of fluids after returning home in order to maintain an adequate urinary output. Periodic follow-up tests of adequate urinary flow are typically scheduled for three weeks, three months, and 12 months after surgery.

#### *Long-term aftercare*

Boys who have had any type of hypospadias repair should be followed through adolescence to exclude the possibility of chronic inflammation or scarring of the urethra. In some cases, psychological counseling may also be necessary.

### Risks

In addition to the risks of bleeding and infection that are common to all operations under general anesthesia, there are some risks specific to hypospadias repair:

- **Wound dehiscence.** Dehiscence means that the incision splits apart or reopens. It is treated by a follow-up operation.
- **Bladder spasms.** These are a reaction to the presence of a urinary catheter, and are treated by giving medications to relax the bladder muscles.
- **Fistula formation.** A fistula is an abnormal opening that forms between the reconstructed urethra and the skin. Most fistulae that form after hypospadias

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Surgery to correct hypospadias is done by a pediatric urologist, a surgeon with advanced training in urology as well as in treating disorders affecting children. According to the Society for Pediatric Urology (SPU), pediatric urologists educated in the United States have completed two years in a general surgery residency after medical school, followed by four years in a urologic surgery residency and an additional two years in a pediatric urology fellowship program.

Surgical procedures to correct mild or moderate hypospadias with little chordee may be done on an outpatient basis. Correction of moderate or severe hypospadias with some chordee, however, involves hospitalizing the child for 1–2 days. Parents can usually arrange to stay overnight with their child.

surgery close by themselves within a few months. The remainder can be closed surgically.

- Recurrent chordee. This complication requires another operation to remove excess fibrous tissue.
- Urethral stenosis. Narrowing of the urethral opening after surgery is treated by dilating the meatus with urethral probes.

## Normal results

Hypospadias repair in both boys and girls has a high rate of long-term success. In almost all cases, the affected children are able to have normal sexual intercourse as adults, and almost all are able to have children.

## Morbidity and mortality rates

Surgical repair of hypospadias has a fairly high short-term complication rate:

- leakage of urine from the area around the urethral meatus: 3–9%
- formation of a fistula: 0.6–23% for one-stage procedures; 2–37% for two-stage procedures
- urethral stenosis: 8.5%
- persistent chordee: less than 1%

## QUESTIONS TO ASK THE DOCTOR

- How often do you perform hypospadias repair, and what is your success rate?
- How severe is my child's hypospadias, and what procedure do you recommend to correct it?
- What do you consider the best age for corrective genital surgery and why?

## Alternatives

There are no medical treatments for hypospadias as of 2007. The only alternative to surgery in childhood is postponement until the child is old enough to decide for himself (or herself) about genital surgery.

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American Board of Urology (ABU). 2216 Ivy Road, Suite 210, Charlottesville, VA 22903. (434) 979 0059. <http://www.abu.org>.

American Urological Association (AUA). 1120 North Charles Street, Baltimore, MD 21201. (410) 727 1100. <http://www.auanet.org>.

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## Hysterectomy

### Definition

Hysterectomy is the surgical removal of all or part of the uterus. In a total hysterectomy, the uterus and cervix are removed. In some cases, the fallopian tubes and ovaries are removed along with the uterus, which is a hysterectomy with bilateral **salpingo-oophorectomy**. In a subtotal hysterectomy, only the uterus is removed. In a radical hysterectomy, the uterus, cervix, ovaries, oviducts, lymph nodes, and lymph channels are removed. The type of hysterectomy performed depends on the reason for the procedure. In all cases, menstruation permanently stops and a woman loses the ability to bear children.

### Purpose

The most frequent reason for hysterectomy in American women is to remove fibroid tumors, accounting for 30% of these surgeries. Fibroid tumors are non-cancerous (benign) growths in the uterus that can cause pelvic, low back pain, and heavy or lengthy menstrual periods. They occur in 30–40% of women over age 40, and are three times more likely to be present in African-American women than in Caucasian women. Fibroids do not need to be removed unless they are causing symptoms that interfere with a woman's normal activities.

Treatment of endometriosis is the reason for 20% of hysterectomies. The endometrium is the lining of the uterus. Endometriosis occurs when the cells from the endometrium begin growing outside the uterus. The outlying endometrial cells respond to the hormones that control the menstrual cycle, bleeding each month the way the lining of the uterus does. This causes irritation of the surrounding tissue, leading to pain and scarring.

Twenty percent of hysterectomies are done because of heavy or abnormal vaginal bleeding that cannot be linked to any specific cause and cannot be controlled by other means. Another 20% are performed to treat prolapsed uterus, pelvic inflammatory disease, or endometrial hyperplasia, a potentially pre-cancerous condition.

About 10% of hysterectomies are performed to treat cancer of the cervix, ovaries, or uterus. Women with cancer in one or more of these organs almost always have the organ(s) removed as part of their cancer treatment.

### Demographics

Hysterectomy is the second most common operation performed on women in the United States. About 556,000 of these surgeries are done annually. By age 60, approximately one out of every three American women will have had a hysterectomy. It is estimated that 30% of hysterectomies are unnecessary.

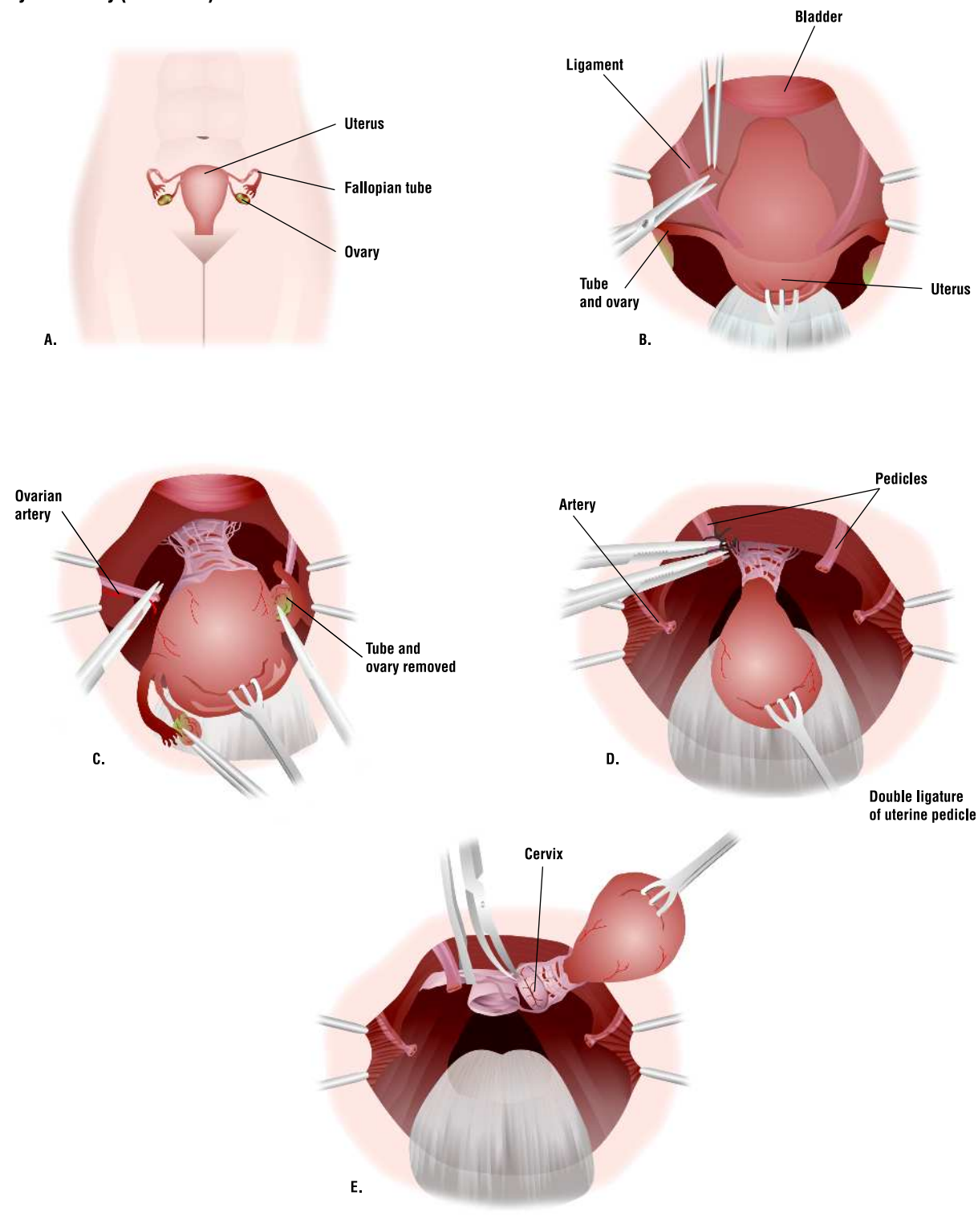
The frequency with which hysterectomies are performed in the United States has been questioned in recent years. It has been suggested that a large number of hysterectomies are performed unnecessarily. The United States has the highest rate of hysterectomies of any country in the world. Also, the frequency of this surgery varies across different regions of the United States. Rates are highest in the South and Midwest, and are higher for African-American women. In recent years, although the number of hysterectomies performed has declined, the number of hysterectomies performed on younger women aged 30s and 40s is increasing, and 55% of all hysterectomies are performed on women ages 35–49.

### Description

A hysterectomy is classified according to what structures are removed during the procedure and what method is used to remove them.

#### Total hysterectomy

A total hysterectomy, sometimes called a simple hysterectomy, removes the entire uterus and the cervix.

**Hysterectomy (abdominal)**

In a hysterectomy, the reproductive organs are accessed through a lower abdominal incision or laparoscopically (A). Ligaments and supporting structures called pedicles connecting the uterus to surrounding organs are severed (B). Arteries to the uterus are severed (C). The uterus, fallopian tubes, and ovaries are removed (D and E). (Illustration by GGS Information Services. Cengage Learning, Gale.)



## KEY TERMS

**Cervix**—The lower part of the uterus extending into the vagina.

**Fallopian tubes**—Slender tubes that carry eggs (ova) from the ovaries to the uterus.

**Lymph nodes**—Small, compact structures lying along the channels that carry lymph, a yellowish fluid. Lymph nodes produce white blood cells (lymphocytes), which are important in forming antibodies that fight disease.

**Pap smear**—The common term for the Papanicolaou test, a simple smear method of examining stained cells to detect cancer of the cervix.

**Prolapsed uterus**—A uterus that has slipped out of place, sometimes protruding down through the vagina.

The ovaries are not removed and continue to secrete hormones. Total hysterectomies are usually performed in the case of uterine and cervical cancer. This is the most common kind of hysterectomy.

In addition to a total hysterectomy, a procedure called a bilateral salpingo-oophorectomy is sometimes performed. This surgery removes the ovaries and the fallopian tubes. Removal of the ovaries eliminates the main source of the hormone estrogen, so menopause occurs immediately. Removal of the ovaries and fallopian tubes is performed in about one-third of hysterectomy operations, often to reduce the risk of ovarian cancer.

### *Subtotal hysterectomy*

If the reason for the hysterectomy is to remove uterine fibroids, treat abnormal bleeding, or relieve pelvic pain, it may be possible to remove only the uterus and leave the cervix. This procedure is called a subtotal hysterectomy (or partial hysterectomy), and removes the least amount of tissue. The opening to the cervix is left in place. Some women believe that leaving the cervix intact aids in their achieving sexual satisfaction. This procedure, which used to be rare, is now performed more frequently.

Subtotal hysterectomy is easier to perform than a total hysterectomy, but leaves a woman at risk for cervical cancer. She will still need to get yearly Pap smears.

### *Radical hysterectomy*

Radical hysterectomies are performed on women with cervical cancer or endometrial cancer that has spread to the cervix. A radical hysterectomy removes the uterus, cervix, above part of the vagina, ovaries, fallopian tubes, lymph nodes, lymph channels, and tissue in the pelvic cavity that surrounds the cervix. This type of hysterectomy removes the most tissue and requires the longest hospital stay and a longer recovery period.

### *Methods of hysterectomy*

There are two ways that hysterectomies can be performed. The choice of method depends on the type of hysterectomy, the doctor's experience, and the reason for the hysterectomy.

**ABDOMINAL HYSTERECTOMY.** About 75% of hysterectomies performed in the United States are abdominal hysterectomies. The surgeon makes a 4–6-in (10–15-cm) incision either horizontally across the pubic hair line from hip bone to hip bone or vertically from navel to pubic bone. Horizontal incisions leave a less noticeable scar, but vertical incisions give the surgeon a better view of the abdominal cavity. The blood vessels, fallopian tubes, and ligaments are cut away from the uterus, which is lifted out.

Abdominal hysterectomies take from one to three hours. The hospital stay is three to five days, and it takes four to eight weeks to return to normal activities.

The advantages of an abdominal hysterectomy are that the uterus can be removed even if a woman has internal scarring (adhesions) from previous surgery or her fibroids are large. The surgeon has a good view of the abdominal cavity and more room to work. Also, surgeons tend to have the most experience with this type of hysterectomy. The abdominal incision is more painful than with vaginal hysterectomy, and the recovery period is longer.

**VAGINAL HYSTERECTOMY.** With a vaginal hysterectomy, the surgeon makes an incision near the top of the vagina. The surgeon then reaches through this incision to cut and tie off the ligaments, blood vessels, and fallopian tubes. Once the uterus is cut free, it is removed through the vagina. The operation takes one to two hours. The hospital stay is usually one to three days, and the return to normal activities takes about four weeks.

The advantages of this procedure are that it leaves no visible scar and is less painful. The disadvantage is that it is more difficult for the surgeon to see the uterus and surrounding tissue. This makes complications

more common. Large fibroids cannot be removed using this technique. It is very difficult to remove the ovaries during a vaginal hysterectomy, so this approach may not be possible if the ovaries are involved.

Vaginal hysterectomy can also be performed using a laparoscopic technique. With this surgery, a tube containing a tiny camera is inserted through an incision in the navel. This allows the surgeon to see the uterus on a video monitor. The surgeon then inserts two slender instruments through small incisions in the abdomen and uses them to cut and tie off the blood vessels, fallopian tubes, and ligaments. When the uterus is detached, it is removed through a small incision at the top of the vagina.

This technique, called laparoscopic-assisted vaginal hysterectomy, allows surgeons to perform a vaginal hysterectomy that might otherwise be too difficult. The hospital stay is usually only one day. Recovery time is about two weeks. The disadvantage is that this operation is relatively new and requires great skill by the surgeon.

Any vaginal hysterectomy may have to be converted to an abdominal hysterectomy during surgery if complications develop.

### Diagnosis/Preparation

Before surgery the doctor will order blood and urine tests. The woman may also meet with the anesthesiologist to evaluate any special conditions that might affect the administration of anesthesia. On the evening before the operation, the woman should eat a light dinner and then have nothing to eat or drink after midnight.

### Aftercare

After surgery, a woman will feel some degree of discomfort; this is generally greatest in abdominal hysterectomies because of the incision. Hospital stays vary from about two days (laparoscopic-assisted vaginal hysterectomy) to five or six days (abdominal hysterectomy with bilateral salpingo-oophorectomy). During the hospital stay, the doctor will probably order more blood tests.

Return to normal activities such as driving and working takes anywhere from two to eight weeks, again depending on the type of surgery. Some women have emotional changes following a hysterectomy. Women who have had their ovaries removed will probably start hormone replacement therapy.

### Risks

Hysterectomy is a relatively safe operation, although like all major surgery it carries risks. These include

unanticipated reaction to anesthesia, internal bleeding, blood clots, damage to other organs such as the bladder, and post-surgery infection.

Other complications sometimes reported after a hysterectomy include changes in sex drive, weight gain, constipation, and pelvic pain. Hot flashes and other symptoms of menopause can occur if the ovaries are removed. Women who have both ovaries removed and who do not take estrogen replacement therapy run an increased risk for heart disease and osteoporosis (a condition that causes bones to be brittle). Women with a history of psychological and emotional problems before the hysterectomy are likely to experience psychological difficulties after the operation.

As in all major surgery, the health of the patient affects the risk of the operation. Women who have chronic heart or lung diseases, diabetes, or iron-deficiency anemia may not be good candidates for this operation. Heavy smoking, obesity, use of steroid drugs, and use of illicit drugs add to the **surgical risk**.

### Normal results

Although there is some concern that hysterectomies may be performed unnecessarily, there are many conditions for which the operation improves a woman's quality of life. In the Maine Woman's Health Study, 71% of women who had hysterectomies to correct moderate or severe painful symptoms reported feeling better mentally, physically, and sexually after the operation.

### Morbidity and mortality rates

The rate of complications differs by the type of hysterectomy performed. Abdominal hysterectomy is associated with a higher rate of complications (9.3%), while the overall complication rate for vaginal hysterectomy is 5.3%, and 3.6% for laparoscopic vaginal hysterectomy. The risk of **death** from hysterectomy is about one in every 1,000 women. The rates of some of the more commonly reported complications are:

- excessive bleeding (hemorrhaging): 1.8–3.4%
- fever or infection: 0.8–4.0%
- accidental injury to another organ or structure: 1.5–1.8%

### Alternatives

Women for whom a hysterectomy is recommended should discuss possible alternatives with their doctor and consider getting a **second opinion**, since this is major surgery with life-changing implications. Whether an alternative is appropriate for any

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Hysterectomies are usually performed under the strict conditions of a hospital operating room. The procedure is generally performed by a gynecologist, a medical doctor who has specialized in the areas of women's general health, pregnancy, labor and childbirth, prenatal testing, and genetics.

individual woman is a decision she and her doctor should make together. Some alternative procedures to hysterectomy include:

- **Embolization.** During uterine artery embolization, interventional radiologists put a catheter into the artery that leads to the uterus and inject polyvinyl alcohol particles right where the artery leads to the blood vessels that nourish the fibroids. By killing off those blood vessels, the fibroids have no more blood supply, and they die off. Severe cramping and pain after the procedure is common, but serious complications are less than 5% and the procedure may protect fertility.
- **Myomectomy.** A myomectomy is a surgery used to remove fibroids, thus avoiding a hysterectomy. Hysteroscopic myomectomy, in which a surgical hysteroscope (telescope) is inserted into the uterus through the vagina, can be done on an outpatient basis. If there are large fibroids, however, an abdominal incision is required. Patients typically are hospitalized for two to three days after the procedure and require up to six weeks recovery. Laparoscopic myomectomies are also being done more often. They only require three small incisions in the abdomen, and have much shorter hospitalization and recovery times. Once the fibroids have been removed, the surgeon must repair the wall of the uterus to eliminate future bleeding or infection.
- **Endometrial ablation.** In this surgical procedure, recommended for women with small fibroids, the entire lining of the uterus is removed. After undergoing endometrial ablation, patients are no longer fertile. The uterine cavity is filled with fluid and a hysteroscope is inserted to provide a clear view of the uterus. Then, the lining of the uterus is destroyed using a laser beam or electric voltage. The procedure is typically done under anesthesia, although women can go home the same day as the surgery. Another newer procedure involves using a balloon, which is filled with superheated liquid and inflated until it fills

## QUESTIONS TO ASK THE DOCTOR

- Why is a hysterectomy recommended for my particular condition?
- What type of hysterectomy will be performed?
- What alternatives to hysterectomy are available to me?
- Will I have to start hormone replacement therapy?

the uterus. The liquid kills the lining, and after eight minutes the balloon is removed.

- **Endometrial resection.** The uterine lining is destroyed during this procedure using an electrosurgical wire loop (similar to endometrial ablation).

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American College of Obstetricians and Gynecologists. 409 12th St., SW, P.O. Box 96920, Washington, DC 20090 6920. <http://www.acog.org>.

National Cancer Institute. Building 31, Room 10A31, 31 Center Drive, MSC 2580, Bethesda, MD 20892 2580. (800) 422 6237. <http://www.nci.nih.gov>.

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## Hysteroscopy

### Definition

Hysteroscopy enables a physician to look through the vagina and neck of the uterus (cervix) to inspect the cavity of the uterus with an instrument called a hysteroscope. Hysteroscopy is used as both a diagnostic and a treatment tool.

### Purpose

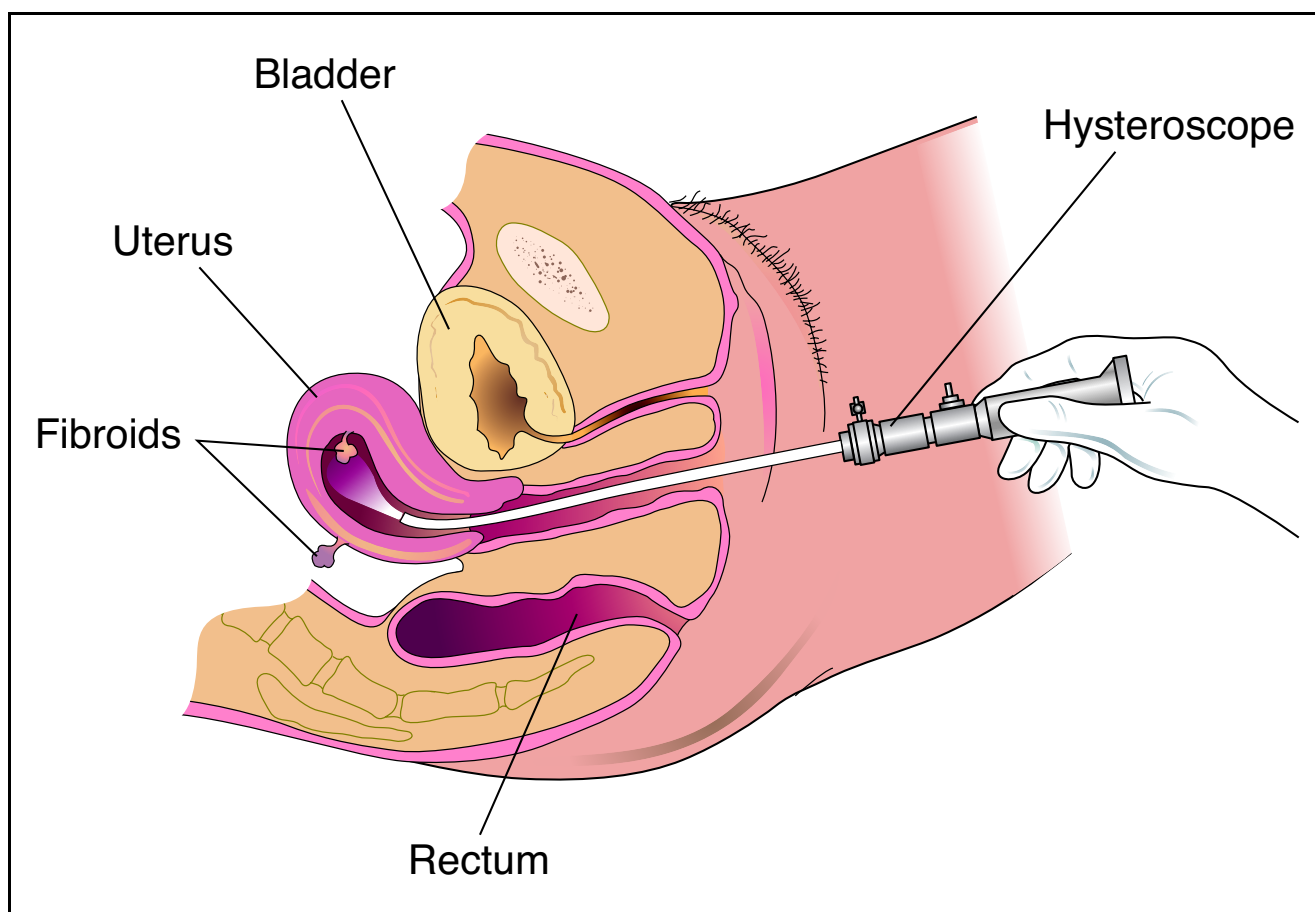
Diagnostic hysteroscopy can be used to help determine the cause of infertility, dysfunctional uterine bleeding, and repeated miscarriages. It can also help locate polyps and fibroids, as well as intrauterine devices (IUDs).

The procedure is also used to investigate and treat gynecological conditions, often done instead of or in addition to, performing a dilation and curettage (D&C).

A D&C is a surgical procedure that expands the cervical canal (dilation) so that the lining of the uterus can be scraped (curettage). A D&C can be used to take a sample of the lining of the uterus for analysis. However, hysteroscopy has advantages over a D&C because the doctor can take tissue samples of specific areas and view any fibroids, polyps, or structural abnormalities. In addition, small fibroids and polyps may be removed via the hysteroscope (in combination with other instruments that are inserted through canals in the hysteroscope), thus avoiding more invasive and complicated open surgery. This approach is also used to remove IUDs that have become embedded in the wall of the uterus.

### Demographics

There is no research available to indicate that hysteroscopy is performed more or less frequently on any subset of the female population.



**Hysteroscopy is a procedure that allows inspection of the uterus by using a telescope-like instrument called a hysteroscope.**  
(Illustration by Electronic Illustrators Group. Cengage Learning, Gale.)





**Hysteroscopy of an intrauterine polyp.** (Ism/Phototake. Reproduced by permission.)

### Description

The hysteroscope is an extremely thin telescope-like instrument that looks like a lighted tube. The modern hysteroscope is so thin that it can fit through the cervix with only minimal or no dilation.

Before inserting the hysteroscope, the doctor administers an anesthetic. Once it has taken effect, the doctor dilates the cervix slightly, and then inserts the hysteroscope through the cervix to reveal the inside of the uterus. Ordinarily, the walls of the uterus are touching each other. In order to get a better view, the uterus may be inflated with carbon dioxide gas or fluid. Hysteroscopy takes approximately 30 minutes.

Treatment involving the use of hysteroscopy is usually performed as a short-stay hospital procedure with regional or **general anesthesia**. Tiny **surgical instruments** may be inserted through the hysteroscope to remove polyps or fibroids. A small sample of tissue lining the uterus is often removed for examination, especially if the patient has experienced any abnormal vaginal bleeding.

### KEY TERMS

**Dilation and curettage (D&C)**—A surgical procedure that expands the cervical canal (dilation) so that the lining of the uterus can be scraped (curettage).

**Fibroid**—A benign tumor of the uterus.

**Intrauterine device (IUD)**—A small flexible device that is inserted into the uterus to prevent pregnancy.

**Polyp**—A growth that projects from the lining of the cervix or any other mucus membrane.

**Septum**—An extra fold of tissue down the center of the uterus; this tissue can be removed with a wire electrode and a hysteroscope.

### Diagnosis/Preparation

If the procedure is performed under general anesthesia, the patient should have nothing to eat or drink after midnight the night before the procedure. Routine lab tests may be ordered if the procedure is performed in a hospital. Occasionally, a mild sedative is administered to help the patient relax. The patient is asked to empty her bladder. She is then placed in position (usually in a special chair that tilts back) and the vagina is cleansed. Usually, a local anesthetic is administered around the cervix, although a regional anesthetic that blocks nerves connected to the pelvic region or a general anesthetic may be required for some patients.

### Aftercare

It is normal to experience light bleeding for one to two days after surgical hysteroscopy. Mild cramping or pain is common after operative hysteroscopy, but usually diminishes within eight hours. If carbon dioxide gas was used, the resulting discomfort usually subsides within 24 hours.

### Risks

Diagnostic hysteroscopy rarely causes complications. The primary risk is infection. Prolonged bleeding may follow a surgical hysteroscopy to remove a growth. Another complication is perforation of the uterus, bowel, or bladder, caused by over-forceful advancement of the hysteroscope. An infrequent but dangerous complication is increased fluid absorption from the uterus into the bloodstream. Keeping track of the amount of fluid used during the procedure can minimize this complication. Surgery under general anesthesia poses the additional risks typically associated with this type of anesthesia.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The test is usually performed by a gynecologist, a medical doctor who specializes in the areas of women's general health, pregnancy, labor and childbirth, and prenatal testing. Nursing staff assists with providing education, positioning the patient, and specimen collection. Diagnostic hysteroscopy is performed in either a doctor's office or hospital. Uterine size and potential diagnosis and complexity of treatment determine the setting.

The procedure is not performed on women with acute pelvic inflammatory disease (PID) due to the potential of exacerbating the condition. Hysteroscopy should be scheduled after menstrual bleeding has ended and before ovulation to avoid a potential interruption of a new pregnancy.

Patients should notify their health care provider if, after the hysteroscopy, they develop any of the following symptoms:

- abnormal discharge
- heavy vaginal bleeding
- fever over 101°F (38.3°C)
- severe lower abdominal pain

### Normal results

Normal hysteroscopy reveals a healthy uterus with no fibroids or other growths. Abnormal results include uterine fibroids, polyps, or a septum (an extra fold of tissue down the center of the uterus). Sometimes, pre-cancerous or malignant growths are discovered.

### Morbidity and mortality rates

The rate of complications during diagnostic hysteroscopy is very low, about 0.01%. Surgical hysteroscopy is associated with a higher number of complications. Perforation of the uterus occurs in 0.8% of procedures and excess bleeding in 1.2–3.5% of cases. **Death** as a result of hysteroscopy occurs at a rate of 2.4 per 100,000 procedures performed.

### Alternatives

A laparoscope (an instrument which is attached to a video camera and a light source, is inserted through

## QUESTIONS TO ASK THE DOCTOR

- Why is hysteroscopy recommended in my case?
- Will a surgical procedure be performed?
- How long will the procedure take?
- Where will the procedure be performed?

the abdominal wall) may be used to visualize the outside of the uterus or perform a surgical procedure on the pelvic organs. **Laparoscopy** and hysteroscopy are sometimes performed simultaneously to maximize their diagnostic capabilities.

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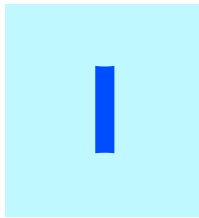
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Ibuprophen see **Nonsteroidal anti-inflammatory drugs**

ICU see **Intensive care unit**

ICU equipment see **Intensive care unit equipment**

## Ileal conduit surgery

### Definition

There are many surgical techniques for urinary diversion surgery. They fall into two categories: continent diversion and conduit diversion. In continent diversion, also known as continent catheterizable stomal reservoir, a separate rectal reservoir for urine is created, which allows evacuation from the body. In conduit diversion, or orthotopic urethral anastomotic procedure, an intestinal stoma or conduit for release of urine is created in the abdominal wall so that a catheter or ostomy can be attached for the release of urine. An ileal conduit is a small urine reservoir that is surgically created from a small segment of bowel. Both techniques are forms of **reconstructive surgery** to replace the bladder or bypass obstructions or disease in the bladder so that urine can pass out of the body. Both procedures have been used for years and should be considered for all appropriate patients. Ileal conduit surgery, the easiest of the reconstructive surgeries, is the gold standard by which other surgical techniques, both continent and conduit, have been compared as the techniques have advanced over the decades.

### Purpose

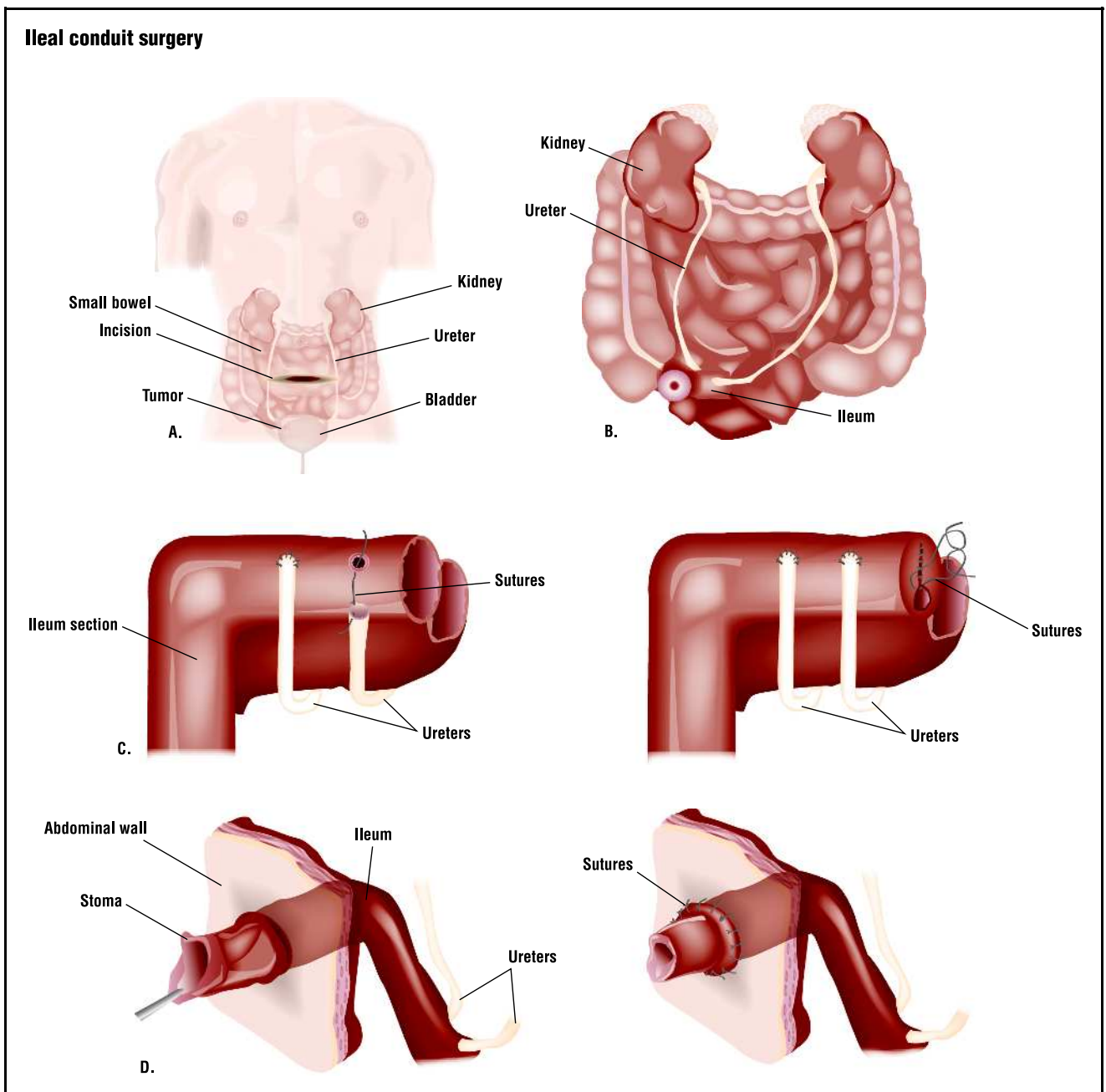
The bladder creates a reservoir for the liquid wastes created by the kidneys as a result of the ability of these organs to filter and retain glucose, salts, and minerals

that the body needs. When the bladder must be removed; or becomes diseased, injured, obstructed, or develops leak points; the release of urinary wastes from the kidneys becomes impaired, endangering the kidneys with an overburden of poisons. Reasons for disabling the urinary bladder are: cancer of the bladder; neurogenic sources of bladder dysfunction; bladder sphincter detrusor overactivity that causes continual urge incontinence; chronic inflammatory diseases of the bladder; tuberculosis; and schistosomiasis, which is an infestation of the bladder by parasites, mostly occurring Africa and Asia. Radical **cystectomy**, removal of the bladder, is the predominant treatment for cancer of the bladder, with radiation and chemotherapy as other alternatives. In both cases, urinary diversion is often necessitated, either due to the whole or partial removal of the bladder or to damage done by radiation to the bladder.

### Demographics

Urinary diversion has a long history and, over the last two decades, has developed new techniques for urinary tract reconstruction to preserve renal function and to increase the quality of life. A number of difficulties had to be solved for such progress to take place. Clean intermittent catheterization by the patient became possible in the 1980s, and many patients with loss of bladder function were able to continue to have urine release through the use of catheters. However, it soon became clear that catheterization left a residue that cumulatively, and over time, increased the risk of infection, which subsequently decreased kidney function through reflux, or backup, of urine into the kidneys. A new way had to be found. With the advent of surgical anastomosis (the grafting of vascularizing tissue for the repair and expansion of organ function) as well as with the ability to include a flap-type of valve to prevent backup, bladder reconstructive surgery that allowed for protection of the kidneys became possible.





In a cystectomy with ileal conduit, an incision is made in the patient's lower abdomen (A). The ureters are disconnected from the bladder, which is then removed (B). They are then attached to a section of ileum (small intestine) that has been removed and refashioned for that purpose (C). A stoma, or hole in the abdominal wall, is created at the site to allow drainage of the urine (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

### Description

Ileal conduit surgery consists of open abdominal surgery that proceeds in the following three stages:

- Isolating the ileum, which is the last section of small bowel. The segment used is about 5.9–7.8 in (15–20 cm) in length.
- The segment is then anastomosed, or grafted, to the ureters with absorbable sutures.
- A stoma, or opening in skin, is created on the right side of the abdomen.
- The other end of the bowel segment is attached to the stoma, which drains into an ostomy bag.

## KEY TERMS

**Neo-bladder**—A term that refers to the creation of a reservoir for urine made from intestinal tissue that allows for evacuation.

**Ostomy**—A pouch attached to an outlet through the abdominal wall that allows urine to drain and be collected after the surgical removal of the bladder.

**Stoma**—A term used for the opening in the abdomen created to reroute urine to an external collection pouch, or ostomy.

**Urinary conduit diversion**—A type of urinary diversion or rerouting that uses a conduit made from an intestinal segment to channel urine to an outside collection pouch.

Stents are used to bypass the surgical site and divert urine externally, ensuring that the anastomotic site has adequate healing time. Continent surgeries are more extensive than the ileal conduit surgery and are not described here. Both types of surgery require an extensive hospitalization with careful monitoring of the patient for infections, removal of stents placed in the bowel during surgery, and removal of catheters.

## Diagnosis/Preparation

Ileal conduit surgery is recommended depending on what conditions are being treated; whether the urinary diversion is immediately necessary; for the relief of pain or discomfort; or for relatively healthy individuals or individuals with terminal illness. Three major decisions that must be made by the physician and patient include:

- The type of surgery to restore bladder function: either by sending urine through the ureters to a new repository fashioned in the rectum, or by creating a conduit for the removal of the urine out through the stomach wall and into a permanent storage pouch or ostomy outside the body.
- The type of material out of which to fashion the reservoir or conduit.
- Where to place the stoma outlet for patient use.

Recent research has shown there is little difference in infection rates or in renal deterioration between the conduit surgical techniques and the continent techniques. The patient's preference becomes important as to which type of surgery and resulting procedures for urination they want. Of course, some patients, unable to conduct catheterization due to debilitating diseases

like multiple sclerosis or neurological injuries, should be encouraged to have the reservoir or continent procedures.

Materials for fashioning continent channels have included sections of the appendix, stomach, ileum and cecum of the intestines, and for the reservoir, sigmoid and ureter tissues, usually with an anti-refluxing mechanism to maximize continence. A segment of the ileum is often preferred, unless the tissue has received radiation. In this case, other tissue must be used. Ileum is preferred because the ileal tissue of the intestines accommodates larger urine volume at lower pressure.

Many urinary diversion procedures are performed in conjunction with surgery for recurrent cancer or complications of pelvic radiation. Fistula development and repeated repair as well as ureteral obstruction also are reasons to have the surgery. If the surgery is considered because of cancer, the physician and the patient need to discuss how appropriate the surgery is for cure or for relieving pain. Highly relevant are the patient's age, medical condition, and ability to comprehend both the procedure and the patient's role in the changed state that will result with the surgery. In general, ileal conduit surgery is easier, faster, and has fewer complications than continent reservoir surgery.

In addition to these considerations, great emphasis must be put on preparing the patient psychologically, and physicians must make themselves available for counseling and questions before proceeding with patient evaluation for the procedures. The renal system must be assessed using pyelography, which is the visualization of the renal pelvis of the kidneys to determine the health of each renal system. Patients with renal disease or abnormalities are not good candidates for urinary diversion. Bowel preparation and prophylactic **antibiotics** are necessary to avoid infection with the surgery. Bowel preparation includes injecting a clear-liquid diet preoperatively for two days, followed by using a cleansing enema or enemas until the bowel runs clear. The importance of these preparations must be explained to the patient: leaking from the bowel during surgery can be life threatening. For ileal conduits, the placement of the stoma must be decided. This is accomplished after the physician evaluates the patient's abdomen in both a sitting and standing position, to avoid placing the stoma in a fatty fold of the abdomen. The input from a stomal therapist is important for this preparation with the patient.

## Aftercare

Ureteral stents are generally removed one week after surgery. A **urine culture** is taken from each stent. Radiologic contrast studies are carried out to ensure

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Surgery is performed by a urological surgeon who specializes in urinary diversion. It is performed in a general hospital.

against ureteral anastomotic leakage or obstruction. On the seventh postoperative day, a contrast study is performed to ensure pouch integrity. Thereafter, ureteral stents may be removed, again with radiologic control. When it has been determined that the ureteral anastomoses and pouch are intact, the suction drain is removed. The patient is shown how to support the operative site when sleeping and with breathing and coughing. Fluids and electrolytes are infused intravenously until the patient can take liquids by mouth. The patient is usually able to get up in eight to 24 hours and leave the hospital in about a week.

Patients are taught how to care for the ostomy, and family members are educated as well. Appropriate supplies and a schedule of how to change the pouch are discussed, along with skin care techniques for the area surrounding the stoma. Often, a stomal therapist will make a home visit after discharge to help the patient return to normal daily activities.

### Risks

This surgery includes the major risks of thrombosis and heart difficulties that can result from abdominal surgery. Many difficulties can occur after urinary diversion surgery, including urinary leakage, problems with a stoma, changes in fluid balance, and infections over time. However, urinary diversion is usually tolerated well by most patients, and reports indicate that patient satisfaction is very high. Common complications are stricture caused by inflammation or scar tissue from surgery, disease, or injury. The incidence of urine leakage for all types of ureterointestinal anastomoses is 3–5% and occurs within the first 10 days after surgery. According to some researchers, this incidence of leakage can be reduced to near zero if stents are used during surgery.

### Normal results

Complete healing is expected without complications, with the patient returning to normal activities once they have recovered from surgery.

## QUESTIONS TO ASK THE DOCTOR

- How soon after the surgery will I be taught how to use an ostomy?
- Will the ostomy be obvious to others?
- Is continent surgery, or surgery with an internal neo-bladder, a better alternative?
- How do conduit and continent surgery compare in terms of recuperation, complications, and quality-of-life issues?

### Morbidity and mortality rates

Possible complications associated with ileal conduit surgery include bowel obstruction, blood clots, urinary tract infection, pneumonia, skin breakdown around the stoma, stenosis of the stoma, and damage to the upper urinary tract by reflux. Pyelonephritis, or bacterial infection of a kidney, occurs both in the early postoperative period and over the long term. Approximately 12% of patients diverted with ileal conduits and 13% in those diverted with anti-refluxing colon conduits have this complication. Pyelonephritis is associated with significant mortality.

### Alternatives

An alternative to ileal conduit surgery is continent surgery in which a neo-bladder is fashioned from bowel segments, allowing the patient to evacuate the urine and avoid having an external appliance. The procedures of continent diversion are more complicated, require more hospitalization, and have higher complication rates than conduit surgery. Many patients, unable to manage a stoma, are good candidates for continent diversion.

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United Ostomy Association, Inc. (UOA). 19772 MacArthur Blvd., Suite 200, Irvine, CA 92612 2405. (800) 826 0826. <http://www.uoa.org>.

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# Ileoanal anastomosis

## Definition

Ileoanal anastomosis is a surgical procedure in which the large intestine is bypassed and the lower portion of the small intestine is directly attached to the anal canal. It is also called an ileal pouch-anal anastomosis.

## Purpose

An ileoanal anastomosis is an invasive procedure performed in patients who have not responded to more conservative treatments. The small intestine is composed of three major sections: the duodenum, which is the upper portion into which the stomach empties; the jejunum, which is the middle portion; and the ileum. The ileum is the last portion of the small intestine and empties into the large intestine. The large intestine is composed of the colon, where stool is formed, and the rectum, which empties to the outside of the body through the anal canal.

Surgical removal of the bowel is usually a procedure of last resort for a patient who has not responded to less invasive medical therapies. For example, many patients with ulcerative colitis, an inflammatory condition of the colon and rectum, can be treated by medications or dietary changes that control the symptoms of the disease. For patients who fail to respond to these approaches, however, the creation of an ileoanal anastomosis removes most or all of the diseased tissue. Certain types of colon cancer and a condition called familial adenomatous polyposis, or FAP, in which the inner

lining of the colon becomes covered with abnormal growths, may also be treated with ileoanal anastomosis.

## Demographics

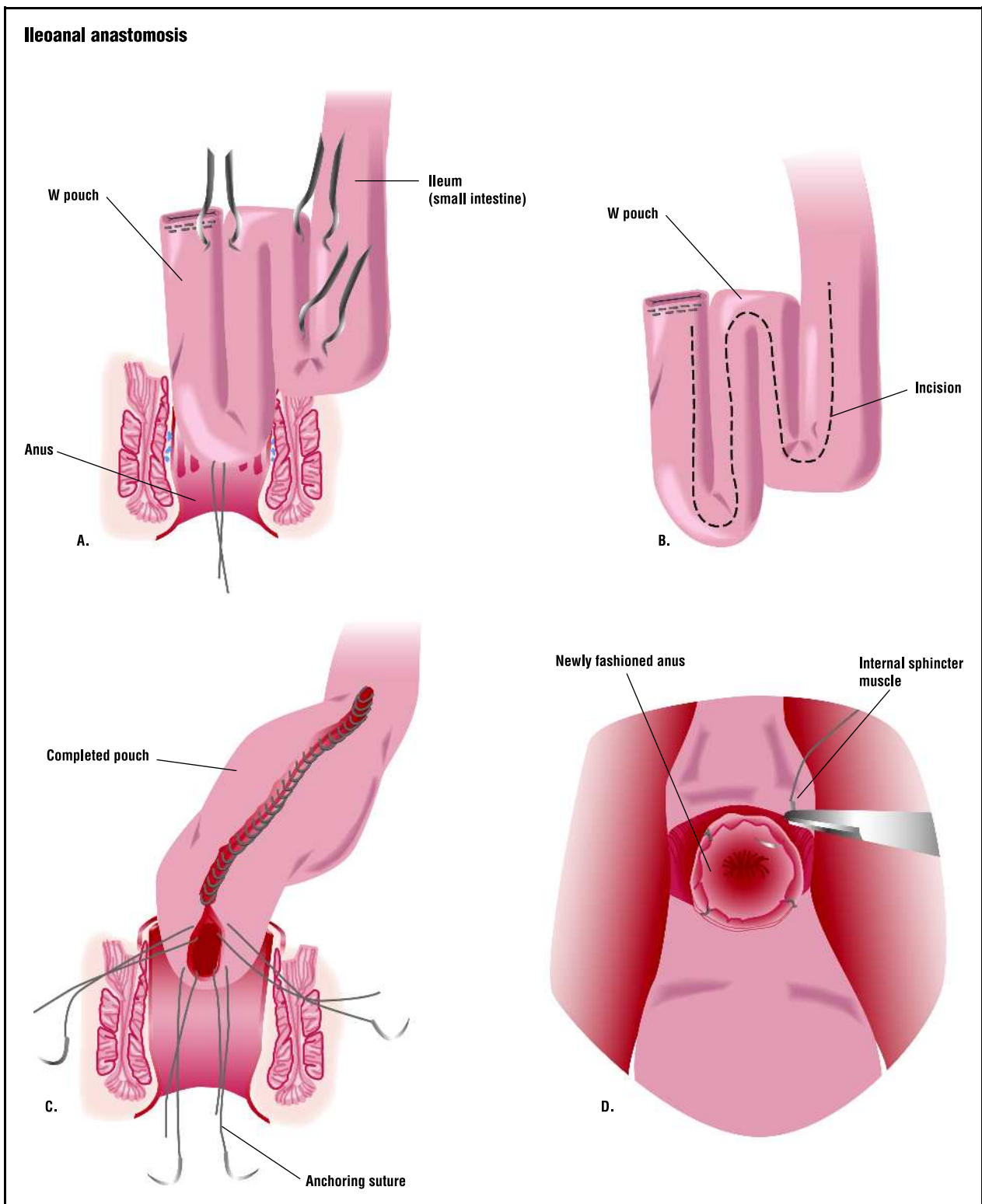
Most patients—more than 85%—who undergo an ileoanal anastomosis are being treated for ulcerative colitis; familial adenomatous polyposis is the next most common condition requiring the surgery. The average age of patients at surgery is 35 years, and the majority of patients are male.

## Description

A surgical anastomosis is the connection of two cut or separate tubular structures to make a continuous channel. To perform an ileoanal anastomosis, the surgeon detaches the ileum from the colon and the anal canal from the rectum. He or she then creates a pouch-like structure from ileal tissue to act as a rectum and connects it directly to the anal canal. This procedure offers distinct advantages over a conventional **ileostomy**, a procedure in which the ileum is connected to the abdominal wall. A conventional ileostomy leaves the patient incontinent (i.e., unable to control the emptying of waste from the body) and unable to have normal bowel movements. Instead, the patient's waste is excreted through an opening in the abdominal wall into a bag. An ileoanal anastomosis, however, removes the diseased large intestine while allowing the patient to pass stool normally without the need of a permanent ileostomy.

An ileoanal anastomosis is usually completed in two separate surgeries. During the first operation, the surgeon makes a vertical incision through the patient's abdominal wall and removes the colon. This procedure is called a colectomy. The inner lining of the rectum is also removed in a procedure called a mucosal proctectomy. The muscles of the rectum and anus are left in place so that the patient will not be incontinent. Next, the surgeon makes a pouch by stapling sections of the small intestine together with surgical **staples**. The pouch may be J-, W-, or S-shaped, and acts as reservoir for waste (as the rectum does) to decrease the frequency of the patient's bowel movements. Once the pouch is constructed, it is connected to the anal canal to form the anastomosis. To allow the anastomosis time to heal before stool begins to pass through, the surgeon creates a temporary “loop” ileostomy. The surgeon then makes a small incision through the abdominal wall and brings a loop of the small intestine through the incision and sutures it to the skin. Waste then exits the body through this opening, which is called a stoma, and collects in a bag attached to the





In an ileoanal anastomosis, a pouch is used to create a large section of bowel whose function replaces that of the large intestine, or colon. In this operation, the ileum (part of the small intestine) is shaped into a W-shaped pouch (A). An incision is made (B) to open up the shape and create the larger pouch, which is left open at one end and brought through the rectal area (C). The bottom of the pouch acts as a new rectum, and a new anus is fashioned (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Anastomosis (plural, anastomoses)**—A surgically created joining or opening between two organs or body spaces that are normally separate.

**Colon**—The portion of the large intestine where stool is formed.

**Continent**—Able to hold the contents of the bladder or bowel until one can use a bathroom. A continent surgical procedure is one that allows the patient to keep waste products inside the body rather than collecting them in an external bag attached to a stoma.

**Enterostomal therapist**—A health care provider who specializes in the care of patients with enterostomies (e.g., ileostomies or colostomies).

**Ostomy**—The surgical creation of an opening from an internal structure to the outside of the body.

**Polyp**—Any mass of tissue that grows out of a mucous membrane in the digestive tract, uterus, or elsewhere in the body.

**Stoma (plural, stomata)**—A surgically created opening in the abdominal wall to allow digestive wastes to pass to the outside of the body.

outside of the abdomen. In an emergency situation, the surgeon may perform the colectomy and ileostomy during one operation, and create the ileal pouch during another.

In the second operation, the surgeon closes the ileostomy, thus restoring the patient's ability to defecate in the normal manner. This second procedure generally takes place two to three months after the original surgery. The surgeon detaches the ileum from the stoma and attaches it to the newly created pouch. A continuous channel then runs from the small intestine through the ileal pouch and anal canal to the outside of the body. In some instances, the surgeon may decide to combine the two surgeries into one operation without creating a temporary ileostomy.

## Diagnosis/Preparation

Because an ileoanal anastomosis is a procedure that is done after a patient has failed to respond to other therapies, the patient's condition has been diagnosed by the time the doctor suggests this surgery.

The patient meets with the operating physician prior to surgery to discuss the details of the surgery and receive instructions on pre- and post-operative

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Ileoanal anastomoses are usually performed in hospital operating rooms. They may be performed by a general surgeon, a colorectal surgeon (a medical doctor who focuses on diseases of the colon, rectum, and anus), or a gastrointestinal surgeon (a medical doctor who focuses on diseases of the gastrointestinal system).

care. Immediately before the operation, an intravenous (IV) line is placed in the patient's arm to administer fluid and medications, and the patient is given a bowel preparation to cleanse the bowel for surgery. The location of the stoma is marked on the skin so that it is placed away from bones, abdominal folds, and scars.

## Aftercare

Following surgery, the staff will instruct the patient in the care of the stoma, placement of the ileostomy bag, and necessary changes regarding diet and lifestyle. Visits with an enterostomal therapist (ET) or a support group for individuals with ostomies may be recommended to help the patient adjust to living with a stoma. After the anastomosis has healed, which usually takes about two to three months, the ileostomy can then be closed. A dietician may suggest permanent changes in the patient's diet to minimize gas and diarrhea.

## Risks

Risks associated with any surgery that involves opening the abdomen include excessive bleeding, infection, and complications due to **general anesthesia**. Specific complications following an ileoanal anastomosis include leakage of stool; anal stenosis (narrowing of the anus); pouchitis (inflammation of the ileal pouch); and pouch failure. Patients who have received a temporary ileostomy may experience obstruction (blockage) of the stoma; stomal prolapse (protrusion of the ileum through the stoma); or a rash or skin irritation around the stoma.

## Normal results

After ileoanal anastomosis, patients will usually experience between four and nine bowel movements during the day and one at night; this frequency generally decreases over time. Because of the nature of the

## QUESTIONS TO ASK THE DOCTOR

- Why are you recommending an ileoanal anastomosis?
- What type of pouch will be created?
- Will an ileostomy be created? When will it be reversed?
- Are there any nonsurgical alternatives to this procedure?
- What kind of ongoing ostomy care will be needed?
- When will I be able to resume my normal diet and activities?

surgery, persons with an ileoanal anastomosis retain the ability to control their bowel movements. They can refrain from defecating for extended periods of time, an advantage not afforded by a conventional ileostomy. One study found that 97% of patients were satisfied with the results of the surgery and would recommend it to others with similar disorders.

### Morbidity and mortality rates

The overall rate of complications associated with ileoanal anastomosis is approximately 10%. Between 10% and 15% of patients will experience at least one episode of pouchitis, and 10–20% will develop postsurgical pelvic or wound infections. The rate of anastomosis failure requiring the creation of a permanent ileostomy is approximately 5–10%.

### Alternatives

An ileostomy is a surgical alternative for patients who are not good candidates for an ileoanal anastomosis. If the patient wishes to retain continence, the surgeon may perform a continent ileostomy. Portions of the small intestine are used to form a pouch and valve; these are then directly attached to the abdominal wall skin to form a stoma. Waste collects inside the internal pouch and is expelled by insertion of a soft, flexible tube through the stoma several times a day.

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United Ostomy Association, Inc. (UOA). 19772 MacArthur Blvd., Suite 200, Irvine, CA 92612 2405. (800) 826 0826. <http://www.uoa.org>.

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## Ileoanal reservoir surgery

### Definition

Ileoanal reservoir surgery or **ileoanal anastomosis** is a two-stage restorative procedure that removes a part of the colon and uses the ileum (a section of the small intestine) to form a new reservoir for waste that can be expelled through the anus. This surgery is one of several continent surgeries that rely upon a newly created pouch to replace the resected colon and retain the patient's sphincter for natural defecation. Ileoanal reservoir surgery is also called a J-pouch, endorectal pullthrough, or pelvic pouch procedure.

### Purpose

A number of diseases require removal of the entire colon or parts of the colon. Proctectomies (removal of the entire colon) are often performed to treat colon cancer. Another surgical option is the creation of an ileoanal pouch to serve as an internal waste reservoir—an alternative to the use of an external ostomy

pouch. An ileoanal reservoir procedure is performed primarily on patients with ulcerative colitis, inflammatory bowel disease (IBD), familial polyposis, or familial adenomatous polyposis (FAP), which is a relatively rare cancer that covers the colon with 100 or more polyps. FAP is caused by a gene mutation on the long arm of human chromosome 5. Ileoanal reservoir surgery is recommended only in those patients who have not previously lost their rectum or anus.

## Demographics

The prevalence of familial adenomatous polyposis (FAP) in the United States is two to three cases per 100,000 persons. It develops before age 40 and accounts for about 0.5% of colorectal cancers; this figure is declining, however, as more at-risk families are undergoing detection and prophylactic colon surgery. The annual incidence of ulcerative colitis is 10.4–12 cases per 100,000 people. The prevalence rate is 35–100 cases per 100,000. People of Jewish descent have two to four times the risk of developing ulcerative colitis than people from other ethnic backgrounds. About 20% of ulcerative colitis patients require surgery of the colon.

## Description

Conventional ileoanal reservoir surgery is an open procedure that is done in two stages. In the first stage, the surgeon removes the diseased colon and creates a pouch. The second stage is performed three months later, when the temporary drainage conduit is closed and the newly created reservoir allows the patient to defecate in the normal fashion. Both surgeries can also be done together, bypassing the creation of a temporary **ileostomy**.

Some surgeons use a laparoscopic approach to ileoanal surgery. This technique involves the insertion of scaled-down **surgical instruments** and a scope that allows the surgeon to see inside the abdomen through several relatively small incisions (about 3.5 inches [9 cm] compared to 6 inches [16 cm] for an open procedure) in the abdominal wall. Studies indicate that there are few differences in the rates of mortality or complications between laparoscopic surgery and conventional open surgery. Because the incisions are smaller, patients typically require less pain medication with laparoscopic surgery.

Ileoanal surgery includes the following steps:

- The surgeon isolates the ileum or small segment of bowel.
- The segment is then attached to the anus with absorbable sutures.
- A pouch is created out of the small bowel above the anus.

## KEY TERMS

**Anastomosis**—A surgically created joining or opening between two organs or body spaces that are normally separate.

**Colon**—The portion of the large intestine where stool is formed.

**Continent**—Able to hold the contents of the bladder or bowel until one can use a bathroom. A continent surgical procedure is one that allows the patient to keep waste products inside the body rather than collecting them in an external bag attached to a stoma.

**Ileoanal anastomosis**—A reservoir for fecal waste surgically created out of the small intestine. It retains the sphincter function of the anus and allows the patient to defecate in the normal fashion.

**Ileum**—The third and lowest portion of the small intestine, extending from the jejunum to the beginning of the large intestine.

**Polyp**—Any mass of tissue that grows out of a mucous membrane in the digestive tract, uterus, or elsewhere in the body.

**Sphincter**—A circular band of muscle fibers that constricts or closes a passageway in the body.

**Stent**—A thin rodlike or tubelike device made of wire mesh, inserted into a blood vessel or a section of the digestive tract to keep the structure open.

**Stoma (plural, stomata)**—A surgically created opening in the abdominal wall to allow digestive wastes to pass to the outside of the body.

- If the surgeon is performing the procedure in two stages, he or she creates a temporary ileostomy. An ileostomy is a tubular bowel segment attached to a stoma at the abdomen that drains into a bag outside the abdomen.
- In the second-stage operation, the surgeon uses an open abdominal procedure to close the temporary pouch.

The surgeon will insert stents to bypass the surgical site and divert urinary and digestive wastes to the outside of the body, thus allowing the new connection between the ileum and the anus to heal properly.

## Diagnosis/Preparation

The diagnosis of FAP is usually made after symptoms caused by polyps in the colon, such as rectal



bleeding, diarrhea, and abdominal pain, have led to a **physical examination**, the taking of a family history, and in some cases a genetic test. Ulcerative colitis or inflammatory bowel disease patients have usually been treated with medical alternatives before they decide to have surgery. All patients who are candidates for an ileoanal procedure will have an evaluation of the upper gastrointestinal tract, an x ray of the small bowel, and a **colonoscopy** with a pathology review. Most patients will also be given a **sigmoidoscopy** and a digital rectal examination.

The surgeon will need to perform an ileostomy in about 5–10% of cases because the patient's rectal muscles are not strong enough for an anastomosis. This possibility is discussed with the patient, as well as the fact that complications in surgery may lead to an ostomy procedure. The placement of a stoma must be decided in the event that an ileostomy is necessary. The physician evaluates the patient's abdomen while the patient is sitting and then standing, in order to avoid placing the stoma inside a fatty fold of the abdomen. A stomal therapist is often called in to prepare the patient for the possibility that an appliance will be needed. In addition to the medical and surgical considerations of the procedure, the patient requires psychological preparation regarding the changes in function and appearance that accompany this surgery.

Prior to surgery, the patient must undergo a bowel preparation, which includes a clear-liquid diet for two days before the procedure. In addition to drinking nothing but clear fluids, the patient must have a cleansing enema until the bowel runs clear. The importance of a thorough bowel preparation must be explained to the patient, because leakage from the bowel during surgery can be life-threatening.

### Aftercare

Open ileoanal reservoir surgery is a lengthy procedure (as long as five hours) with a slow recovery rate (approximately six weeks) and a relatively long stay in the hospital (about 10 days). The catheters and stents that were used are removed several days after surgery. The patient will be introduced to a special diet in the hospital, and the diet will be altered if needed in response to changes in the chemistry of the colon. The patient's stools are measured, and he or she is monitored for dehydration. In addition, the patient will have the opportunity to discuss his or her concerns about care of the new reservoir and frequency of defecation with staff members before leaving the hospital.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

An ileoanal reservoir procedure is performed by a gastrointestinal surgeon specializing in reconstructive bowel or colon surgery. The operation takes place in a general hospital as an inpatient procedure.

### Results

For carefully selected patients this procedure, developed over 30 years, is the preferred form of radical colon surgery when the patient's sphincter and rectum are still intact. The advantage of the ileoanal reservoir surgery is that the patient has an internal pouch for the collection of waste material and can pass this waste normally through the anus. Bowel movements may be more fluid, however, and more frequent with the new reservoir. In a small percentage of cases, the surgeon may eventually need to perform an ileostomy due to complications. In one quality of life study for patients who have undergone ileoanal reservoir surgery, researchers found only slight differences in their general health and level of daily activity compared with subjects recruited from the general population.

### Morbidity/mortality

Morbidity rates with this procedure have decreased over time due to improvements in technique. The most common complication is inflammation of the pouch, which occurs in as many as 40% of patients. This complication can be treated with medication. Other complications include severe scarring around the incision, and some risk of injury to the nerves that control erection and bladder function. In one major study of 379 patients, researchers at the University of Cincinnati reported that 79 patients had pouch infections (24.3%) and another 20 patients required further surgery for obstructions of the small bowel (6.2%).

### Alternatives

The major surgical alternative to an ileoanal reservoir procedure is an ileostomy. In an ileostomy, the patient's fecal matter drains into a plastic bag attached to a stoma on the outside of the patient's abdomen or into a pouch attached to the abdominal wall to be withdrawn through a plastic tube.

## QUESTIONS TO ASK THE DOCTOR

- How often has this procedure been performed in this hospital?
- Am I a candidate for a laparoscopic operation?
- How many surgeries of this kind have you performed?
- How likely is it that I might have to have an ileostomy once I am in surgery?

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- American Society of Colon and Rectal Surgeons. 85 W. Algonquin Rd., Suite 550, Arlington Heights, IL 60005. [www.fascrs.org](http://www.fascrs.org).
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- United Ostomy Association, Inc. (UOA). 19772 MacArthur Blvd., Suite 200, Irvine, CA 92612-2405. (800) 826-0826. [www.uoa.org](http://www.uoa.org).

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Ileorectal anastomosis see **Ileoanal anastomosis**

## Ileostomy

### Definition

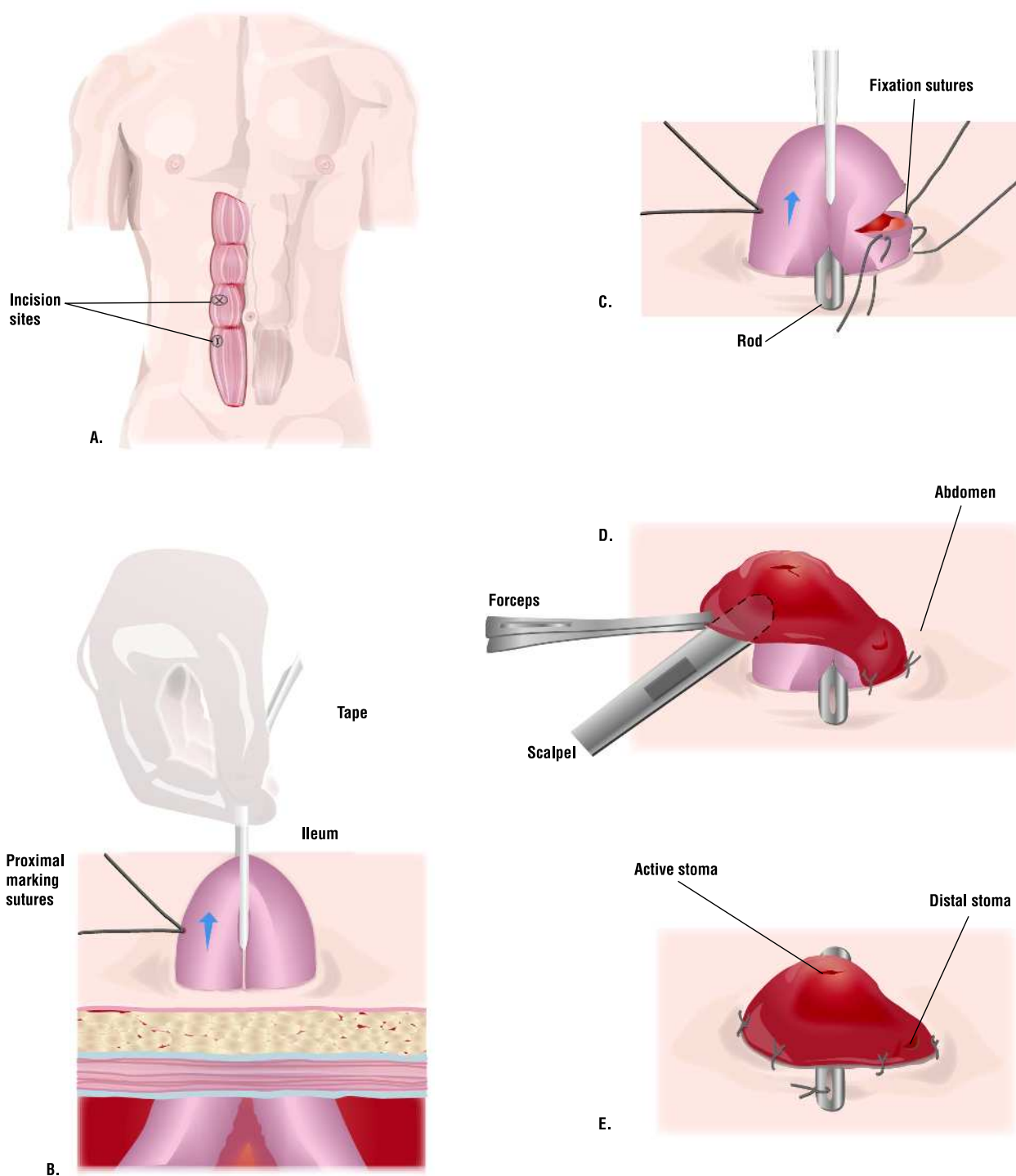
An ileostomy is a surgical procedure in which the small intestine is attached to the abdominal wall in order to bypass the large intestine; digestive waste then exits the body through an artificial opening called a stoma (from the Greek word for "mouth").

### Purpose

In general, an ostomy is the surgical creation of an opening from an internal structure to the outside of the body. An ileostomy, therefore, creates a temporary or permanent opening between the ileum (the portion of the small intestine that empties to the large intestine) and the abdominal wall. The colon and/or rectum may be removed or bypassed. A temporary ileostomy may be recommended for patients undergoing bowel surgery (e.g., removal of a segment of bowel), to provide the intestines with sufficient time to heal without the stress of normal digestion.

Chronic ulcerative colitis is an example of a medical condition that is treated with the removal of the large intestine. Ulcerative colitis occurs when the body's immune system attacks the cells in the lining of the large intestine, resulting in inflammation and

## Ileostomy



An ileostomy can be placed in different sites on the abdomen (A). Once the incision is made, the ileum is pulled through the incision (B), and a rod is placed under the loop. The loop is cut open, one side is stitched to the abdomen (C). The portion of intestine is flipped open to expose the interior surface (D), and the opposite side is stitched in place (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Anastomosis**—A surgically created joining or opening between two organs or body spaces that are normally separate.

**Colon**—The portion of the large intestine where stool is formed.

**Enterostomal therapist**—A health care provider who specializes in the care of individuals with enterostomies (e.g. ileostomies or colostomies).

**Rectum**—The portion of the large intestine where stool is stored until exiting the body through the anal canal.

**Stoma (plural, stomata)**—A surgically created opening in the abdominal wall to allow digestive wastes to pass to the outside of the body.

tissue damage. Patients with ulcerative colitis often experience pain, frequent bowel movements, bloody stools, and loss of appetite. An ileostomy is a treatment option for patients who do not respond to medical or dietary therapies for ulcerative colitis.

Other conditions that may be treated with an ileostomy include:

- bowel obstructions
- cancer of the colon and/or rectum
- Crohn's disease (chronic inflammation of the intestines)
- congenital bowel defects
- uncontrolled bleeding from the large intestine
- injury to the intestinal tract

## Demographics

The United Ostomy Association estimates that approximately 75,000 ostomy surgeries are performed each year in the United States, and that 750,000 Americans have an ostomy. Ulcerative colitis and Crohn's disease affect approximately one million Americans. There is a greater incidence of the diseases among Caucasians under the age of 30 or between the ages of 50 and 70.

## Description

For some patients, an ileostomy is preceded by removal of the colon (colonectomy) or the colon and rectum (proctocolectomy). After the patient is placed under **general anesthesia**, an incision approximately 8 in (20 cm) long is made down the patient's midline,

through the abdominal skin, muscle, and other subcutaneous tissues. Once the abdominal cavity has been opened, the colon and rectum are isolated and removed. The anal canal is stitched closed. Other patients undergoing ileostomy will have only a temporary bypass of the colon and rectum; examples are patients undergoing **small bowel resection** or the creation of an **ileoanal anastomosis**. An ileoanal anastomosis is a procedure in which the surgeon forms a pouch out of tissue from the ileum and connects it directly to the anal canal.

There are two basic types of permanent ileostomy: conventional and continent. A conventional ileostomy, also called a Brooke ileostomy, involves a separate, smaller incision through the abdominal wall skin (usually on the lower right side) to which the cut end of the ileum is sutured. The ileum may protrude from the skin, often as far as 2 in (5 cm). Patients with this type of stoma are considered fecal-incontinent, meaning they can no longer control the emptying of wastes from the body. After a conventional ileostomy, the patient is fitted with a plastic bag worn over the stoma and attached to the abdominal skin with adhesive. The ileostomy bag collects waste as it exits from the body.

An alternative to conventional ileostomy is the continent ileostomy. Also called a Kock ileostomy, this procedure allows a patient to control when waste exits the stoma. Portions of the small intestine are used to form a pouch and valve; these are directly attached to the abdominal wall skin to form a stoma. Waste collects internally in the pouch and is expelled by insertion of a soft, flexible tube through the stoma several times a day.

## Diagnosis/Preparation

The patient meets with the operating physician prior to surgery to discuss the details of the surgery and receive instructions on pre- and **postoperative care**. Directly preceding surgery, an intravenous (IV) line is placed to administer fluid and medications, and the patient is given a bowel prep to cleanse the bowel and prepare it for surgery. The location where the stoma will be placed is marked, away from bones, abdominal folds, and scars.

## Aftercare

Following surgery, the patient is instructed in the care of the stoma, placement of the ileostomy bag, and necessary changes to diet and lifestyle. Because the large intestine (a site of fluid absorption) is no longer a part of the patient's digestive system, fecal matter



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Ileostomies are usually performed in a hospital operating room. The surgery may be performed by a general surgeon, a colorectal surgeon (a medical doctor who focuses on diseases of the colon, rectum, and anus), or gastrointestinal surgeon (a medical doctor who focuses on diseases of the gastrointestinal system).

exiting the stoma has a high water content. The patient must therefore be diligent about his or her fluid intake to minimize the risk of dehydration. Visits with an enterostomal therapist (ET) or a support group for individuals with ostomies may be recommended to help the patient adjust to living with a stoma. Once the ileostomy has healed, a normal diet can usually be resumed, and the patient can return to normal activities.

### Risks

Risks associated with the ileostomy procedure include excessive bleeding, infection, and complications due to general anesthesia. After surgery, some patients experience stomal obstruction (blockage); inflammation of the ileum; stomal prolapse (protrusion of the ileum through the stoma); or irritation of the skin around the stoma.

### Normal results

The physical quality of life of most patients is not affected by an ileostomy, and with proper care most patients can avoid major medical complications. Patients with a permanent ileostomy, however, may suffer emotional aftereffects and benefit from psychotherapy.

### Morbidity and mortality rates

Among patients who have undergone a Brooke ileostomy, medical literature reports a 19–70% risk of complications. Small bowel obstruction occurs in 15% of patients; 30% have problems with the stoma; 20–25% require further surgery to repair the stoma; and 30% experience postsurgical infections. The rate of complications is also high among patients who have had a continent ileostomy (15–60%). The most common complications associated with this procedure are small bowel obstruction (7%); wound complications

## QUESTIONS TO ASK THE DOCTOR

- Why is an ileostomy being recommended?
- What type of ileostomy would work best for me?
- What are the risks and complications associated with the recommended procedure?
- Are any nonsurgical treatment alternatives available?
- How soon after surgery may I resume my normal diet and activities?

(35%); and failure to restore continence (50%). The mortality rate of both procedures is less than 1%.

### Alternatives

Patients with mild to moderate ulcerative colitis may be able to manage their disease with medications. Medications that are given to treat ulcerative colitis include enemas containing hydrocortisone or mesalamine; oral sulfasalazine or olsalazine; oral **corticosteroids**; or cyclosporine and other drugs that affect the immune system.

A surgical alternative to ileostomy is the ileal pouch-anal anastomosis, or ileoanal anastomosis. This procedure, used more frequently than permanent ileostomy in the treatment of ulcerative colitis, is similar to a continent ileostomy in that an ileal pouch is formed. The pouch, however, is not attached to a stoma but to the anal canal. This procedure allows the patient to retain fecal continence. An ileoanal anastomosis usually requires the placement of a temporary ileostomy for 2–3 months to give the connected tissues time to heal.

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## Immunology tests

### Definition

Immunoassays are chemical tests used to detect or quantify a specific substance, the analyte, in a blood or body fluid sample, using an immunological reaction. Immunoassays are highly sensitive and specific. Their high specificity results from the use of antibodies and purified antigens as reagents. An antibody is a protein (immunoglobulin) produced by B-lymphocytes (immune cells) in response to stimulation by an antigen. Immunoassays measure the formation of antibody-antigen complexes and detect them via an indicator reaction. High sensitivity is achieved by using an indicator system (e.g., enzyme label) that results in amplification of the measured product.

Immunoassays may be qualitative (positive or negative) or quantitative (amount measured). An example of a qualitative assay is an immunoassay test for pregnancy. Pregnancy tests detect the presence of human chorionic gonadotropin (hCG) in urine or serum. Highly purified antibodies can detect pregnancy within two days of fertilization. Quantitative immunoassays are performed by measuring the signal produced by the indicator reaction. This same test for pregnancy can be made into a quantitative assay of hCG by measuring the concentration of product formed.

### Purpose

The purpose of an immunoassay is to measure (or, in a qualitative assay, to detect) an analyte. Immunoassay is the method of choice for measuring analytes normally present at very low concentrations that cannot be determined accurately by other less expensive tests. Common uses include measurement of drugs, hormones, specific proteins, tumor markers, and markers of cardiac injury. Qualitative immunoassays are often used to detect antigens on infectious agents and antibodies that the body produces to fight them. For example, immunoassays are used to detect antigens on *Hemophilus*, *Cryptococcus*, and *Streptococcus* organisms in the cerebrospinal fluid (CSF) of meningitis patients. They are also used to detect antigens associated with organisms that are difficult to

culture, such as hepatitis B virus and *Chlamydia trachomatis*. Immunoassays for antibodies produced in viral hepatitis, HIV, and Lyme disease are commonly used to identify patients with these diseases.

### Description

There are several different methods used in immunoassay tests.

- **Immunoprecipitation.** The simplest immunoassay method measures the quantity of precipitate, which forms after the reagent antibody (precipitin) has incubated with the sample and reacted with its respective antigen to form an insoluble aggregate. Immunoprecipitation reactions may be qualitative or quantitative.
- **Particle immunoassays.** By linking several antibodies to the particle, the particle is able to bind many antigen molecules simultaneously. This greatly accelerates the speed of the visible reaction. This allows rapid and sensitive detection of antibodies that are markers of such diseases, as infectious mononucleosis and rheumatoid arthritis.
- **Immunonephelometry.** The immediate union of antibody and antigen forms immune complexes that are too small to precipitate. However, these complexes will scatter incident light and can be measured using an instrument called a nephelometer. The antigen concentration can be determined within minutes of the reaction.
- **Radioimmunoassay (RIA)** is a method employing radioactive isotopes to label either the antigen or antibody. This isotope emits gamma rays, which are usually measured following removal of unbound (free) radiolabel. The major advantages of RIA, compared with other immunoassays, are higher sensitivity, easy signal detection, and well-established, rapid assays. The major disadvantages are the health and safety risks posed by the use of radiation and the time and expense associated with maintaining a licensed radiation safety and disposal program. For this reason, RIA has been largely replaced in routine clinical laboratory practice by enzyme immunoassay.
- **Enzyme (EIA) immunoassay** was developed as an alternative to radioimmunoassay (RIA). These methods use an enzyme to label either the antibody or antigen. The sensitivity of EIA approaches that for RIA, without the danger posed by radioactive isotopes. One of the most widely used EIA methods for detection of infectious diseases is the enzyme-linked immunosorbent assay (ELISA).
- **Fluorescent immunoassay (FIA)** refers to immunoassays which utilize a fluorescent label or an enzyme label which acts on the substrate to form a fluorescent

## KEY TERMS

**Antibody**—A protein produced by B-lymphocytes in response to stimulation by an antigen.

**Antigen**—Any substance which induces an immune response.

**Human chorionic gonadotropin (hCG)**—A hormone that is measured to detect early pregnancy.

**Immunoassay**—A method that measures antibody-antigen complexes formed by reacting purified antibody or antigen with the sample.

**Nephelometry**—A method for measuring the light scattering properties of a sample.

**Radioimmunoassay**—A method that uses a radioisotope label in an immunoassay.

product. Fluorescent measurements are inherently more sensitive than colorimetric (spectrophotometric) measurements. Therefore, FIA methods have greater analytical sensitivity than EIA methods, which employ absorbance (optical density) measurement.

- Chemiluminescent immunoassays utilize a chemiluminescent label. Chemiluminescent molecules produce light when they are excited by chemical energy. These emissions are measured by a light detector.

## Precautions

Blood samples are collected by vein puncture with a needle. It is not necessary to restrict fluids or food prior to collection. Blood should be collected in tubes containing no additive. Risks of vein puncture include bruising of the skin or bleeding into the skin. Random urine samples are acceptable for drug assays; however, 24-hour urine samples are preferred for hormones and other substances which show diurnal or pulse variation.

Special safety precautions must be observed when performing RIA methods. Radioactive isotopes are used by RIA tests to label antigens or antibodies. Pregnant females should not work in an area where RIA tests are being performed. Personnel handling isotope reagents must wear badges which monitor their exposure to radiation. Special sinks and waste disposal containers are required for disposal of radioactive waste. The amount of radioisotope discarded must be documented for both liquid and solid waste. Leakage or spills of radioactive reagents must be measured for radioactivity; the amount of radiation and containment and disposal processes must be documented.

## Normal results

Immunoassays which are qualitative are reported as positive or negative. Quantitative immunoassays are reported in mass units, along with reference intervals (normal ranges) for the test. Normal ranges may be age- and gender-dependent. Positive immunoassay test results for HIV and drugs of abuse generally require confirmatory testing.

Although immunoassays are both highly sensitive and specific, false positive and negative results may occur. False-negative results may be caused by improper sample storage or treatment, reagent deterioration, or improper washing technique. False-positive results are sometimes seen in persons who have certain antibodies, especially to mouse immunoglobulins (immune cells) that may be used in the test. False-positive results have been reported for samples containing small fibrin strands that adhere to the solid phase matrix. False-positives may also be caused by substances in the blood or urine that cross-react or bind to the antibody used in the test.

## Preparation

Generally, no special instructions need be given to patients for immunoassay testing. Some assays require a timed specimen collection, while others may have special dietary restrictions.

## Aftercare

When blood testing is used for the immunoassay, the vein puncture site will require a bandage or light dressing to accomplish blood clotting.

## Risks

Immunoassay is an *in vitro* procedure, and is therefore not associated with complications. When blood is collected, slight bleeding into the skin and subsequent bruising may occur. The patient may become lightheaded or queasy from the sight of blood.

## Resources

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## Immunologic therapies

### Definition

Immunologic therapy is an approach to the treatment of disease that uses medicines for stimulating the body's natural immune response.

### Purpose

Immunologic therapy is used to improve the immune system's natural ability to fight such diseases as cancer, hepatitis, and AIDS. These drugs may also be used to help the body recover from immunosuppression resulting from such treatments as chemotherapy or radiation therapy.

### Description

Most drugs in this category are synthetic versions of substances produced naturally in the body. In their natural forms, these substances help defend the body against disease. For example, aldesleukin (Proleukin) is an artificial form of interleukin-2, which helps white blood cells work. Aldesleukin is administered to patients with kidney cancers and skin cancers that have spread to other parts of the body. Filgrastim (Neupogen) and sargramostim (Leukine) are versions of natural substances called colony stimulating factors, which encourage the bone marrow to make new white blood cells. Another type of drug, epoetin (Epogen, Procrit), is a synthetic version of human erythropoietin, which stimulates the bone marrow to make new red blood cells. Thrombopoietin stimulates the production of platelets, which are disk-shaped bodies in the blood that are important in clotting. Interferons are substances that the body produces naturally, using cells in the immune system to fight infections and tumors. Synthetic interferons carry such brand names as Alferon, Roferon or Intron A. Some of the interferons that are currently in use as medications are recombinant interferon alfa-2a, recombinant interferon alfa-2b, interferon alfa-n1, and interferon alfa-n3. Alfa interferons are used to treat hairy cell leukemia, malignant melanoma, and Kaposi's

## KEY TERMS

**Bone marrow**—Soft tissue that fills the hollow centers of bones. Blood cells and platelets (disk-shaped bodies in the blood that are important in clotting) are produced in the bone marrow.

**Chemotherapy**—Treatment of an illness with chemical agents. The term is usually used to describe the treatment of cancer with drugs.

**Hepatitis**—Inflammation of the liver caused by a virus, chemical, or drug.

**Immune response**—The body's natural protective reaction against disease and infection.

**Immune system**—The system that protects the body against disease and infection through immune responses.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

**Seizure**—A sudden attack, spasm, or convulsion.

**Shingles**—A disease caused the Herpes zoster virus the same virus that causes chickenpox. Symptoms of shingles include pain and blisters along one nerve, usually on the face, chest, stomach, or back.

**Sickle cell anemia**—An inherited disorder in which red blood cells contain an abnormal form of hemoglobin, a protein that carries oxygen.

sarcoma, which is a type of cancer associated with HIV infection. In addition, interferons are also used to treat such other conditions as laryngeal papillomatosis, genital warts, and certain types of hepatitis.

### Recommended dosage

The recommended dosage depends on the type of immunologic therapy. For some medicines, the physician will decide the dosage for each patient, taking into account a patient's weight and whether he or she is taking other medicines. Some drugs used in immunologic therapy are given only in a hospital under a physician's supervision. Patients who are taking drugs that can be used at home should consult the physician who prescribed the medicine or the pharmacist who filled the prescription for the correct dosage.

Most of these drugs come in an injectable form, which is generally administered by a cancer care provider.



## Precautions

### *Aldesleukin*

This drug may temporarily increase the patient's risk of getting infections. It may also lower the number of platelets in the blood, and thus interfere with the blood's ability to clot. Taking the following precautions may reduce the chance of such complications:

- Avoiding people with infectious diseases whenever possible.
- Being alert to such signs of infection as fever, chills, sore throat, pain in the lower back or side, cough, hoarseness, or painful or difficult urination. If any of these symptoms occur, the patient should call the physician immediately.
- Being alert to such signs of bleeding problems as black or tarry stools; tiny red spots on the skin; blood in the urine or stools; or any other unusual bleeding or bruising.
- Taking care to avoid cuts or other injuries, particularly when using knives, razors, nail clippers, and other sharp objects. The patient should consult his or her dentist for the best ways to clean the teeth and mouth without injuring the gums. In addition, patients should not have any dental work done without checking with their primary physician.
- Washing hands frequently, and avoiding touching the eyes or inside of the nose unless the hands have just been washed.

Aldesleukin may make some disorders worse, including chickenpox, shingles (herpes zoster), liver disease, lung disease, heart disease, underactive thyroid, psoriasis, immune system problems and mental problems. The medicine may also increase the risk of seizures (convulsions) in people with epilepsy or other seizure disorders. In addition, the drug's effects may be intensified in people with kidney disease, because their kidneys are slow to clear the medicine from their bodies.

### *Colony stimulating factors*

Certain drugs used in treating cancer reduce the body's ability to fight infections. Although colony stimulating factors help restore the body's natural defenses, the process takes time. Getting prompt treatment for infections is important, even while the patient is taking these medications. Patients taking colony stimulating factors should call their physician at the first sign of illness or infection, including a sore throat, fever, or chills.

People with certain medical conditions may have problems if they take colony stimulating factors. Patients with kidney disease, liver disease, or conditions related to

inflammation or immune system disorders may find that colony stimulating factors make their disorder worse. People with heart disease may be more likely to experience such side effects as water retention and irregular heart rhythm while taking these drugs. Patients with lung disease may increase their risk of shortness of breath. People with any of these medical conditions should consult their personal physician before using colony stimulating factors.

### *Epoetin*

Epoetin is a medicine that may cause seizures (convulsions), especially in people with epilepsy or other seizure disorders. No one who takes epoetin should drive, operate heavy machinery, or do anything that would be dangerous to themselves or others in the event of a seizure.

Epoetin helps the body make new red blood cells, but it is not effective unless there are adequate stores of iron in the body. The patient's physician may recommend taking iron supplements or certain vitamins that help to maintain the body's iron supply. It is necessary to follow the physician's advice in this instance, as with any dietary supplements that should come only from a physician.

Studies of laboratory animals indicate that epoetin taken during pregnancy causes birth defects in these species, including damage to the bones and spine. The drug, however, has not been reported to cause problems in human babies whose mothers took it during pregnancy. Nevertheless, women who are or may become pregnant should check with their physicians for the most up-to-date information on the safety of taking this medicine during pregnancy.

People with certain medical conditions may have problems if they take epoetin. For example, there appears to be a greater risk of side effects in people with high blood pressure, disorders of the heart or blood vessels, or a history of blood clots. In addition, epoetin may not work properly in people who have bone disorders or sickle cell anemia.

### *Interferons*

Interferons may intensify the effects of alcohol and other drugs that slow down the central nervous system, including antihistamines, over-the-counter cold medicines, allergy medications, sleep aids, anticonvulsants, tranquilizers, some pain relievers, and **muscle relaxants**. Interferons may also intensify the effects of anesthetics, including the local anesthetics used for dental procedures. Patients taking interferons should consult

their physicians before taking any of the medications listed above.

Some people experience dizziness, unusual fatigue, or drowsiness while taking these drugs. Because of these possible problems, anyone who takes these drugs should not drive, use heavy machinery, or do anything else that requires full alertness until they have determined how the drugs affect them.

Interferons often cause flu-like symptoms, including fever and chills. The physician who prescribes this medicine may recommend taking **acetaminophen** (Tylenol) before—and sometimes after—each dose to keep the fever from getting too high. If the physician recommends taking acetaminophen, the patient should follow his or her instructions carefully.

Like aldesleukin, interferons may temporarily increase the risk of getting infections and lower the number of platelets in the blood, which may lead to clotting problems. Patients should observe the precautions listed above for reducing the risk of infection and bleeding for aldesleukin.

People who have certain medical conditions may have problems if they take interferons. For example, the drugs may worsen some medical conditions, including heart disease, kidney disease, liver disease, lung disease, diabetes, bleeding problems, and certain psychiatric disorders. In people who have overactive immune systems, these drugs can even increase the activity of the immune system. People who have shingles or chickenpox, or who have recently been exposed to chickenpox, may increase their risk of developing severe problems in other parts of the body if they take interferons. People with a history of seizures or associated mental disorders may be at risk if they take interferon.

Elderly people appear to be at increased risk of side effects from taking interferons.

Interferons may cause changes in the menstrual cycles of teenagers. Young women should discuss this possibility with their physicians. These drugs are not known to cause fetal **death**, birth defects, or other problems in humans when taken during pregnancy. Women who are pregnant or who may become pregnant should ask their physicians for the latest information on the safety of taking these drugs during pregnancy.

Women who are breastfeeding their babies may need to stop while taking this medicine. It is not yet known whether interferons pass into breast milk; however, because of the chance of serious side effects that might affect the baby, women should not breastfeed

while taking interferon. Patients should consult their physician for more specific advice.

### *General precautions for all types of immunologic therapy*

Regular appointments with the doctor are necessary during immunologic therapy treatment. These checkups give the physician a chance to make sure the medicine is working and to monitor the patient for unwanted side effects.

Anyone who has had unusual reactions to the drugs used in immunologic therapy should inform the doctor before resuming the drugs. Any allergies to foods, dyes, preservatives, or other substances should also be reported.

## Side effects

### *Aldesleukin*

Aldesleukin may cause serious side effects. It is ordinarily given only in a hospital, where medical professionals can watch for early signs of problems. Medical tests may be performed to check for unwanted side effects. In general, anyone who has breathing problems, fever or chills while being given aldesleukin should consult their doctor at once.

Other side effects should be brought to a physician's attention as soon as possible:

- dizziness
- drowsiness
- confusion
- agitation
- depression
- nausea and vomiting
- diarrhea
- sores in the mouth and on the lips
- tingling of hands or feet
- decrease in urination
- unexplained weight gain of 5 lb (2 kg) or more

Some side effects of aldesleukin are usually temporary and do not need medical attention unless they are bothersome. These include dry skin; itchy or burning rash or redness followed by peeling; loss of appetite; and a general feeling of illness or discomfort.

### *Colony stimulating factors*

Patients sometimes experience mild pain in the lower back or hips in the first few days of treatment with colony stimulating factors. This side effect is not a cause for concern, and usually goes away within a

few days. If the pain is intense or causes discomfort, the physician may prescribe a painkiller.

Other possible side effects include headache, joint or muscle pain, and skin rash or itching. These side effects tend to disappear as the body adjusts to the medicine, and do not need medical treatment. If they continue, or if they interfere with normal activities, the patient should consult their physician.

### ***Epoetin***

Epoetin may cause such flu-like symptoms as muscle aches, bone pain, fever, chills, shivering, and sweating within a few hours after it is taken. These symptoms usually go away within 12 hours. If they persist or are severe, the patient should call their doctor. Other possible side effects of epoetin that do not need medical attention are diarrhea, nausea or vomiting, and fatigue or weakness.

Other side effects, however, should be brought to a physician's attention as soon as possible. These include headache; vision problems; a rise in blood pressure; fast heartbeat; weight gain; or swelling of the face, fingers, lower legs, ankles, or feet. Anyone who has chest pain or seizures after taking epoetin should seek professional emergency medical attention immediately.

### ***Interferons***

Interferons may cause temporary hair loss (alopecia). Although this side effect may be upsetting because it affects the patient's appearance, it is not a sign that something is seriously wrong. The hair should grow back normally after treatment ends.

As the body adjusts to these medications, the patient may experience other side effects that usually go away during treatment. These include flu-like symptoms; alterations in the sense of taste; loss of appetite (anorexia); nausea and vomiting; skin rashes; and unusual fatigue. The patient should consult a doctor if these problems persist or if they interfere with normal life.

Other side effects are more serious and should be brought to a physician's attention as soon as possible:

- confusion
- difficulty thinking or concentrating
- nervousness
- depression
- sleep problems
- numbness or tingling in the fingers, toes, and face

### ***General precautions regarding side effects for all types of immunologic therapy***

Other side effects are possible with any type of immunologic therapy. Anyone who has unusual symptoms during or after treatment with these drugs should contact the physician immediately.

### **Interactions**

Anyone who has immunologic therapy should give their physician a list of all other medications that they take, including over-the-counter and herbal preparations. Some combinations of drugs may increase or decrease the effects of one or both drugs, or increase the likelihood of side effects.

### **Alternatives**

#### ***Immunoprevention***

Immunoprevention is a form of treatment that has been proposed as a form of cancer therapy. There are two types of immunoprevention, active and passive. Treatment that involves such immune molecules as cytokines, which are prepared synthetically, or other immune molecules that are not produced by patients themselves are called passive immunotherapy. By contrast, vaccines are a form of active immune therapy because they elicit an immune response from the patient's body. Cancer vaccines may be made of whole tumor cells or from substances or fragments from the tumor known as antigens.

#### ***Adoptive immunotherapy***

Adoptive immunotherapy involves stimulating T lymphocytes by exposing them to tumor antigens. These modified cells are grown in the laboratory and then injected into patients. Since the cells taken from a different person for this purpose are often rejected, patients serve both as donor and recipient of their own T cells. Adoptive immunotherapy is particularly effective in patients who have received massive doses of radiation and chemotherapy. In such patients, therapy results in immunosuppression (weakened immune systems), making them vulnerable to viral infections. For example, CMV-specific T cells can reduce the risk of cytomegalovirus (CMV) infection in organ transplant patients.

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## Immunosuppressant drugs

### Definition

Immunosuppressant drugs, also called anti-rejection drugs, are used to inhibit or prevent the activity of the body's immune system. They have three major uses as of the early 2000s: to prevent the body from rejecting a transplanted organ; to treat such autoimmune diseases as rheumatoid arthritis (RA), Crohn's disease, ulcerative colitis, and systemic lupus erythematosus (SLE); and to treat a few inflammatory diseases that are not autoimmune disorders, such as long-term allergic asthma.

### Purpose

When an organ, such as a liver, heart, or kidney, is transplanted from one person (the donor) into another (the recipient), the immune system of the recipient triggers the same response against the new organ that it would have against any foreign material, setting off a chain of events that can damage the transplanted organ. This process is called rejection. It can occur rapidly (acute rejection), or over a long period of time (chronic rejection). Rejection can occur despite close matching of the donated organ and the transplant patient. Immunosuppressant drugs greatly decrease the risks of rejection, protecting the new organ and preserving its function. These drugs act by blocking the recipient's immune system so that it is less likely to react against the transplanted organ. A wide variety of drugs are available to achieve this aim but work in different ways to reduce the risk of rejection.

In addition to being used to prevent organ rejection, immunosuppressant drugs are also used to treat such severe skin disorders as psoriasis and such other diseases as rheumatoid arthritis, Crohn's disease (chronic inflammation of the digestive tract), and patchy hair loss (alopecia areata). These conditions are termed autoimmune diseases, indicating that the immune system is reacting against the body itself.

### Description

Immunosuppressant drugs can be classified according to their specific molecular mode of action. There are four main categories of immunosuppressant drugs currently used in treating patients with transplanted organs:

- Cyclosporins (Neoral, Sandimmune, SangCya). These drugs act by inhibiting T-cell activation, thus preventing T-cells from attacking the transplanted organ.
- Azathioprine (Imuran). These drugs disrupt the synthesis of DNA and RNA as well as the process of cell division. They are sometimes called cytostatic drugs because they inhibit cell division.
- Monoclonal antibodies, including basiliximab (Simulect), daclizumab (Zenpax), and muromonab (Orthoclone OKT3). These drugs act by inhibiting the binding of interleukin-2, which in turn slows down the production of T-cells in the patient's immune system.
- Such corticosteroids as prednisolone (Deltasone, Orasone). These drugs suppress the inflammation associated with transplant rejection.

Most patients are prescribed a combination of drugs—sometimes called a multiple-drug cocktail—after their transplant, one from each of the above main groups; for example, they may be given a combination of



## KEY TERMS

**Antibody**—A protein produced by the immune system in response to the presence in the body of an antigen.

**Antigen**—Any substance or organism that is foreign to the body. Examples of antigens include bacteria, bacterial toxins, viruses, or other cells or proteins.

**Autoimmune disease**—A disease in which the immune system is overactive and produces antibodies that attack the body's own tissues.

**Corticosteroids**—A class of drugs that are synthetic versions of the cortisone produced by the body. They rank among the most powerful anti-inflammatory agents.

**Cortisone**—A glucocorticoid compound produced by the adrenal cortex in response to stress. Cortisone is a steroid with anti-inflammatory and immunosuppressive properties.

**Cytostatic**—A type of drug that inhibits the process of cell division. Azathioprine is an example of a cytostatic drug.

**Immune system**—The network of organs, cells, and molecules that work together to defend the body

from such foreign substances and organisms causing infection and disease as bacteria, viruses, fungi, and parasites.

**Immunosuppressive cytotoxic drugs**—A class of drugs that function by destroying cells and suppressing the immune response.

**Inflammation**—A process occurring in body tissues, characterized by increased circulation and the accumulation of white blood cells. Inflammation also occurs in such disorders as arthritis and causes harmful effects.

**Lymphocyte**—A type of white blood cell involved in the immune response. The two main groups of lymphocytes are the B cells, which carry antibody molecules on their surface; and T cells, which destroy antigens.

**Psoriasis**—A skin disease characterized by itchy, scaly, red patches on the skin.

**T cells**—Any of several lymphocytes that have specific antigen receptors, and are involved in cell-mediated immunity and the destruction of antigen-bearing cells.

cyclosporin, azathioprine, and prednisolone. Over a period of time, the doses of each drug and the number of drugs taken may be reduced as the risks of rejection decrease. Most transplant patients, however, will need to take at least one immunosuppressive medication for the rest of their lives.

The major limitation of the immunosuppressant drugs in use as of early 2008 is that they cannot target only those cells involved in graft or transplant rejection; they impair the immune responses of other cells as well. In 2007 a major action plan for further research in transplantation noted the importance of developing immunosuppressive drugs with more specific targets.

Immunosuppressants can also be classified according to the specific organ that is transplanted:

- Basiliximab (Simulect) is also used in combination with such other drugs as cyclosporin and corticosteroids in kidney transplants.
- Daclizumab (Zenapax) is also used in combination with such other drugs as cyclosporin and corticosteroids in kidney transplants.
- Muromonab CD3 (Orthoclone OKT3) is used along with cyclosporin in kidney, liver and heart transplants.

- Tacrolimus (Prograf) is used in liver and kidney transplants. It is under study for bone marrow, heart, pancreas, pancreatic island cell, and small bowel transplantation
- Sirolimus (Rapamune, Rapamycin) is used in kidney transplants.

Some immunosuppressants are also used to treat a variety of autoimmune diseases:

- Azathioprine (Imuran) is used not only to prevent organ rejection in kidney transplants, but also in treatment of rheumatoid arthritis. It has been used to treat chronic ulcerative colitis, although it has proved to be of limited value for this use.
- Cyclosporin (Sandimmune, Neoral) is used in heart, liver, kidney, pancreas, bone marrow, and heart/lung transplantation. The Neoral form of cyclosporin has been used to treat psoriasis and rheumatoid arthritis. The drug has also been used to treat many other conditions, including multiple sclerosis, diabetes, and myasthenia gravis.
- Glatiramer acetate (Copaxone) is used in the treatment of relapsing-remitting multiple sclerosis. In one study, glatiramer reduced the frequency of multiple sclerosis attacks by 75% over a two-year period.

- Mycophenolate (CellCept) is used along with cyclosporin in kidney, liver, and heart transplants. It has also been used to prevent the kidney problems associated with lupus erythematosus.
- Sirolimus (Rapamune, Rapamycin) is used in combination with other drugs, including cyclosporin and corticosteroids, in kidney transplants. The drug is also used to treat patients with psoriasis.

### Recommended dosage

Immunosuppressant drugs are available only with a physician's prescription. They come in tablet, capsule, liquid, and injectable forms. The recommended dosage depends on the type and form of immunosuppressant drug and the purpose for which it is being used. Doses may be different for different patients. The prescribing physician or the pharmacist who filled the prescription will advise the patient on the correct dosages.

Patients who are taking immunosuppressant drugs should take them *exactly as directed*. They should never take smaller, larger, or more frequent doses of these medications. In addition, immunosuppressant drugs should never be taken for a longer period of time than directed. The physician will decide exactly how much of the medicine each patient needs. Blood tests are usually necessary to monitor the action of these drugs.

Patients should always consult the prescribing physician before they stop taking an immunosuppressant drug.

### Precautions

Patients who are taking immunosuppressant drugs should see their doctor on a regular basis. Periodic checkups will allow the physician to make sure the drug is working as it should and to monitor the patient for unwanted side effects. These drugs are very powerful and can cause such serious side effects as high blood pressure, kidney problems and liver disorders. Some side effects may not show up until years after the medicine was used. Anyone who has been advised to take immunosuppressant drugs should thoroughly discuss the risks and benefits of these medications with the prescribing physician.

Immunosuppressant drugs lower a person's resistance to infection and can make infections harder to treat. The drugs can also increase the chance of uncontrolled bleeding. Anyone who has a serious infection or injury while taking immunosuppressant drugs should get prompt medical attention and should make sure that the treating physician knows that he or she is taking an immunosuppressant medication.

The prescribing physician should be immediately informed if such signs of infection as fever or chills; cough or hoarseness; pain in the lower back or side; painful or difficult urination; bruising or bleeding; blood in the urine; bloody or black, tarry stools occur. Other ways of preventing infection and injury include washing the hands frequently, avoiding sports in which injuries may occur, and being careful when using knives, razors, fingernail clippers, or other sharp objects. Avoiding contact with people who have infections is also important.

In addition, people who are taking or have been taking immunosuppressant drugs should not have such immunizations as smallpox vaccinations without consulting their physician. Because their resistance to infection has been lowered, people taking these drugs might get the disease that the vaccine is designed to prevent. People taking immunosuppressant drugs should avoid contact with anyone who has had a recent dose of oral polio vaccine, as there is a chance that the virus used to make the vaccine could be passed on to them.

Immunosuppressant drugs may cause the gums to become tender and swollen or to bleed. If this happens, a physician or dentist should be notified. Regular brushing, flossing, cleaning, and gum massage may help prevent this problem. A dentist can provide advice on how to clean the teeth and mouth without causing injury.

### Special conditions

People who have certain diseases or disorders, or who are taking certain other medicines may have problems if they take immunosuppressant drugs. Before taking these drugs, patients should inform the prescribing physician about any of the following conditions:

**ALLERGIES.** Anyone who has had unusual reactions to immunosuppressant drugs in the past should let his or her physician know before taking the drugs again. The physician should also be told about any allergies to foods, dyes, preservatives, or other substances.

**PREGNANCY.** Azathioprine has been considered a cause of birth defects. The British National Formulary, however, states: "Transplant patients immunosuppressed with azathioprine should not discontinue it on becoming pregnant; there is no evidence that azathioprine is teratogenic. There is less experience of cyclosporin in pregnancy but it does not appear to be any more harmful than azathioprine. The use of these drugs during pregnancy needs to be supervised in specialist units. Any risk to the offspring of azathioprine-treated men is small." Nonetheless, patients who are taking any immunosuppressive drug should consult

with their physician before conceiving a child, and they should notify the doctor at once when there is any indication of pregnancy.

Basiliximab should not be used during pregnancy. The manufacturer recommends using adequate contraception during use of this drug, and for eight weeks following the final dose.

The manufacturers warn against the use of tacrolimus and mycophenolate during pregnancy, on the basis of findings from animal studies. They recommend using adequate contraception while taking these drugs, and for six weeks after the last dose.

The safety of **corticosteroids** during pregnancy has not been absolutely determined. There is some evidence that use of these drugs during pregnancy may affect the baby's growth; however, this result is not certain, and may vary with the medication used. Patients taking any steroid drug should consult with their physician before starting a family, and should notify the doctor at once if they think they are pregnant.

Most of these medicines have not been studied in humans during pregnancy. Women who are pregnant or who may become pregnant and who need to take immunosuppressants should consult their physicians.

**LACTATION.** Immunosuppressant drugs pass into breast milk and may cause problems in nursing babies whose mothers take it. Breastfeeding is not recommended for women taking immunosuppressants.

**OTHER MEDICAL CONDITIONS.** People with any of the following conditions may have problems if they take immunosuppressant drugs:

- People who have shingles (herpes zoster) or chickenpox, or who have recently been exposed to chickenpox, may develop severe disease in other parts of their bodies when they take these medicines.
- Immunosuppressants may produce more intense side effects in people with kidney disease or liver disease, because their bodies are slow to get rid of the medicine.
- Oral forms of immunosuppressants may be less effective in people with intestinal problems, because the medicine cannot be absorbed into the body.

Before using immunosuppressants, people with these or other medical problems should make sure their physicians are aware of their conditions.

### Side effects

Increased risk of infection is a common side effect of all immunosuppressant drugs. The immune system protects the body from infections; when the immune

system is suppressed, infections are more likely. Taking such **antibiotics** as co-trimoxazole (SXT, TMP-SMX, or TMP-sulfa) prevents some of these infections. Immunosuppressant drugs are also associated with a slightly increased risk of cancer because the immune system plays a role in protecting the body against some forms of cancer. For example, the long-term use of immunosuppressant drugs carries an increased risk of developing skin cancer as a result of the combination of the drugs and exposure to sunlight.

Other side effects of immunosuppressant drugs are minor and usually go away as the body adjusts to the medicine. These include loss of appetite, nausea or vomiting, increased hair growth, and trembling or shaking of the hands. Medical attention is not necessary unless these side effects continue or cause problems.

The treating physician should be notified immediately if any of the following side effects occur:

- unusual tiredness or weakness
- fever or chills
- frequent need to urinate

### Interactions

Immunosuppressant drugs may interact with other medicines. When interactions occur, the effects of one or both drugs may change or the risk of side effects may be greater. Other drugs may also have adverse effects on immunosuppressant therapy. It is particularly important for patients taking cyclosporin or tacrolimus to be careful about the possibility of drug interactions. Other examples of problematic interactions are:

- The effects of azathioprine may be greater in people who take allopurinol, a medicine used to treat gout.
- A number of drugs, including female hormones (estrogens), male hormones (androgens), the antifungal drug ketoconazole (Nizoral), the ulcer drug cimetidine (Tagamet), and the erythromycins (used to treat infections), may intensify the effects of cyclosporine. Certain herbs are also reported to interact with cyclosporine.
- When sirolimus is taken at the same time as cyclosporin, the blood levels of sirolimus may be increased to a level that produces severe side effects. Although these two drugs are usually used together, the dose of sirolimus should be taken four hours after the dose of cyclosporin.
- Tacrolimus is eliminated through the kidneys. When this drug is used with other medications that may harm the kidneys, such as cyclosporin, the antibiotics gentamicin and amikacin, or the antifungal drug amphotericin B, the blood levels of tacrolimus may

rise. Careful kidney monitoring is essential when tacrolimus is given with any drug that might cause kidney damage. Tacrolimus is another immunosuppressive drug reported to interact with some over-the-counter herbal preparations.

- The risk of cancer or infection may be greater when immunosuppressant drugs are combined with certain other drugs that also lower the body's ability to fight disease and infection. These drugs include corticosteroids, especially prednisone; the anticancer drugs chlorambucil (Leukeran), cyclophosphamide (Cytosan) and mercaptopurine (Purinethol); and the monoclonal antibody muromonab-CD3 (Orthoclone), which is also used to prevent transplanted organ rejection.

Not every drug that may interact with immunosuppressant drugs is listed here. Anyone who takes immunosuppressant drugs should give their doctor a list of all other medicines—including herbal formulations—that he or she is taking and should ask whether there are any potential interactions that might interfere with treatment.

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Bethesda, MD 20892 8322. (800) 4 CANCER or (800) 332 8615 (TTY). [www.nci.nih.gov](http://www.nci.nih.gov).

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## Implantable cardioverter-defibrillator

### Definition

The implantable cardioverter-defibrillator (ICD) is a surgically implanted electronic device that directs an electric charge directly into the heart to treat life-threatening arrhythmias.

### Purpose

The implantable cardioverter-defibrillator is used to detect and stop life-threatening arrhythmias and restore a productive heartbeat that is able to provide adequate cardiac output to sustain life. The exact indications for the implantation of the device are controversial, but patients suffering from ventricular fibrillation (unproductive heartbeat), ventricular tachycardia (abnormally fast heartbeat), long QT syndrome (an inherited heart disease), or others at risk for sudden cardiac death are potential candidates for this device. A study by the National Institute for Heart, Lung, and Blood of the National Institutes of Health showed a significant increase in survival for



patients suffering from ventricular arrhythmias when ICD implant is compared to medication. Several follow-up studies indicate that this may be due to the marked increase in survival for the sickest patients, generally defined as those having a heart weakened to less than 50% of normal, as measured by the ability of the left side of the heart to pump blood. Overall, studies have documented a very low mortality rate of 1–2% annually for persons implanted with the device, compared to approximately 15–25% for patients on drug therapy.

### Demographics

ICD implant is limited to patients that face the risk of sudden cardiac death from sustained ventricular arrhythmia, including ventricular tachycardia and ventricular fibrillation. Less than 1% of the more than 100,000 device implants done in the United States are performed on pediatric patients. Reduction in the risk of sudden cardiac death improves to less than 2% for both populations.

### Diagnosis

Patients experiencing syncope (fainting) will be monitored with a **cardiac monitor** for arrhythmias. Following unsuccessful medical treatment for sustained ventricular arrhythmias, ICD implant will be indicated.

### Description

Similar in structure to a pacemaker, an ICD has three main components: a generator, leads, and an electrode. The generator is encased in a small rectangular container, usually about 2 in (5 cm) wide and around 3 oz (85 g) in weight. Even smaller generators have been developed, measuring 1 in (2.5 cm) in diameter and weighing about 0.5 oz (14 g). The generator is powered by lithium batteries and is responsible for generating the electric shock. The generator is controlled by a computer chip that can be programmed to follow specific steps according to the input gathered from the heart. The programming is initially set and can be changed using a wand programmer, a device that communicates by radio waves through the chest of the patient after implantation. One or two leads, or wires, are attached to the generator. These wires are generally made of platinum with an insulating coating of either silicone or polyurethane. The leads carry the electric shock from the generator. At the tip of each lead is a tiny device called an electrode that delivers the necessary electrical shock to the heart. Thus, the electric shock is created by the generator, carried by the

## KEY TERMS

**Arrhythmia**—A variation of the normal rhythm of the heartbeat.

**Cardioverter**—A device to apply electric shock to the chest to convert an abnormal heartbeat into a normal heartbeat.

**Defibrillation**—An electronic process that helps reestablish a normal heart rhythm.

**Ventricles**—The two large lower chambers of the heart that pump blood to the lungs and the rest of the human body.

**Ventricular fibrillation**—An arrhythmia in which the heart beats very fast, but blood is not pumped out to the body, which can become fatal if not corrected.

**Ventricular tachycardia**—An arrhythmia in which the heart rate is more than 100 beats per minute.

leads, and delivered by the electrodes to the heart. The decision of where to put the leads depends on the needs of the patient, but they can be located in the left ventricle, the left atrium, or both.

According to the American College of Cardiology, more than 100,000 persons worldwide currently have an ICD. The battery-powered device rescues the patient from a life-threatening arrhythmia by performing a number of functions in order to reestablish normal heart rhythm, which varies with the particular problem of the patient. Specifically, if encountered with ventricular tachycardia, many devices will begin treatment with a pacing regimen. If the tachycardia is not too fast, the ICD can deliver several pacing signals in a row. When those signals stop, the heart may go back to a normal rhythm. If the pacing treatment is not successful, many devices will move onto **cardioversion**. With cardioversion, a mild shock is sent to the heart to stop the fast heartbeat. If the problem detected is ventricular fibrillation, a stronger shock called a **defibrillation** is sent. This stronger shock can stop the fast rhythm and help the heartbeat return to normal. Finally, many ICDs can also detect heartbeats that are too slow; they can act like a pacemaker and bring the heart rate up to normal. ICDs that defibrillate both the ventricles and the atria have also been developed. Such devices not only provide dual-chamber pacing but also can distinguish ventricular from atrial fibrillation. Patients that experience both atrial and ventricle fibrillations, or atrial fibrillation alone, that

would not be controlled with a single-chamber device are candidates for this kind of ICD.

### Operation

ICD insertion is considered minor surgery, and can be performed in either an **operating room** or an electrophysiology laboratory. The insertion site in the chest will be cleaned, shaved, and numbed with local anesthetic. Generally, left-handed persons have ICDs implanted on the right side, and vice versa, to speed return to normal activities. Two small cuts (incisions) are made, one in the chest wall and one in a vein just under the collarbone. The wires of the ICD are passed through the vein and attached to the inner surface of the heart. The other ends of the wires are connected to the main box of the ICD, which is inserted into the tissue under the collarbone and above the breast. Once the ICD is implanted, the physician will test it several times before the anesthesia wears off by causing the heart to fibrillate and making sure the ICD responds properly. The doctor then closes the incision with sutures (**stitches**), **staples**, or surgical **glue**. The entire procedure takes about an hour.

Immediately following the procedure, a **chest x ray** will be taken to confirm the proper placement of the wires in the heart. The ICD's programming may be adjusted by passing the programming wand over the chest. After the initial operation, the physician may induce ventricular fibrillation or ventricular tachycardia one more time prior to the patient's discharge, although recent studies suggest that this final test is not generally necessary.

A short stay in the hospital is usually required following ICD insertion, but this varies with the patient's age and condition. If there are no complications, complete recovery from the procedure will take about four weeks. During that time, the wires will firmly take hold where they were placed. In the meantime, the patient should avoid heavy lifting or vigorous movements of the arm on the side of the ICD, or else the wires may become dislodged.

After implantation, the cardioverter-defibrillator is programmed to respond to rhythms above the patient's **exercise** heart rate. Once the device is in place, many tests will be conducted to ensure that the device is sensing and defibrillating properly. About 50% of patients with ICDs require a combination of drug therapy and the ICD.

### Morbidity and mortality rates

Perioperative mortality demonstrates a 0.4–1.8% risk of death for primary non-thoracotomy implants.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Electrophysiologists are specially trained cardiologists or thoracic surgeons who study and treat problems with the heart conduction system. In a hospital operating room, they often implant the ICD system and oversee the programming or reprogramming of the device. Electrophysiologists receive special continuing medical education to provide successful implantation. Implantation, follow-up, and replacement can be limited at any one institution, therefore an experienced well-trained electrophysiologist should perform these procedures.

The ICD showed improved survival compared to medical therapy, improving by 38% at one year. There is a 96% survival rate at four years for those implanted with ICD. Less than 2% of patients require termination of the device, with a return to only medical therapy.

### Normal results

Ventricular tachycardia can be successfully relieved by pacing in 96% of instances with the addition of defibrillation converting 98% of patients to a productive rhythm that is able to sustain cardiac output. Ventricular fibrillation is successfully converted in 98.6–98.8% of all cases. Atrial fibrillation and rapid ventricular response leads to erroneous fibrillation in as many as 11% of patients.

### Risks

Environmental conditions that can affect the functioning of the ICD after installation include:

- strong electromagnetic fields such as those used in arc-welding
- contact sports
- shooting a rifle from the shoulder nearest the installation site
- cell phones used on that side of the body
- magnetic mattress pads such as those believed to treat arthritis
- some medical tests such as magnetic resonance imaging (MRI)

## QUESTIONS TO ASK THE DOCTOR

- How many of these procedures have been performed by the physician?
- What type of longevity can be expected from the device?
- What will happen during device activation?
- What precautions should be taken in the weeks immediately following implant?
- After implantation how long will it be before normal daily activities can be resumed such as driving, exercise, and work?
- What indications of device malfunction will there be, and when should emergency treatment be sought?
- What precautions should be taken by bystanders when the device activates?
- How will device recalls be communicated?
- Can psychological counseling benefit patient satisfaction and comfort?

Environmental conditions often erroneously thought to affect ICDs include:

- microwave ovens (The waves only affect old, unshielded pacemakers and do not affect ICDs.)
- airport security (Metal detector alarms could be set off, so patients should carry a card stating they have an ICD implanted.)
- anti-theft devices in stores (Patients should avoid standing near the devices for prolonged periods.)

Patients should also be instructed to memorize the manufacturer and make of their ICD. Although manufacturing defects and recalls are rare, they do occur and a patient should be prepared for that possibility.

### Aftercare

In general, if the condition of the patient's heart, drug intake, and metabolic condition remain the same, the ICD requires only periodic checking every two months or so for battery strength and function. This is done by placing a special device over the ICD that allows signals to be sent over the telephone to the doctor, a process called trans-telephonic monitoring.

If changes in medications or physical condition occur, the doctor can adjust the ICD settings using a programmer, which involves placing the wand above the pacemaker and remotely changing the internal settings. One relatively common problem is the so-called "ICD

storm," in which the machine inappropriately interprets an arrhythmia and gives a series of shocks. Reprogramming can sometimes help alleviate that problem.

When the periodic testing indicates that the battery is getting low, an elective ICD replacement operation is scheduled. The entire signal generator is replaced because the batteries are sealed within the case. The leads can often be left in place and reattached to the new generator. Batteries usually last from four to eight years.

### Alternatives

Patients are treated with medical therapy to reduce the chance of arrhythmia. This alternative has been shown to have a higher rate of sudden death when compared to ICD over the initial three years of treatment, but has not been compared at five years. If the site of ventricular tachycardia generation can be mapped by electrophysiology studies, the aberrant cells can be removed or destroyed. Less than 5% of patients die during this cell removal procedure.

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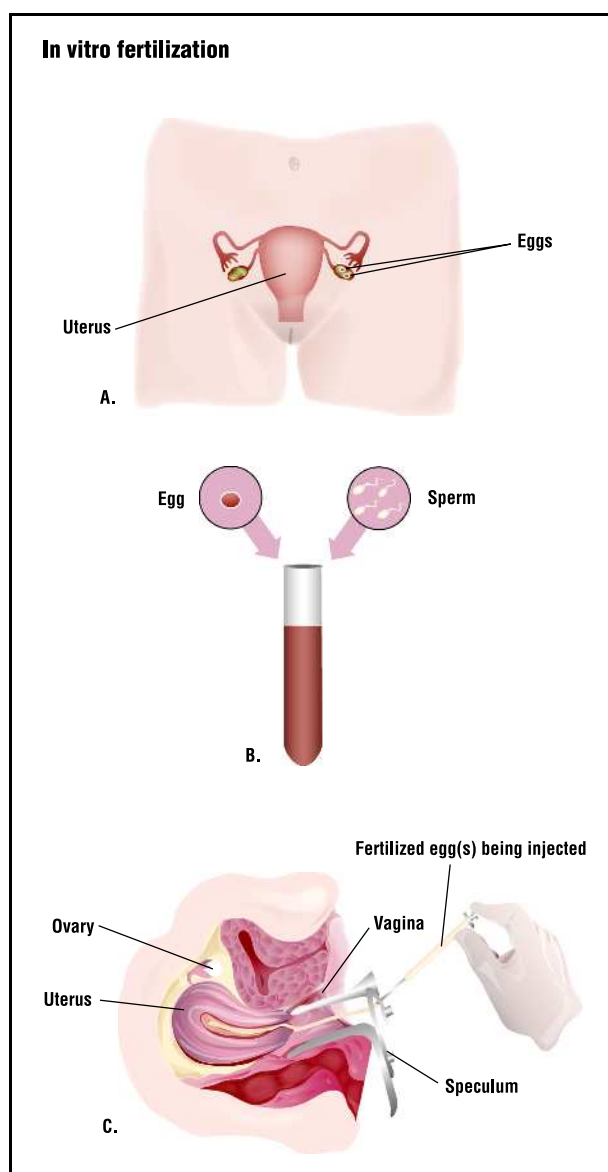
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## In vitro fertilization

### Definition

*In vitro* fertilization (IVF) is a procedure in which eggs (ova) from a woman's ovary are removed, they are fertilized with sperm in a laboratory procedure, and then the fertilized egg (embryo) is returned to the woman's uterus.



For in vitro fertilization, hormones are administered to the patient, and then eggs are harvested from her ovaries (A). The eggs are fertilized by sperm donated by the father (B). Once the cells begin to divide, one or more embryos are placed into the woman's uterus to develop (C). (Illustration by GGS Information Services. Cengage Learning, Gale.)

### Purpose

IVF is one of several assisted reproductive techniques (ART) used to help infertile couples to conceive a child. If after one year of having sexual intercourse without the use of birth control a woman is unable to get pregnant, infertility is suspected. Some of the reasons for infertility are damaged or blocked fallopian tubes, hormonal imbalance, or endometriosis in the woman. In the man, low sperm count or poor quality sperm can cause infertility.

### KEY TERMS

**Endometriosis**—An inflammation of the endometrium, the mucous lining of the uterus.

**Fallopian tubes**—In a woman's reproductive system, a pair of narrow tubes (one for each ovary) that carries eggs from the ovary to the uterus.

**Gamete intrafallopian tube transfer (GIFT)**—A process where eggs are taken from a woman's ovaries, mixed with sperm, and then deposited into the woman's fallopian tube.

**Intracytoplasmic sperm injection (ICSI)**—A process used to inject a single sperm into each egg before fertilized eggs are put back into a woman's body; the procedure may be used if the male has a low sperm count.

**Zygote intrafallopian tube transfer (ZIFT)**—The woman's eggs are fertilized in a laboratory dish and then placed in her fallopian tube.

IVF is one of several possible methods to increase the chances for an infertile couple to become pregnant. Its use depends on the reason for infertility. IVF may be an option if there is a blockage in the fallopian tube or endometriosis in the woman, or low sperm count or poor quality sperm in the man. There are other possible treatments for these conditions, such as surgery for blocked tubes or endometriosis, which may be attempted before IVF.

IVF will not work for a woman who is incapable of ovulating or with a man who is not able to produce at least a few healthy sperm.

### Demographics

IVF has been used successfully since 1978, when the first child to be conceived by this method was born in England. Over the past 30 years, thousands of couples have used this method of ART or similar procedures to conceive.

### Description

*In vitro* fertilization is a procedure in which the joining of egg and sperm takes place outside of a woman's body. A woman may be given fertility drugs before this procedure so that several eggs mature in the ovaries at the same time. The mature eggs (ova) are removed from the woman's ovaries using a long, thin needle. The physician has access to the ovaries using one of two possible procedures. One involves inserting the needle



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

An obstetrician-gynecologist (OB-GYN) with specialized training in IVF supervises the activities of IVF. This specialist performs most of the procedures involving the woman. Most IVF activities are performed in a professional medical office.

through the vagina (transvaginally); the physician guides the needle to the location in the ovaries with the help of an **ultrasound** machine. In the other procedure, called **laparoscopy**, a small thin tube with a viewing lens is inserted through an incision in the navel. This allows the physician to see on a video monitor inside the uterus to locate the ovaries.

Once the eggs are removed, they are mixed with sperm in a laboratory dish or test tube. (This is the origin of the term “test tube baby.”) The eggs are monitored for several days. Once there is evidence that fertilization has occurred and the cells have begun to divide, they are then returned to the woman’s uterus.

In the procedure to remove eggs, a sufficient number may be gathered to be frozen and saved (either fertilized or unfertilized) for additional IVF attempts.

### Diagnosis/Preparation

Once a woman is determined to be a good candidate for *in vitro* fertilization, she will generally be given fertility drugs to stimulate ovulation and the development of multiple eggs. These drugs may include gonadotropin-releasing hormone agonists (GnRHa), Pergonal, Clomid, or human chorionic gonadotropin (hcg). The maturation of the eggs is then monitored with ultrasound tests and frequent blood tests. If enough eggs mature, a physician will perform the procedure to remove them. The woman may be given a sedative prior to the procedure. A local anesthetic agent may also be used to reduce discomfort during the procedure.

The screening procedures and treatments for infertility can become a long, expensive, and, sometimes, disappointing process. Each IVF attempt takes at least an entire menstrual cycle and can cost \$5,000–10,000, which may or may not be covered by health insurance. The anxiety of dealing with infertility can challenge both individuals and their relationship. The added stress and expense of multiple clinic visits, testing, treatments, and surgical procedures can become

## QUESTIONS TO ASK THE DOCTOR

Candidates for in-vitro fertilization should consider asking the following questions, including:

- What is the physician’s evaluation of IVF and its alternatives for the woman seeking assistance?
- Is the surgeon certified to treat infertility?
- How many procedures has the physician performed?
- What is the physician’s overall success rate?
- What is the success rate for women of the same age as the person seeking assistance?

overwhelming. Couples may want to receive counseling and support through the process.

### Aftercare

After the IVF procedure is performed, the woman can resume normal activities. A pregnancy test can be done approximately 12–14 days after the procedure to determine if it was successful.

### Risks

The risks associated with in vitro fertilization include the possibility of multiple pregnancy (since several embryos may be implanted) and ectopic pregnancy (an embryo that implants in the fallopian tube or in the abdominal cavity outside the uterus). There is a slight risk of ovarian rupture, bleeding, infections, and complications of anesthesia. If the procedure is successful and pregnancy is achieved, the pregnancy carries the same risks as any pregnancy achieved without assisted technology.

### Normal results

Success rates vary widely among clinics and among physicians performing the procedure. A couple has about a 10% chance of becoming pregnant each time the procedure is performed. Therefore, the procedure may have to be repeated more than once to achieve pregnancy.

Abnormal results include ectopic or multiple pregnancy that may abort spontaneously or that may require termination if the health of the mother is at risk.

## Morbidity and mortality rates

The most common cause of morbidity is ectopic pregnancy. Pain is associated with most components of the procedure. Mortality as a result of IVF is extremely rare.

## Alternatives

Other types of assisted reproductive technologies might be used to achieve pregnancy. A procedure called intracytoplasmic sperm injection (ICSI) utilizes a manipulation technique that must be performed using a microscope to inject a single sperm into each egg. The fertilized eggs can then be returned to the uterus, as in IVF. In gamete intrafallopian tube transfer (GIFT), the eggs and sperm are mixed in a narrow tube, and then deposited in the fallopian tube, where fertilization normally takes place. Another variation on IVF is zygote intrafallopian tube transfer (ZIFT). As in IVF, the fertilization of the eggs occurs in a laboratory dish. And, similar to GIFT, the embryos are placed in the fallopian tube, rather than in the uterus as with IVF.

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## ORGANIZATIONS

- American Board of Obstetrics and Gynecology. 2915 Vine Street, Suite 300, Dallas, TX 75204. (214) 871 1619; Fax: (214) 871 1943. E mail: [info@abog.org](mailto:info@abog.org). <http://www.abog.org>.
- American College of Obstetricians and Gynecologists. 409 12th St., SW, P.O. Box 96920, Washington, DC 20090 6920. <http://www.acog.org>.
- American Fertility Association. 305 Madison Avenue Suite 449, New York, NY 10165. (888) 917 3777. <http://www.afafamilymatters.com/>.
- American Society for Reproductive Medicine. 1209 Montgomery Highway, Birmingham, AL 35216 2809. (205) 978 5000. <http://www.asrm.com>.
- International Council on Infertility Information Dissemination, Inc. P.O. Box 6836, Arlington, VA 22206. (703) 379 9178. <http://www.inciid.org>.

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## Incision care

### Definition

Incision care refers to a series of procedures and precautions related to closing a wound or surgical incision; protecting the cut or injured tissues from contamination or infection; and caring properly for the new skin that forms during the healing process. Incision care begins in the hospital or outpatient clinic and is continued by the patient during **recovery at home**.

## Purpose

There are several reasons for caring properly for an incision or wound. These include:

- lowering the risk of postoperative complications, particularly infection
- avoiding unnecessary pain or discomfort
- minimizing scarring
- preventing blood loss

## Description

### *Types of wound or incision closure*

Proper care of an incision begins with knowing what material or technique the surgeon used to close the cut. There are four major types of closure used in Canada and the United States as of 2003.

**SURGICAL SUTURES.** Sutures, or **stitches**, are the oldest method still in use to close an incision. The surgeon uses a sterilized thread, which may be made of natural materials (silk or catgut) or synthetic fibers, to stitch the edges of the cut together with a special curved needle. There are two major types of sutures, absorbable and nonabsorbable. Absorbable sutures are gradually broken down in the body, usually within two months. Absorbable sutures do not have to be removed. They are used most commonly to close the deeper layers of tissue in a large incision or in such areas as the mouth. Nonabsorbable sutures are not broken down in the body and must be removed after the incision has healed. They are used most often to close the outer layers of skin or superficial cuts.

Sutures have several disadvantages. Because they are made of materials that are foreign to the body, they must be carefully sterilized and the skin around the incision cleansed with Betadine or a similar antiseptic to minimize the risk of infection. Suturing also requires more time than newer methods of closure. If the patient is not under **general anesthesia**, the surgeon must first apply or inject a local anesthetic before suturing. Lastly, there is a higher risk of scarring with sutures, particularly if the surgeon puts too much tension on the thread while stitching or selects thread that is too thick for the specific procedure.

**SURGICAL STAPLES.** Surgical **staples** are a newer method of incision closure. Staples are typically made of stainless steel or titanium. They are used most commonly to close lacerations on the scalp or to close the outer layers of skin in orthopedic procedures. They cannot be used on the face, hand, or other areas of the body where tendons and nerves lie close to

## KEY TERMS

**Catgut**—The oldest type of absorbable suture. In spite of its name, catgut is made from collagen derived from sheep or cattle intestines. Synthetic absorbable sutures have been available since the 1980s.

**Dehiscence**—Separation or splitting open of the different layers of tissue in a surgical incision. Dehiscence may be partial, involving only a few layers of surface tissue; or complete, reopening all the layers of the incision.

**Drainage**—The withdrawal or removal of blood and other fluid matter from an incision or wound. An incision that is oozing blood or tissue fluids is said to be draining.

**Dressing**—A bandage, gauze pad, or other material placed over a wound or incision to cover and protect it.

**Incision**—The medical term for a cut made by a surgeon into a tissue or organ.

**Laceration**—A type of wound with rough, torn, or ragged edges.

**Suture**—A loop of thread, catgut, or synthetic material used to draw together and align the edges of a wound or incision. Sutures may be either absorbable or nonabsorbable.

the surface. Staples are usually removed seven to 10 days after surgery.

Staples are less likely to cause infections than sutures, and they also take less time to use. They can, however, leave noticeable scars if the edges of the wound or incision have not been properly aligned. In addition, staples require a special instrument for removal.

**STERI-STRIPS.** Steri-strips are pieces of adhesive material that can be used in some surgical procedures to help the edges of an incision grow together. They have several advantages, including low rates of infection, speed of application, no need for **local anesthesia**, and no need for special removal. Steri-strips begin to curl and peel away from the body, usually within five to seven days after surgery. They should be pulled off after two weeks if they have not already fallen off. Steri-strips, however, have two disadvantages: they are not as precise as sutures in bringing the edges of an incision into alignment; and they cannot be used on areas of the body that are hairy or that secrete moisture, such as the palms of the hands or the armpits.

**LIQUID TISSUE GLUES.** Tissue glues are the newest type of incision closure. They are applied to the edges of the incision and form a bond that holds the tissues together until new tissue is formed. The tissue glues most commonly used as of 2003 belong to a group of chemicals known as cyanoacrylates. In addition to speed of use and a low infection rate, tissue glues are gradually absorbed by the body. They are less likely to cause scarring, which makes them a good choice for facial surgery and other cosmetic procedures. They are also often used to close lacerations or incisions in children, who find them less frightening or painful than sutures or staples. Like Steri-strips, however, tissue glues cannot be used on areas of high moisture. They are also ineffective for use on the knee or elbow joints.

### *Dressings and drainage devices*

After the incision is closed, it is covered with a dressing of some sort to keep it dry and clean, and prevent infection. Most **dressings** consist of gauze pads held in place by strips of adhesive tape or ACE **bandages**. An antibiotic ointment may also be applied to the gauze. A newer type of dressing, called OpSite, is a thin transparent membrane made of polyurethane coated with adhesive. It keeps disease organisms out of the wound while holding a layer of moisture close to the skin. This moist environment keeps scabs from forming and speeds up healing of the incision. OpSite can also be used to hold catheters or drainage tubes in place. It cannot, however, be used for severe (third-degree) burns or deep incisions.

Some surgical procedures, such as a **mastectomy** or removal of a ruptured appendix, require the surgeon to insert a drainage device to remove blood, pus, or other tissue fluids from the area of the incision. It is important to prevent these fluids from collecting under the incision because they encourage the growth of disease organisms. The drain may be left in place after the patient leaves the hospital. If so, the patient will need to check and empty the drain daily in addition to general incision care.

### *Home care of incisions*

Guidelines for **home care** of an incision vary somewhat depending on the material that was used for closure, the location and size of the incision, and the nature of the operation. The following section is a general description of the major aspects of incision care.

Patients should ask their doctor for specific information about caring for their incision:

- the type of closure used
- whether another appointment will be needed to remove any sutures or staples

- the length of time that the incision should be kept covered, and the type of dressing that should be used
- whether the incision must be kept dry, and for how long
- any specific signs or symptoms that should be reported to the doctor

Most hospitals and surgery clinics provide patients with written handouts or checklists about incision care; however, it is always helpful to go over the information in the handout with the doctor or nurse, and to ask any further questions that may arise.

**BATHING AND SHOWERING.** Incisions should be kept dry for several days after surgery, with the exception of incisions closed with tissue **glue**. Incisions closed with nonabsorbable sutures or staples must be kept dry until the doctor removes the sutures or staples, usually about seven to 10 days after surgery. Incisions closed with Steri-strips should be kept dry for about four to five days. If the incision gets wet accidentally, it must be dried at once. Patients with incisions on the face, hands, or arms may be able to take showers or tub baths as long as they are able to hold the affected area outside the water. Patients with incisions in other parts of the body can usually take sponge baths.

It is usually safe to allow incisions closed with tissue glue to get wet during showering or bathing. The patient should, however, dry the area around the incision carefully after washing.

**PHYSICAL ACTIVITY AND EXERCISE.** Patients should avoid any activity that is likely to pull on the edges of the incision or put pressure on it. Walking and other light activities are encouraged, as they help to restore normal energy levels and digestive functions. Patients should not, however, participate in sports, engage in sexual activity, or lift heavy objects until they have had a postoperative checkup.

**MEDICATIONS.** Patients are asked to avoid **aspirin** or over-the-counter medications containing aspirin for a week to 10 days after surgery, because aspirin interferes with blood clotting and makes it easier for bruises to form in the skin near the incision. The doctor will usually prescribe codeine or another non-aspirin medication for pain control.

Patients with medications prescribed for other conditions or disorders should ask the doctor before starting to take them again.

**SUN EXPOSURE.** As an incision heals, the new skin that is formed over the cut is very sensitive to sunlight and will burn more easily than normal skin. Sunburn in turn will lead to worse scarring. Patients should keep the incision area covered for three to nine months



from direct sun exposure in order to prevent burning and severe scarring.

#### **SPECIAL CONSIDERATIONS FOR FACIAL INCISIONS.**

Patients who have had facial surgery are usually given very detailed instructions about incision care because the skin of the face is relatively thin, and incisions in this area can be easily stretched out of alignment. In addition, patients should not apply any cosmetic creams or makeup after surgery without the surgeon's approval because of the risk of infection or allergic reaction.

**GENERAL HYGIENE.** Infection is the most common complication of surgical procedures. It can be serious; of the 300,000 patients whose incisions become infected each year in the United States, about 10,000 will die. It is important, therefore, to minimize the risk of an infection when caring for an incision at home.

Patients should observe the following precautions about general cleanliness and personal habits:

- Wash hands carefully after using the toilet and after touching or handling trash or garbage; pets and pet equipment; dirty laundry or soiled incision dressings; and anything else that is dirty or has been used outdoors.
- Ask family members, close friends, and others who touch the patient to wash their hands first.
- Avoid contact with family members and others who are sick or recovering from a contagious illness.
- Stop smoking. (Smoking slows down the healing process.)

#### **Normal results**

As an incision heals, it is normal to experience some redness, swelling, itching, minor skin irritation or oozing of tissue fluid, or small lumps in the skin near the incision. At first, the skin over the incision will feel thick and hard. After a period of two to six months, the swelling and irritation will go down and the scar tissue will soften and begin to blend into the surrounding tissue.

#### **Risk factors for abnormal results**

Some patients are more likely to develop infections or to have their incision split open, which is known as dehiscence. Risk factors for infection or dehiscence include:

- obesity
- diabetes
- malnutrition
- a weakened immune system
- taking corticosteroid medications prescribed for another disorder or condition
- a history of heavy smoking

#### **Warning signs**

Patients who notice any of the following signs or symptoms should call their doctor:

- fever of 100.5°F (38°C) or higher
- severe pain in the area of the incision
- intense redness in the area of the incision
- bruising
- bleeding or increased drainage of tissue fluid

#### **Resources**

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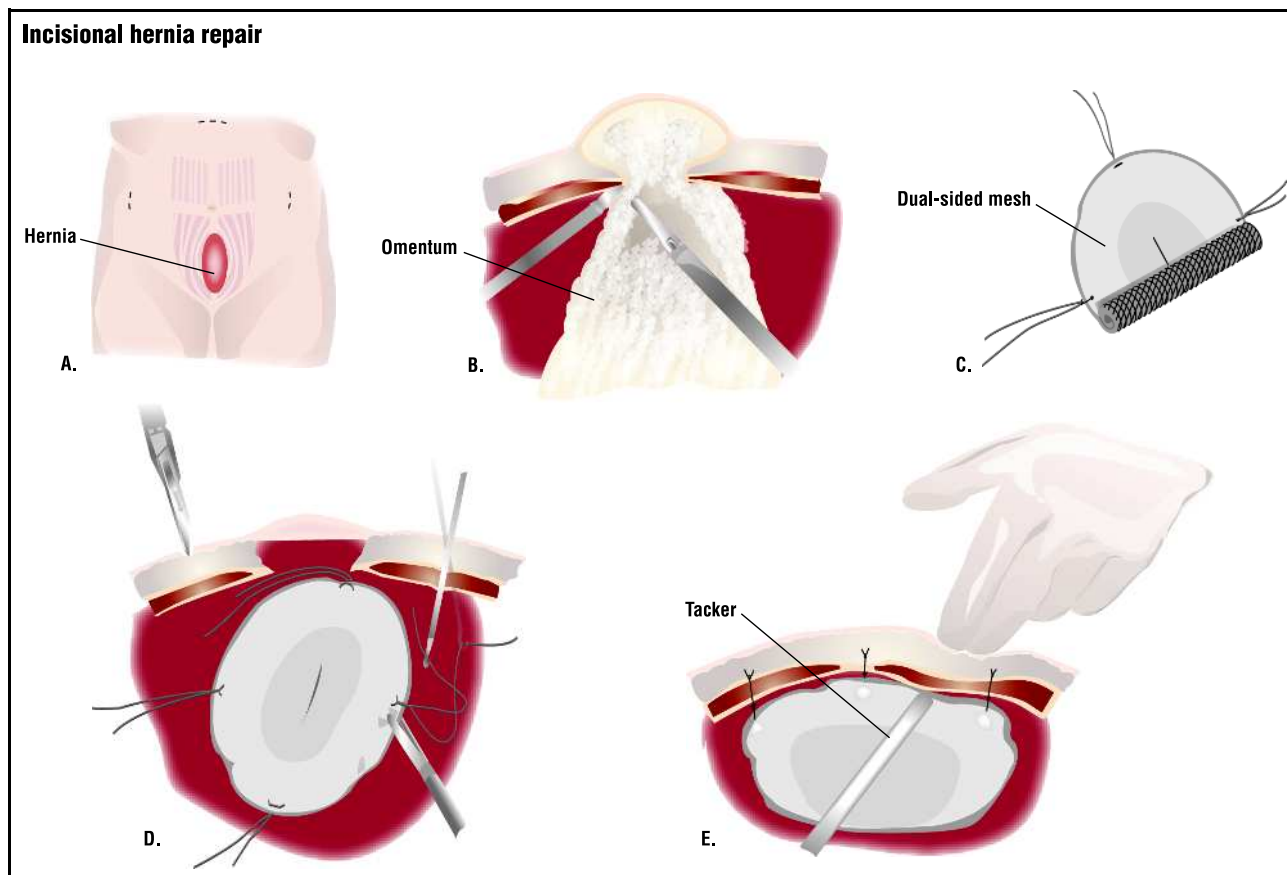
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## **Incisional hernia repair**

### **Definition**

Incisional hernia repair is a surgical procedure performed to correct an incisional hernia. An incisional hernia, also called a **ventral hernia**, is a bulge or



An incisional hernia occurs at the site of a previous incision (A). Intestinal contents break through the abdominal wall and bubble up under the skin. In a laparoscopic repair, the surgeon uses laparoscopic forceps to pull the material, omentum, from the hernia site (B). A mesh pad is inserted into the site to line the hernia site (C and D), and is tacked into place (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

protrusion that occurs near or directly along a prior abdominal surgical incision. The surgical repair procedure is also known as incisional or ventral herniorrhaphy.

### Purpose

Incisional hernia repair is performed to correct a weakened area that has developed in the scarred muscle tissue around a prior abdominal surgical incision, occurring as a result of tension (pulling in opposite directions) created when the incision was closed with sutures, or by any other condition that increases abdominal pressure or interferes with proper healing.

### Demographics

Because incisional hernias can occur at the site of any type of abdominal surgery previously performed on a wide range of individuals, there is no outstanding profile of an individual most likely to have an

incisional hernia. Men, women, and children of all ages and ethnic backgrounds may develop an incisional hernia after abdominal surgery. Incisional hernia occurs more commonly among adults than among children.

### Description

An incisional hernia can develop in the scar tissue around any surgery performed in the abdominal area, from the breastbone down to the groin. Depending upon the location of the hernia, internal organs may press through the weakened abdominal wall. The rate of incisional hernia occurrence can be as high as 13% with some abdominal surgeries. These hernias may occur after large surgeries such as intestinal or vascular (heart, arteries, and veins) surgery, or after smaller surgeries such as an **appendectomy** or a **laparoscopy**, which typically requires a small incision at the navel. Incisional hernias themselves can be very small or large and

## KEY TERMS

**Autogenous tissue**—Tissue or skin taken from any part of a person's body to graft onto another part of the body that needs repairing; laid on as a patch.

**Herniorrhaphy**—The surgical repair of any type of hernia.

**Incarcerated intestine**—Intestines trapped in the weakened area of the hernia that cannot slip back into the abdominal cavity.

**Incisional hernia**—Hernia occurring at the site of a prior surgery.

**Inguinal hernia**—A weak spot in the lower abdominal muscles of the groin through which body organs, usually the large intestines, can push through as a result of abdominal pressure.

**Laparoscopy**—The use of a camera-tipped viewing tube called a laparoscope to perform minimally invasive surgery while viewing the procedure on a video screen.

**Strangulated hernia**—A twisted piece of herniated intestine that can block blood flow to the intestines.

complex, involving growth along the scar tissue of a large incision. They may develop months after the surgery or years after, usually because of inadequate healing or excessive pressure on an abdominal wall scar. The factors that increase the risk of incisional hernia are conditions that increase strain on the abdominal wall, such as obesity, advanced age, malnutrition, poor metabolism (digestion and assimilation of essential nutrients), pregnancy, dialysis, excess fluid retention, and either infection or hematoma (bleeding under the skin) after a prior surgery.

Tension created when sutures are used to close a surgical wound may also be responsible for developing an incisional hernia. Tension is known to influence poor healing conditions because of related swelling and wound separation. Tension and abdominal pressure are greater in people who are overweight, creating greater risk of developing incisional hernias following any abdominal surgery, including surgery for a prior inguinal (groin) hernia. People who have been treated with steroids or chemotherapy are also at greater risk for developing incisional hernias because of the affect these drugs have on the healing process.

The first symptom a person may have with an incisional hernia is pain, with or without a bulge in the abdomen at or near the site of the original surgery.

Incisional hernias can increase in size and gradually produce more noticeable symptoms. Incisional hernias may or may not require surgical treatment.

The effectiveness of surgical repair of an incisional hernia depends in part on reducing or eliminating tension at the surgical wound. The tension-free method used by many medical centers and preferred by surgeons who specialize in hernia repair involves the permanent placement of surgical (prosthetic) steel or polypropylene mesh patches well beyond the edges of the weakened area of the abdominal wall. The mesh is sewn to the area, bridging the hole or weakened area beneath it. As the area heals, the mesh becomes firmly integrated into the inner abdominal wall membrane (peritoneum) that protects the organs of the abdomen. This method creates little or no tension and has a lower rate of hernia recurrence, as well as a faster recovery with less pain. Incisional hernias recur more frequently when **staples** are used rather than sutures to secure mesh to the abdominal wall. Autogenous tissue (skin from the patient's own body) has also been used for this type of repair.

Two surgical approaches are used to treat incisional hernias: either a laparoscopic incisional herniorrhaphy, which uses small incisions and a tube-like instrument with a camera attached to its tip; or a conventional open repair procedure, which accesses the hernia through a larger abdominal incision. Open procedures are necessary if the intestines have become trapped in the hernia (incarceration) or the trapped intestine has become twisted and its blood supply cut off (strangulation). Extremely obese patients may also require an open procedure because deeper layers of fatty tissue will have to be removed from the abdominal wall. Mesh may be used with both types of surgical access.

Minimally invasive laparoscopic surgery has been shown to have advantages over conventional open procedures, including:

- reduced hospital stays
- reduced postoperative pain
- reduced wound complications
- reduced recovery time

### *Surgical procedure*

In both open and laparoscopic procedures, the patient lies on the operating table, either flat on the back or on the side, depending on the location of the hernia. **General anesthesia** is usually given, though some patients may have local or regional anesthesia, depending on the location of the hernia and complexity of the repair. A catheter may be inserted into the

bladder to remove urine and decompress the bladder. If the hernia is near the stomach, a gastric (nose or mouth to stomach) tube may be inserted to decompress the stomach.

In an open procedure, an incision is made just large enough to remove fat and scar tissue from the abdominal wall near the hernia. The outside edges of the weakened hernial area are defined and excess tissue removed from within the area. Mesh is then applied so that it overlaps the weakened area by several inches (centimeters) in all directions. Non-absorbable sutures (the kind that must be removed by the doctor) are placed into the full thickness of the abdominal wall. The sutures are tied down and knotted.

In the less-invasive laparoscopic procedure, two or three small incisions will be made to access the hernia site—the laparoscope is inserted in one incision and **surgical instruments** in the others to remove tissue and place the mesh in the same fashion as in an open procedure. Significantly less abdominal wall tissue is removed in laparoscopic repair. The surgeon views the entire procedure on a video monitor to guide the placement and suturing of mesh.

## Diagnosis/Preparation

### Diagnosis

Reviewing the patient's symptoms and medical history are the first steps in diagnosing an incisional hernia. All prior surgeries will be discussed. The doctor will ask how much pain the patient is experiencing, when it was first noticed, and how it has progressed. The doctor will palpate (touch) the area, looking for any abnormal bulging or mass, and may ask the patient to cough or strain in order to see and feel the hernia more easily. To confirm the presence of the hernia, an **ultrasound** examination or other scan such as computed tomography (CT) may be performed. Scans will allow the doctor to visualize the hernia and to make sure that the bulge is not another type of abdominal mass such as a tumor or enlarged lymph gland. The doctor will be able to determine the size of the defect and whether or not surgery is an appropriate way to treat it. A referral to a surgeon will be made if the doctor believes that medical treatment will not effectively correct the incisional hernia.

### Preparation

Many months before the surgery, the patient's doctor may advise weight loss to help reduce the risks of surgery and to improve the surgical results. Control of diabetes and **smoking cessation** are also recommended for a better surgical result. Close to the time

of the scheduled surgery, the patient will have standard preoperative blood and urine tests, an **electrocardiogram**, and a **chest x ray** to make sure that heart and lungs and major organ systems are functioning well. A week or so before surgery, medications may be discontinued, especially **aspirin** or anticoagulant (blood-thinning) drugs. Starting the night before surgery, patients must not eat or drink anything. Once in the hospital, a tube may be placed into a vein in the arm (intravenous line) to deliver fluid and medication during surgery. The patient will be given a preoperative injection of **antibiotics** before the procedure. A sedative may be given to relax the patient.

## Aftercare

Immediately after surgery, the patient will be observed in a recovery area for several hours, for monitoring of **body temperature**, pulse, blood pressure, and heart function, as well as observation of the surgical wound for undue bleeding or swelling. Patients will usually be discharged on the day of the surgery; only more complex hernias such as those with incarcerated or strangulated intestines will require overnight hospitalization. Some patients may have prolonged suture-site pain, which may be treated with pain medication or anti-inflammatory drugs. Antibiotics may be prescribed to help prevent postoperative infection.

Once the patient is home, the hernia repair site must be kept clean, and any sign of swelling or redness reported to the surgeon. Patients should also report a fever or any abdominal pain. Outer sutures may have to be removed by the surgeon in a follow-up visit about a week after surgery. Activities may be limited to non-strenuous movement for up to two weeks, depending on the type of surgery performed. To allow proper healing of muscle tissue, hernia repair patients should avoid heavy lifting for at least six to eight weeks after surgery, or longer as advised.

## Risks

Long-term complications seldom occur after incisional hernia repair. Short-term risks are greater with obese patients or those who have had multiple earlier operations or the prior placement of mesh patches. The risk of complications has been shown to be about 13%. The risk of recurrence and repeat surgery is as high as 52%, particularly with open procedures or those using staples rather than sutures for wound closure. Some of the factors that cause incisional hernias to occur in the first place, such as obesity and nutritional disorders, will persist in certain patients and encourage the development of a second incisional hernia and repeat



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Incisional hernia repair is performed in a hospital operating room or a one-day surgical center by a general surgeon who may specialize in hernia repair procedures.

surgery. Each subsequent time, the surgery will become more difficult and the risk of complications greater. Postoperative infection is higher with open procedures than with laparoscopic procedures.

Postoperative complications may include:

- fluid buildup at the site of mesh placement, sometimes requiring aspiration (draining off)
- postoperative bleeding, though seldom enough to require repeat surgery
- prolonged suture pain, treated with pain medication or anti-inflammatory drugs
- intestinal injury
- nerve injury
- fever, usually related to surgical wound infection
- intra-abdominal (within the abdominal wall) abscess
- urinary retention
- respiratory distress

### Normal results

Good outcomes are expected with incisional hernia repair, particularly with the laparoscopic method. Patients will usually go home the day of surgery and can expect a one- to two-week recovery period at home, and then a return to normal activities. The American College of Surgeons reports that recurrence rates after the first repair of an incisional hernia range from 25–52%. Recurrence is more frequent when conventional surgical wound closure with standard sutures (**stitches**) is used. Recurrence after open procedures has been shown to be less likely when mesh is used, although complications, especially infection, have been shown to increase because of the larger abdominal incisions. Laparoscopy with mesh has shown rates of recurrence as low as 3.4%, with fewer complications as well.

### Morbidity and mortality rates

Deaths are not reported resulting directly from the performance of herniorrhaphy for incisional hernia.

## QUESTIONS TO ASK THE DOCTOR

- What procedure will be performed to correct my hernia?
- What is your experience with this procedure? How often do you perform this procedure?
- Why must I have the surgery?
- What are my options if I do not have the surgery?
- How can I expect to feel after surgery?
- What are the risks involved in having this surgery?
- How quickly will I recover? When can I return to school or work?
- What are my chances of having this type of hernia again?
- What can I do to avoid getting this type of hernia again?

### Alternatives

The alternatives to first-time and recurrent incisional hernia repair begin with preventive measures such as:

- Losing weight; maintaining suitable weight for age and height.
- Strengthening abdominal muscles through regular moderate exercise such as walking, tai chi, yoga, or stretching exercises and gentle aerobics.
- Reducing abdominal pressure by avoiding constipation and the buildup of excess body fluids, achieved by adopting a high-fiber, low-salt diet.
- Learning to lift heavy objects in a safe, low-strain way using arm and leg muscles.
- Controlling diabetes and poor metabolism with regular medical care and dietary changes as recommended.
- Eating a healthy, balanced diet of whole foods, high in essential nutrients, including whole grains, fruits and vegetables, limited meat and dairy, and eliminating prepared and refined foods.

### Resources

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American College of Surgeons (ACS), Office of Public Information. 633 North Saint Clair Street, Chicago, IL 60611 3211. (312) 202 5000. <http://www.facs.org>.

The National Digestive Diseases Information Clearinghouse (NIDDK). 2 Information Way, Bethesda, MD 20892 3570. <http://www.niddk.nih.gov/health/digest/niddic.htm>.

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*Incisional and Ventral Hernias (Patient Information)*. Central Montgomery Medical Center, Outpatient Surgery Department. 2100 N. Broad Street, Lansdale, PA 19446. (215) 368 1122.

L. Lee Culvert

Inflatable sphincter see **Artificial sphincter insertion**

## Informed consent

### Definition

Informed consent is a legal document in all 50 states. It is an agreement for a proposed medical treatment or non-treatment, or for a proposed invasive procedure. It requires physicians to disclose the benefits, risks, and alternatives to the proposed treatment, non-treatment, or procedure. It is the method by which fully informed, rational persons may be involved in choices about their health care.

### Description

Informed consent stems from the legal and ethical right an individual has to decide what is done to his or her body, and from the physician’s ethical duty to make sure that individuals are involved in decisions about their own health care. The process of securing informed consent has three phases, all of which involve information exchange between doctor and patient and are part of patient education. First, in words an individual can understand, the physician must convey the details of a planned procedure or treatment, its potential benefits and serious risks, and any feasible alternatives. The patient should be presented with information on the most likely outcomes of the treatment. Second, the physician must evaluate whether or not the person has understood what has been said, must ascertain that the risks have been accepted, and that the patient is giving consent to proceed with the procedure or treatment with full knowledge and forethought. Finally, the individual must sign the consent form, which documents in generic format the major points of consideration. The

## KEY TERMS

**Consent**—Permission or agreement.

**Informed**—From full knowledge; not coerced.

only exception to this is securing informed consent during extreme emergencies.

It is critical that a patient receive enough information on which to base informed consent, and that the consent is wholly voluntary and has not been forced in any way. It is the responsibility of the physician who discusses the particulars with the patient to detail the conversation in the medical record. A physician may, at his or her discretion, appoint another member of the health care team to obtain the patient’s signature on the consent form, with the assurance that the physician has satisfied the requirements of informed consent.

The law requires that a reasonable physician/patient standard be applied when determining how much information is considered adequate when discussing a procedure or treatment with the patient. There are three approaches to making this discussion: what the typical physician would say about the intervention (the reasonable physician standard); what an average patient would need to know to be an informed participant in the decision (the reasonable patient standard); and what a patient would need to know and understand to make a decision that is informed (the subjective standard).

There is a theory that the practice of acquiring informed consent is rooted in the post–World War II Nuremberg Trials. At the war crimes tribunal in 1949, 10 standards were put forth regarding physicians’ requirements for experimentation on human subjects. This established a new standard of ethical medical behavior for the post–WW II human rights age, and the concept of voluntary informed consent was established. A number of rules accompanied voluntary informed consent. It could only be requested for experimentation for the gain of society, for the potential acquisition of knowledge of the pathology of disease, and for studies performed that avoided physical and mental suffering to the fullest extent possible.

Today, all of the 50 United States have legislation that delineates the required standards for informed consent. For example, the State of Washington employs the second approach outlined as the reasonable patient standard (what an average patient would need to know to be an informed participant in the decision). This approach ensures that a doctor fulfills all professional

responsibilities and provides the best care possible and that patients have choices in decisions about their health care. However, the patient's competence in making a decision is considered. This points to the issue of the patient's mental capacity. Anyone suffering from an illness, anticipating surgery, or undergoing treatment for a disease is under a great deal of stress and anxiety. It may be natural for a patient to be confused or indecisive. When the attending physician has serious doubts about the patient's understanding of the intervention and its risks, the patient may be referred for a psychiatric consultation. This is strictly a precaution to ensure that the patient understands what has been explained; declining to be treated or operated on does not necessarily mean the person is incompetent. It could mean that the person is exercising the right to make his or her own health care decisions.

Although the law requires a formal presentation of the procedure or treatment to the patient, physicians do express doubt as to the wisdom of this. Some believe that informing patients of the risks of treatment might scare them into refusing it, even when the risks of non-treatment are even greater. But patients might have a different view. Without the complete story, for example, a patient might consent to beginning a particular course of chemotherapy. Convinced by the pressures from a pharmaceutical company, it is conceivable that a doctor will use an agent less effective than a newer treatment. By withholding information about treatment alternatives, the physician may be denying the patient a choice and, worse, perhaps a chance of an extended life of greater quality.

Undeniably, physicians in surgery, anesthesia, oncology, infectious disease, and other specialties are faced with issues regarding informed consent. As the federal government takes a more active role in deciding the extent to which patients must be informed of treatments, procedures, and clinical trials in which they voluntarily become enrolled, more and more health care providers must become educated in what must be conveyed to patients. This is emphasized by the report of a case in which a federal court (*Hutchinson v. United States* [91 F2d 560 (9th Cir. 1990)]) ruled in favor of the physician, despite his failure to advise his asthmatic patient, for whom he had prescribed the steroid, prednisone, of the drug's well-known risk of developing aseptic necrosis (bone death), which did occur. The practitioner neglected to inform the patient that there were other drugs available with much less serious side effects that could have treated the asthma. However, a higher appellate court reversed the ruling and found the physician guilty. Apparently, the patient had used more conservative drugs in the past with good results. The court believed that if the

physician had merely advised the patient of the more serious side effects of prednisone and offered the patient more conservative treatment, the physician would have avoided liability.

Nursing professionals have a greater role than they might believe in evaluating whether or not consent is informed. When a nurse witnesses the signature of a patient for a procedure, or surgery, he or she is not responsible for providing the details. Rather, the role is to be the patient's advocate, to protect the patient's dignity, to identify any fears, and to determine the patient's degree of comprehension and approval of care to be received. Each patient is an individual, and each one will have a different and unique response depending on his or her personality, level of education, emotions, and cognitive status. If a patient can restate the information that has been imparted, then that will help to confirm that he or she has received enough information and has understood it. The nurse is obligated to report any doubts about the patient's understanding regarding what has been said or any concerns about his or her capacity to make decisions.

## Results

The result of informed consent is greater safety and protection for patients, physicians, and society.

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## ORGANIZATIONS

American Academy of Family Physicians. 11400 Tomahawk Creek Parkway, Leawood, KS 66211 2672. (913) 906 6000. E mail: fp@aafp.org. <http://www.aafp.org>.

American Bar Association. 321 N Clark St., Chicago, IL 60610. 800 285 2221. <http://www.abanet.org/home.html>.

American College of Physicians. 190 N Independence Mall West, Philadelphia, PA 19106 1572. (800) 523 1546, x2600, or (215) 351 2600. <http://www.acponline.org>.

American Medical Association. 515 N. State Street, Chicago, IL 60610. 312 464 5000. <http://www.ama-assn.org>.

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L. Fleming Fallon, Jr, MD, DrPH

# Inguinal hernia repair

## Definition

Inguinal hernia repair, also known as herniorrhaphy, is the surgical correction of an inguinal hernia. An inguinal hernia is an opening, weakness, or bulge in the lining tissue (peritoneum) of the abdominal wall in the groin area between the abdomen and the thigh. The surgery may be a standard open procedure through an incision large enough to access the hernia or a laparoscopic procedure performed through tiny

incisions, using an instrument with a camera attached (laparoscope) and a video monitor to guide the repair. When the surgery involves reinforcing the weakened area with steel mesh, the repair is called hernioplasty.

## Purpose

Inguinal hernia repair is performed to close or mend the weakened abdominal wall of an inguinal hernia.

## Demographics

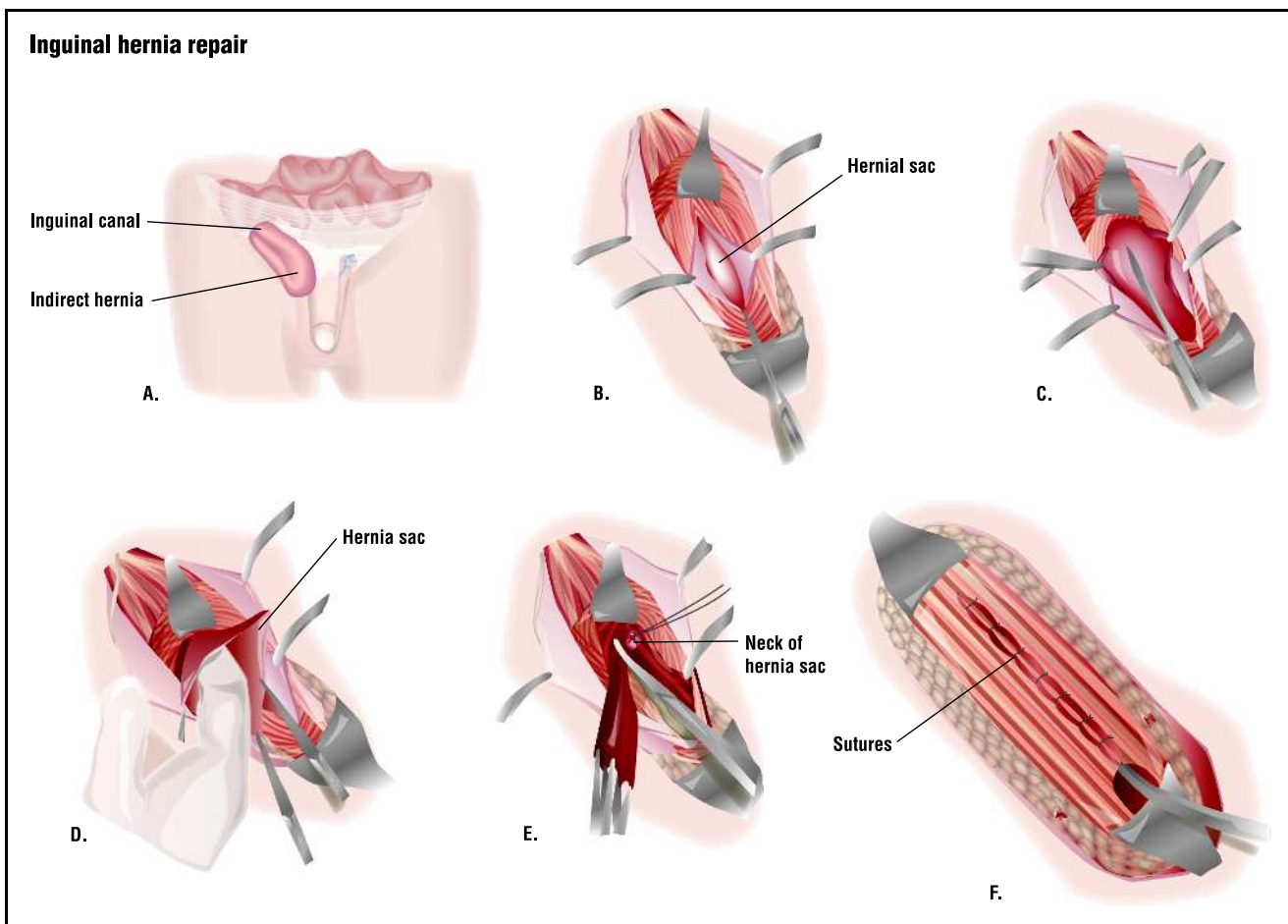
The majority of hernias occur in males. Nearly 25% of men and only 2% of women in the United States will develop inguinal hernias. Inguinal hernias occur nearly three times more often in African American adults than in Caucasians. Among children, the risk of groin hernia is greater in premature infants or those of low birth weight. Indirect inguinal hernias will occur in 10–20 children in every 1,000 live births.

## Description

About 75% of all hernias are classified as inguinal hernias, which are the most common type of hernia occurring in men and women as a result of the activities of normal living and aging. Because humans stand upright, there is a greater downward force on the lower abdomen, increasing pressure on the less muscled and naturally weaker tissues of the groin area. Inguinal hernias do not include those caused by a cut (incision) in the abdominal wall (incisional hernia). According to the National Center for Health Statistics, about 700,000 inguinal hernias are repaired annually in the United States. The inguinal hernia is usually seen or felt first as a tender and sometimes painful lump in the upper groin where the inguinal canal passes through the abdominal wall. The inguinal canal is the normal route by which testes descend into the scrotum in the male fetus, which is one reason these hernias occur more frequently in men.

Hernias are divided into two categories: congenital (from birth), also called indirect hernias, and acquired, also called direct hernias. Among the 75% of hernias classified as inguinal hernias, 50% are indirect or congenital hernias, occurring when the inguinal canal entrance fails to close normally before birth. The indirect inguinal hernia pushes down from the abdomen and through the inguinal canal. This condition is found in 2% of all adult males and in 1–2% of male children. Indirect inguinal hernias can occur in women, too, when abdominal pressure pushes folds of genital





**This patient has an indirect inguinal hernia (A). To repair it, the surgeon makes an incision over the area and separates the muscle and tissues to expose the hernia sac (B). The sac is cut open (C), and the contents are replaced into the abdomen (D). The neck of the hernia sac is tied off (E), and the muscles and tissues are sutured (F). (Illustration by GGS Information Services. Cengage Learning, Gale.)**

tissue into the inguinal canal opening. In fact, women will more likely have an indirect inguinal hernia than direct. Direct or acquired inguinal hernias occur when part of the large intestine protrudes through a weakened area of muscles in the groin. The weakening results from a variety of factors encountered in the wear and tear of life.

Inguinal hernias may occur on one side of the groin or both sides at the same or different times, but occur most often on the right side. About 60% of hernias found in children, for example, will be on the right side, about 30% on the left, and 10% on both sides. The muscular weak spots develop because of pressure on the abdominal muscles in the groin area occurring during normal activities such as lifting, coughing, straining during urination or bowel movements, pregnancy, or excessive weight gain. Internal organs such as the

intestines may then push through this weak spot, causing a bulge of tissue. A congenital indirect inguinal hernia may be diagnosed in infancy, childhood, or later in adulthood, influenced by the same causes as direct hernia. There is evidence that a tendency for inguinal hernia may be inherited.

A direct and an indirect inguinal hernia may occur at the same time; this combined hernia is called a pantaloon hernia.

A femoral hernia is another type of hernia that appears in the groin, occurring when abdominal organs and tissue press through the femoral ring (passageway where the major femoral artery and vein extend from the leg into the abdomen) into the upper thigh. About 3% of all hernias are femoral, and 84% of all femoral hernias occur in women. These are not inguinal hernias, but they can sometimes confuse the

## KEY TERMS

**Incarcerated hernia**—An inguinal hernia that is trapped in place and cannot slip back into the abdominal cavity, often causing intestinal obstruction.

**Incisional hernia**—Hernia occurring at the site of a prior surgery.

**Inguinal hernia**—A weak spot in the lower abdominal muscles of the groin through which body organs, usually the large intestines, can push through as a result of abdominal pressure.

**Ischemia**—The death of tissue that results from lack of blood flow and oxygen.

**Laparoscopy**—The use of a camera-tipped viewing tube called a laparoscope to perform minimally invasive surgery while viewing the procedure on a video screen.

**Strangulated hernia**—A twisted piece of herniated intestine that can block blood flow to the intestines.

diagnosis of inguinal hernias because they curve over the inguinal area. They are more often accompanied by intestinal obstruction than inguinal hernias.

Because inguinal hernias do not heal on their own and can become larger or twisted, which may close off the intestines, the prevailing medical opinion is that hernias must be treated surgically when they cause pain or limit activity. Protruding intestines can sometimes be pushed back temporarily into the abdominal cavity, or an external support (truss) may be worn to hold the area in place until surgery can be performed. Sometimes, other medical conditions complicate the presence of a hernia by adding constant abdominal pressure. These conditions, including chronic coughing, constipation, fluid retention, or urinary obstruction, must be treated simultaneously to reduce abdominal pressure and the recurrence of hernias after repair. A relationship between smoking and hernia development has also been shown. Groin hernias occur more frequently in smokers than nonsmokers, especially in women. A hernia may become incarcerated, which means that it is trapped in place and cannot slip back into the abdomen. This causes bowel obstruction, which may require the removal of affected parts of the intestines (**bowel resection**) as well as hernia repair. If the herniated intestine becomes twisted, blood supply to the intestines may be cut off (intestinal ischemia) and the hernia is said to be strangulated, a condition causing severe pain and requiring immediate surgery.

## Surgical procedures

In open inguinal hernia repair procedures, the patient is typically given a light **general anesthesia** of short duration. Local or regional anesthetics may be given to some patients. Open surgical repair of an indirect hernia begins with sterilizing and draping the inguinal area of the abdomen just above the thigh. An incision is made in the abdominal wall and fatty tissue removed to expose the inguinal canal and define the outer margins of the hole or weakness in the muscle. The weakened section of tissue is dissected (cut and removed) and the inguinal canal opening is sutured closed (primary closure), making sure that no abdominal organ tissue is within the sutured area. The exposed inguinal canal is examined for any other trouble spots that may need reinforcement. Closing the underlayers of tissue (subcutaneous tissue) with fine sutures and the outer skin with **staples** completes the procedure. A sterile dressing is then applied.

An open repair of a direct hernia begins just as the repair of an indirect hernia, with an incision made in the same location above the thigh, just large enough to allow visualization of the hernia. The surgeon will look for and palpate (touch) the bulging area of the hernia and will reduce it by placing sutures in the fat layer of the abdominal wall. The hernial sac itself will be closed, as in the repair of the indirect hernia, by using a series of sutures from one end of the weakened hernia defect to the other. The repair will be checked for sturdiness and for any tension on the new sutures. The subcutaneous tissue and skin will be closed and a sterile dressing applied.

Laparoscopic procedures are conducted using general anesthesia. The surgeon will make three tiny incisions in the abdominal wall of the groin area and inflate the abdomen with carbon dioxide to expand the surgical area. A laparoscope, which is a tube-like fiberoptic instrument with a small video camera attached to its tip, will be inserted in one incision and **surgical instruments** inserted in the other incisions. The surgeon will view the movement of the instruments on a video monitor, as the hernia is pushed back into place and the hernial sac is repaired with surgical sutures or staples. Laparoscopic surgery is believed to produce less postoperative pain and a quicker recovery time. The risk of infection is also reduced because of the small incisions required in laparoscopic surgery.

The use of surgical (prosthetic) steel mesh or polypropylene mesh in the repair of inguinal hernias has been shown to help prevent recurrent hernias. Instead of the tension that develops between sutures and the skin in a conventionally repaired area, hernioplasty

using mesh patches has been shown to virtually eliminate tension. The procedure is often performed in an outpatient facility with **local anesthesia** and patients can walk away the same day, with little restrictions in activity. Tension-free repair is also quick and easy to perform using the laparoscopic method, although general anesthesia is usually used. In either open or laparoscopic procedures, the mesh is placed so that it overlaps the healthy skin around the hernia opening and then is sutured into place with fine silk. Rather than pulling the hole closed as in conventional repair, the mesh makes a bridge over the hole and as normal healing takes place, the mesh is incorporated into normal tissue without resulting tension.

## Diagnosis/Preparation

### Diagnosis

Reviewing the patient's symptoms and medical history are the first steps in diagnosing a hernia. The surgeon will ask when the patient first noticed a lump or bulge in the groin area, whether or not it has grown larger, and how much pain the patient is experiencing. The doctor will palpate the area, looking for any abnormal bulging or mass, and may ask the patient to cough or strain in order to see and feel the hernia more easily. This may be all that is needed to diagnose an inguinal hernia. To confirm the presence of the hernia, an **ultrasound** examination may be performed. The ultrasound scan will allow the doctor to visualize the hernia and to make sure that the bulge is not another type of abdominal mass such as a tumor or enlarged lymph gland. It is not usually possible to determine whether the hernia is direct or indirect until surgery is performed.

### Preparation

Patients will have standard preoperative blood and urine tests, an **electrocardiogram**, and a **chest x ray** to make sure that the heart, lungs, and major organ systems are functioning well. A week or so before surgery, medications may be discontinued, especially **aspirin** or anticoagulant (blood-thinning) drugs. Starting the night before surgery, patients must not eat or drink anything. Once in the hospital, a tube may be placed into a vein in the arm (intravenous line) to deliver fluid and medication during surgery. A sedative may be given to relax the patient.

### Aftercare

The hernia repair site must be kept clean and any sign of swelling or redness reported to the surgeon. Patients should also report a fever, and men should

report any pain or swelling of the testicles. The surgeon may remove the outer sutures in a follow-up visit about a week after surgery. Activities may be limited to non-strenuous movement for up to two weeks, depending on the type of surgery performed and whether or not the surgery is the first hernia repair. To allow proper healing of muscle tissue, hernia repair patients should avoid heavy lifting for six to eight weeks after surgery. The postoperative activities of patients undergoing repeat procedures may be even more restricted.

Prevention of indirect hernias, which are congenital, is not possible. However, preventing direct hernias and reducing the risk of recurrence of direct and indirect hernias can be accomplished by:

- Maintaining body weight suitable for age and height.
- Strengthening abdominal muscles through regular exercise.
- Reducing abdominal pressure by avoiding constipation and the build-up of excess body fluids, achieved by adopting a high-fiber, low-salt diet.
- Lifting heavy objects in a safe, low-stress way, using arm and leg muscles.

## Risks

Hernia surgery is considered to be a relatively safe procedure, although complication rates range from 1–26%, most in the 7–12% range. This means that about 10% of the 700,000 inguinal hernia repairs each year will have complications. Certain specialized clinics report markedly fewer complications, often related to whether open or laparoscopic technique is used. One of the greatest risks of inguinal hernia repair is that the hernia will recur. Unfortunately, 10–15% of hernias may develop again at the same site in adults, representing about 100,000 recurrences annually. The risk of recurrence in children is only about 1%. Recurrent hernias can present a serious problem because incarceration and strangulation are more likely and because additional surgical repair is more difficult than the first surgery. When the first hernia repair breaks down, the surgeon must work around scar tissue as well as the recurrent hernia. Incisional hernias, which are hernias that occur at the site of a prior surgery, present the same circumstance of combined scar tissue and hernia and even greater risk of recurrence. Each time a repair is performed, the surgery is less likely to be successful. Recurrence and infection rates for mesh repairs have been shown in some studies to be lower than with conventional surgeries.

Complications that can occur during surgery include injury to the spermatic cord structure; injuries

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Inguinal hernia repair is performed in a hospital operating room or one-day surgical facility by a general surgeon who may specialize in hernia surgery.

to veins or arteries, causing hemorrhage; severing or entrapping nerves, which can cause paralysis; injuries to the bladder or bowel; reactions to anesthesia; and systemic complications such as cardiac arrhythmias, cardiac arrest, or **death**. Postoperative complications include infection of the surgical incision (less in **laparoscopy**); the formation of blood clots at the site that can travel to other parts of the body; pulmonary (lung) problems; and urinary retention or urinary tract infection.

### Normal results

Inguinal hernia repair is usually effective, depending on the size of the hernia, how much time has gone by between its first appearance and the corrective surgery, and the underlying condition of the patient. Most first-time hernia repair procedures will be one-day surgeries, in which the patient will go home the same day or in 24 hours. Only the most challenging cases will require an overnight stay. Recovery times will vary, depending on the type of surgery performed. Patients undergoing open surgery will experience little discomfort and will resume normal activities within one to two weeks. Laparoscopy patients will be able to enjoy normal activities within one or two days, returning to a normal work routine and lifestyle within four to seven days, with the exception of heavy lifting and contact sports.

### Morbidity and mortality rates

Mortality related to inguinal hernia repair or postoperative complications is unlikely, but with advanced age or severe underlying conditions, deaths do occur. Recurrence is a notable complication and is associated with increased morbidity, with recurrence rates for indirect hernias from less than 1–7% and 4–10% for direct.

### Alternatives

If a hernia is not surgically repaired, an incarcerated or strangulated hernia can result, sometimes involving life-threatening bowel obstruction or ischemia.

## QUESTIONS TO ASK THE DOCTOR

- What procedure will be performed to correct my hernia?
- What is your experience with this procedure? How often do you perform this procedure?
- Why must I have the surgery now rather than waiting?
- What are my options if I do not have the surgery?
- How can I expect to feel after surgery?
- What are the risks involved in having this surgery?
- How quickly will I recover? When can I return to school or work?
- What are my chances of having another hernia?

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Inner ear tube insertion see **Endolymphatic shunt**

## Intensive care unit

### Definition

An intensive care unit, or ICU, is a specialized section of a hospital that provides comprehensive and continuous care for persons who are critically ill and who can benefit from treatment.



## Purpose

The purpose of the intensive care unit (ICU) is simple even though the practice is complex. Health-care professionals who work in the ICU or rotate through it during their training provide around-the-clock intensive monitoring and treatment of patients seven days a week. Patients are generally admitted to an ICU if they are likely to benefit from the level of care provided. Intensive care has been shown to benefit patients who are severely ill and medically unstable—that is, they have a potentially life-threatening disease or disorder.

Although the criteria for admission to an ICU are somewhat controversial—excluding patients who are either too well or too sick to benefit from intensive care—there are four recommended priorities that intensivists (specialists in critical care medicine) use to decide this question. These priorities include:

- critically ill patients in a medically unstable state who require an intensive level of care (monitoring and treatment)
- patients requiring intensive monitoring who may also require emergency interventions
- patients who are medically unstable or critically ill and who do not have much chance for recovery due to the severity of their illness or traumatic injury
- patients who are generally not eligible for ICU admission because they are not expected to survive (Patients in this fourth category require the approval of the director of the ICU program before admission.)

ICU care requires a multidisciplinary team that consists of but is not limited to intensivists (clinicians who specialize in critical illness care); pharmacists and nurses; respiratory care therapists; and other medical consultants from a broad range of specialties including surgery, pediatrics, and anesthesiology. The ideal ICU will have a team representing as many as 31 different health care professionals and practitioners who assist in patient evaluation and treatment. The intensivist will provide treatment management, diagnosis, interventions, and individualized care for each patient recovering from severe illness.

## Demographics

A large and comprehensive study conducted in 1992 by the Society of Critical Care Medicine in collaboration with the American Hospital Association found that approximately 8% of all licensed hospital beds in the United States were designated for intensive care. The average size of an adult or pediatric ICU averaged 10–12 beds per unit. Small hospitals with

## KEY TERMS

**Critical care**—Care given to a severely ill person who requires continuous medical monitoring and may require urgent treatment.

**Intensivist**—A physician who specializes in caring for patients in intensive care units.

fewer than 100 beds usually had one ICU, whereas larger hospitals with more than 300 beds usually had several ICUs designated for medical, surgical, and coronary patients. Smaller hospitals do not usually have a full-time board-certified specialist in critical care medicine, whereas larger medical centers generally employ certified intensivists—60% of hospitals with more than 500 beds had full-time specialist directors at the time the survey was conducted.

In a 2006 report, the Society of Critical Care Medicine noted that there are approximately 6,000 ICUs in the United States, caring for 55,000 critically ill patients each day. Statistics reveal that more than 5 million patients are admitted annually to these ICU departments. Most often patients presenting to the ICU have high acuity diagnoses such as respiratory insufficiency, sepsis, and heart failure, necessitating treatment from skilled clinicians and the need for expert care. Since 1991 treatment of patients presenting with serious conditions has become more frequent due in part, to a rise in the U.S. population of individuals aged 65 and older. In fact, in 2004, the number of patients age 85 and older, rose from 4.1% in 1991 to 6.9%.

With regard to the nursing staff in ICUs, the proportion of nurses with specialized and advanced training in critical care medicine is higher in larger medical centers—about 16% in hospitals with 100 beds or fewer, but 21% in hospitals with more than 500 beds.

Most pediatric ICUs have four to six beds per unit. The mortality rate in pediatric ICUs tends to increase in proportion to size, with larger units reporting more deaths (approximately 8% in the larger units). Eighty percent of pediatric ICUs have full-time medical directors.

## Description

ICUs are highly regulated departments, typically limiting the number of visitors to the patient's immediate family even during visiting hours. The patient usually has several monitors attached to various parts of his or her body for real-time evaluation of medical stability. The intensivist will make periodic assessments

of the patient's cardiac status, breathing rate, urinary output, and blood levels for nutritional and hormonal problems that may arise and require urgent attention or treatment. Patients who are admitted to the ICU for observation after surgery may have special requirements for monitoring. These patients may have catheters placed to detect hemodynamic (blood pressure) changes, or require **endotracheal intubation** to help their breathing, with the breathing tube connected to a mechanical ventilator.

In addition to the intensivist's role in direct patient care, he or she is usually the lead physician when multiple consultants are involved in an intensive care program. The intensivist coordinates the care provided by the consultants, which allows for an integrated treatment approach to the patient.

Nursing care has an important role in an intensive care unit. The nurse's role usually includes clinical assessment, diagnosis, and an individualized plan of expected treatment outcomes for each patient (implementation of treatment and patient evaluation of results). The ICU pharmacist evaluates all drug therapy, including dosage, route of administration, and monitoring for signs of allergic reactions. In addition to checking and supervising all levels of medication administration, the ICU pharmacist is also responsible for enteral and parenteral nutrition (tube feeding) for patients who cannot eat on their own. ICUs also have respiratory care therapists with specialized training in cardiorespiratory (heart and lung) care for critically ill patients. Respiratory therapists generally provide medications to help patients breathe as well as the care and support of mechanical ventilators. Respiratory therapists also evaluate all respiratory therapy procedures to maximize efficiency and cost-effectiveness.

Large medical centers may have more than one ICU. These specialized intensive care units typically include a CCU (coronary care unit); a pediatric ICU (PICU, dedicated to the treatment of critically ill children); a newborn ICU or NICU, for the care of premature and critically ill infants; and a surgical ICU (SICU, dedicated to the treatment of postoperative patients).

## Preparation

Persons who are critically ill may be admitted to the ICU from the emergency room, a surgical ward, or from any other hospital department. ICUs are arranged around a central station so that patients can be seen either through the room windows or from a nursing station a few steps away. Patients are given 24-hour

assessments by the intensivist. Preparatory orders for the ICU generally vary from patient to patient since treatment is individualized. The initial workup should be coordinated by the attending ICU staff (intensivist and ICU nurse specialist), pharmacists (for medications and IV fluid therapy), and respiratory therapists for stabilization, improvement, or continuation of cardiopulmonary care. Well-coordinated care includes prompt consultation with other specialists soon after the patient is admitted to the ICU. The patient is connected to monitors that record his or her **vital signs** (pulse, blood pressure, and breathing rate). Orders for medications, laboratory tests, or other procedures are instituted upon arrival.

In general there are eight categories of diseases and disorders that are regarded as medical justification for admission to an ICU. These categories include disorders of the cardiac, nervous, pulmonary, and endocrine (hormonal) systems, together with postsurgical crises and **medication monitoring** for drug ingestion or overdose. Cardiac problems can include heart attacks (myocardial infarction), shock, cardiac arrhythmias (abnormal heart rhythm), heart failure (congestive heart failure or CHF), high blood pressure, and unstable angina (chest pain). Lung disorders can include acute respiratory failure, pulmonary emboli (blood clots in the lungs), hemoptysis (coughing up blood), and respiratory failure. Neurological disorders may include acute stroke (blood clot in the brain), coma, bleeding in the brain (intracranial hemorrhage), such infections as meningitis, and traumatic brain injury (TBI). Medication monitoring is essential, including careful attention to the possibility of seizures and other drug side effects.

When patients are transferred to the ICU from another hospital department, treatment orders and planning must be reviewed and new treatment plans written for the patient's current status. For example, a chronically ill inpatient may grow markedly worse within a few hours and may be transferred to the ICU, where the staff must reevaluate orders for his or her care.

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www.hospitalconnect.com

Joint Commission on Accreditation of Healthcare Organizations (JCAHO). One Renaissance Blvd., Oakbrook Terrace, IL 60181. (630) 792 5000 or (630) 792 5085.  
www.jcaho.org/.

Society of Critical Care Medicine (SCCM). 701 Lee Street, Suite 200, Des Plaines, IL 60016. (847) 827 6869; Fax: (847) 827 6869. www.sccm.org.

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## Intensive care unit equipment

### Definition

**Intensive care unit (ICU)** equipment includes patient monitoring, respiratory and cardiac support, **pain management**, emergency resuscitation devices, and other life support equipment designed to care for patients who are seriously injured, have a critical or life-threatening illness, or have undergone a major surgical procedure, thereby requiring 24-hour care and monitoring.

### Purpose

An ICU may be designed and equipped to provide care to patients with a range of conditions, or it may be designed and equipped to provide specialized care to patients with specific conditions. For example, a neuro-medical ICU cares for patients with acute conditions involving the nervous system or patients who have just had neurosurgical procedures and require equipment for monitoring and assessing the brain and spinal cord. A neonatal ICU is designed and equipped to care for infants who are ill, born prematurely, or have a condition requiring constant monitoring. A trauma/burn

ICU provides specialized injury and **wound care** for patients involved in auto accidents and patients who have gunshot injuries or burns.

### Description

Intensive care unit equipment includes patient monitoring, life support and emergency resuscitation devices, and diagnostic devices.

### Patient monitoring equipment

Patient monitoring equipment includes the following:

- **Acute care physiologic monitoring system**—Comprehensive patient monitoring systems that can be configured to continuously measure and display a number of parameters via electrodes and sensors that are connected to the patient. These may include the electrical activity of the heart via an EKG, respiration rate (breathing), blood pressure, body temperature, cardiac output, and amount of oxygen and carbon dioxide in the blood. Each patient bed in an ICU has a physiologic monitor that measure these body activities. All monitors are networked to a central nurses' station.
- **Pulse oximeter**—Monitors the arterial hemoglobin oxygen saturation (oxygen level) of the patient's blood with a sensor clipped over the finger or toe.
- **Intracranial pressure monitor**—Measures the pressure of fluid in the brain in patients with head trauma or other conditions affecting the brain (such as tumors, edema, or hemorrhage). These devices warn of elevated pressure and record or display pressure trends. Intracranial pressure monitoring may be a capability included in a physiologic monitor.
- **Apnea monitor**—Continuously monitors breathing via electrodes or sensors placed on the patient. An apnea monitor detects cessation of breathing in infants and adults at risk of respiratory failure, displays respiration parameters, and triggers an alarm if a certain amount of time passes without a patient's breath being detected. Apnea monitoring may be a capability included in a physiologic monitor.

### Life support and emergency resuscitative equipment

Intensive care equipment for life support and emergency resuscitation includes the following:

- **Ventilator (also called a respirator)**—Assists with or controls pulmonary ventilation in patients who cannot breathe on their own. Ventilators consist of a flexible breathing circuit, gas supply, heating/humidification mechanism, monitors, and alarms.

## KEY TERMS

**Apnea**—Cessation of breathing.

**Arterial line**—A catheter inserted into an artery and connected to a physiologic monitoring system to allow direct measurement of oxygen, carbon dioxide, and invasive blood pressure.

**Catheter**—A small, flexible tube used to deliver fluids or medications. A catheter may also be used to drain fluid or urine from the body.

**Central venous line**—A catheter inserted into a vein and connected to a physiologic monitoring system to directly measure venous blood pressure.

**Chest tube**—A tube inserted into the chest to drain fluid and air from around the lungs.

**Critical care**—The multidisciplinary health care specialty that provides care to patients with acute, life-threatening illness or injury.

**Edema**—An abnormal accumulation of fluids in intercellular spaces in the body; causes swelling.

**Endotracheal tube**—A tube inserted through the patient's nose or mouth that functions as an airway and is connected to the ventilator.

**Foley catheter**—A catheter inserted into the bladder to drain urine into a bag.

**Gastrointestinal tube**—A tube surgically inserted into the stomach for feeding a patient unable to eat by mouth.

**Heart monitor leads**—Sticky pads placed on the chest to monitor the electrical activity of the heart. The pads are connected to an electrocardiogram machine.

**Infectious disease team**—A team of physicians who help control the hospital environment to protect patients against harmful sources of infection.

**Life support**—Methods of replacing or supporting a failing bodily function, such as using mechanical ventilation to support breathing. In treatable or curable conditions, life support is used temporarily to aid healing, until the body can resume normal functioning.

**Nasogastric tube**—A tube inserted through the nose and throat and into the stomach for direct feeding of the patient.

**Sepsis**—The body's response to infection. Normally, the body's own defense system fights infection, but in severe sepsis, the body "overreacts," causing widespread inflammation and blood clotting in tiny vessels throughout the body.

**Swan-Ganz catheter**—Also called a pulmonary artery catheter. This type of catheter is inserted into a large vessel in the neck or chest and is used to measure the amount of fluid in the heart and to determine how well the heart is functioning.

**Tracheostomy tube**—A breathing tube inserted in the neck, used when assisted breathing is needed for a long period of time.

They are microprocessor-controlled and programmable, and regulate the volume, pressure, and flow of patient respiration. Ventilator monitors and alarms may interface with a central monitoring system or information system.

- **Infusion pump**—Device that delivers fluids intravenously or epidurally through a catheter. Infusion pumps employ automatic, programmable pumping mechanisms to deliver continuous anesthesia, drugs, and blood infusions to the patient. The pump is hung on an intravenous pole placed next to the patient's bed.
- **Crash cart**—Also called a resuscitation or code cart. This is a portable cart containing emergency resuscitation equipment for patients who are "coding." That is, their vital signs are in a dangerous range. The emergency equipment includes a defibrillator, airway intubation devices, a resuscitation bag/mask, and medication box. Crash carts are strategically located

in the ICU for immediate availability for when a patient experiences cardiorespiratory failure.

- **Intraaortic balloon pump**—A device that helps reduce the heart's workload and helps blood flow to the coronary arteries for patients with unstable angina, myocardial infarction (heart attack), or patients awaiting organ transplants. Intraaortic balloon pumps use a balloon placed in the patient's aorta. The balloon is on the end of a catheter that is connected to the pump's console, which displays heart rate, pressure, and electrocardiogram (ECG) readings. The patient's ECG is used to time the inflation and deflation of the balloon.

### *Diagnostic equipment*

The use of diagnostic equipment is also required in the ICU. Mobile x-ray units are used for bedside radiography, particularly of the chest. Mobile x-ray units use a battery-operated generator that powers an x-ray tube. Handheld, portable clinical laboratory



devices, or point-of-care analyzers, are used for blood analysis at the bedside. A small amount of whole blood is required, and blood chemistry parameters can be provided much faster than if samples were sent to the central laboratory.

### Other ICU equipment

Disposable ICU equipment includes urinary (Foley) catheters, catheters used for arterial and central venous lines, Swan-Ganz catheters, chest and endotracheal tubes, gastrointestinal and nasogastric feeding tubes, and monitoring electrodes. Some patients may be wearing a posey vest, also called a Houdini jacket for safety; the purpose is to keep the patient stationary. Spenco boots are padded support devices made of lamb's wool to position the feet and ankles of the patient. Support hose may also be placed on the patient's legs to support the leg muscles and aid circulation.

### Operation

The ICU is a demanding environment due to the critical condition of patients and the variety of equipment necessary to support and monitor patients. Therefore, when operating ICU equipment, staff should pay attention to the types of devices and the variations between different models of the same type of device so they do not make an error in operation or adjustment. Although many hospitals make an effort to standardize equipment—for example, using the same manufacturer's infusion pumps or patient monitoring systems, older devices and nonstandardized equipment may still be used, particularly when the ICU is busy. Clinical staff should be sure to check all devices and settings to ensure patient safety.

Intensive care unit patient monitoring systems are equipped with alarms that sound when the patient's **vital signs** deteriorate—for instance, when breathing stops, blood pressure is too high or too low, or when the heart rate is too fast or too slow. Usually, all patient monitors connect to a central nurses' station for easy supervision. Staff at the ICU should ensure that all alarms are functioning properly and that the central station is staffed at all times.

For reusable patient care equipment, clinical staff make certain to properly disinfect and sterilize devices that have contact with patients. Disposable items, such as catheters and needles, should be disposed of in a properly labeled container.

### Maintenance

Since ICU equipment is used continuously on critically ill patients, it is essential that equipment be

properly maintained, particularly devices that are used for life support and resuscitation. Staff in the ICU should perform daily checks on equipment and inform biomedical engineering staff when equipment needs maintenance, repair, or replacement. For mechanically complex devices, service and preventive maintenance contracts are available from the manufacturer or third-party servicing companies, and should be kept current at all times.

### Health care team roles

Equipment in the ICU is used by a team specialized in their use. The team usually comprises a critical care attending physician (also called an intensivist), critical care nurses, an infectious disease team, critical care respiratory therapists, pharmacologists, physical therapists, and dietitians. Physicians trained in other specialties, such as anesthesiology, cardiology, radiology, surgery, neurology, pediatrics, and orthopedics, may be consulted and called to the ICU to treat patients who require their expertise. Radiologic technologists perform mobile x ray examinations (bedside radiography). Either nurses or clinical laboratory personnel perform point-of-care blood analysis. Equipment in the ICU is maintained and repaired by hospital biomedical engineering staff and/or the equipment manufacturer.

Some studies have shown that patients in the ICU following high-risk surgery are at least three times as likely to survive when cared for by "intensivists," physicians trained in critical care medicine.

### Training

Manufacturers of more sophisticated ICU equipment, such as ventilators and patient monitoring devices, provide clinical training for all staff involved in ICU treatment when the device is purchased. All ICU staff must have undergone specialized training in the care of critically ill patients and must be trained to respond to life-threatening situations, since ICU patients are in critical condition and may experience respiratory or cardiac emergencies.

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National Association of Neonatal Nurses. 4700 West Lake Ave., Glenview, IL 60025-1485. (847) 375 3660 or (800) 451 3795. <http://www.nann.org>.

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National Institutes of Health, U.S. Department of Health and Human Services, 9000 Rockville Pike, Bethesda, MD 20892. (301) 496 4000. <http://www.nih.gov>.

Society of Critical Care Medicine. 701 Lee St., Suite 200, Des Plaines, IL 60016. (847) 827 6869. E mail: [info@sccm.org](mailto:info@sccm.org). <http://www.sccm.org>.

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Interpositional reconstruction see

**Arthroplasty**

Intestinal anastomosis see

**Ileoanal anastomosis**

## Intestinal obstruction repair

### Definition

An intestinal obstruction is a partial or complete blockage of the small or large intestine. Surgery is sometimes necessary to relieve the obstruction.

### Purpose

The small intestine is composed of three major sections: the duodenum just below the stomach; the jejunum, or middle portion; and the ileum, which empties into the large intestine. The large intestine is composed of the colon, where stool is formed; and the rectum, which empties to the outside of the body through the anal canal. A blockage that occurs in the small intestine is called a small bowel obstruction, and one that occurs in the colon is a colonic obstruction.

There are numerous conditions that may lead to an intestinal obstruction. The three most common causes of small bowel obstruction are adhesions, which are bands of scar tissue that form in the abdomen following injury or surgery; hernias, which develop when a portion of the intestine protrudes through a weak spot in the abdominal wall; and cancerous tumors. Adhesions account for approximately 50% to 75% of all small bowel obstructions, hernias for about 25%, and tumors for about 5% to 10%. Other causes include volvulus, or formation of kinks or knots in the bowel; the presence of foreign bodies in the digestive tract; intussusception, which occurs when a portion of the intestine telescopes or pulls over another portion; infection; and congenital defects. While most small bowel blockages can be treated with the administration of intravenous (IV) fluids and decompression of the bowel by the insertion of a nasogastric (NG) tube, surgical intervention can be avoided in approximately 65% to 81% of patients with a partial obstruction, while early operation is recommended for all patients with a complete obstruction.

An obstruction of the large intestine is less common than blockages of the small intestine. Blockages of the large bowel are usually caused by colon cancer; volvulus; **diverticulitis** (inflammation of sac-like structures called diverticula that form in the intestines); ischemic colitis (inflammation of the colon resulting from insufficient blood flow); Crohn's disease (a disease that causes chronic inflammation of the intestines); inflammation due to radiation therapy; and the presence of foreign bodies. As in the case of small bowel obstruction, most patients with a blockage of the large intestine can be treated with IV fluids and bowel decompression.

## KEY TERMS

**Adhesion**—A band of fibrous tissue forming an abnormal bond between two adjacent tissues or organs.

**Anastomosis (plural, anastomoses)**—A surgically created joining or opening between two organs or body spaces that are normally separate.

**Congenital defect**—A defect present at birth.

**Gangrenous**—Referring to tissue that is dead.

**Intestinal perforation**—A hole in the intestinal wall.

**Intussusception**—The telescoping of one part of the intestine inside an immediately adjoining part.

**Lysis**—The process of removing adhesions from an organ. The term comes from a Greek word that means “loosening.”

**Simple obstruction**—A blockage in the intestine that does not affect the flow of blood to the area.

**Stoma (plural, stomata)**—A surgically created opening in the abdominal wall to allow digestive wastes to pass to the outside of the body.

**Strangulation obstruction**—A blockage in the intestine that closes off the flow of blood to the area.

**Volvulus**—An intestinal obstruction caused by a knotting or twisting of the bowel.

## Demographics

Approximately 300,000 intestinal obstruction repairs are performed in the United States each year. Among patients who are admitted to the hospital for severe abdominal pain, 20% have an intestinal obstruction. While bowel obstruction can affect individuals of any age, different conditions occur at higher rates in certain age groups. Children under the age of two, for example, are more likely to present with intussusceptions or congenital defects. Elderly patients, on the other hand, have a higher rate of colon cancer.

## Description

After the patient has been prepared for surgery and given **general anesthesia**, the surgeon usually enters the abdominal cavity by way of a laparotomy, which is a large incision made through the patient’s abdominal wall. This type of surgery is sometimes referred to as open surgery. An alternative to laparotomy is **laparoscopy**, a surgical procedure in which a laparoscope (a thin tube with a built-in light source) and other instruments are inserted into the abdomen through small incisions. The internal operating field is

then visualized on a video monitor that is connected to the scope. In some patients, the technique may be used for abdominal exploration in place of a laparotomy. Laparoscopy is associated with faster recovery times, shorter hospital stays, and smaller surgical scars, but requires advanced training on the part of the surgeon as well as costly equipment. Moreover, it offers a more limited view of the operating field.

Treating an intestinal obstruction depends on the condition causing the blockage. Some of the more common surgical procedures used to treat bowel obstructions include:

- **Lysis of adhesions.** The process of removing these bands of scar tissue is called lysis. After the abdominal cavity has been opened, the surgeon locates the obstructed area and delicately dissects the adhesions from the intestine using surgical scissors and forceps.
- **Hernia repair.** This procedure involves an incision placed near the location of the hernia through which the hernia sac is opened. The herniated intestine is placed back in the abdominal cavity and the muscle wall is repaired.
- **Resection with end-to-end anastomosis.** “Resection” means to remove part or all of a tissue or structure. Resection of the small or large intestine, therefore, involves the removal of the obstructed or diseased section. Anastomosis is the connection of two cut ends of a tubular structure to form a continuous channel; the anastomosis of the intestine is most often accomplished with sutures or surgical staples.
- **Resection with ileostomy or colostomy.** In some patients, an anastomosis is not possible because of the extent of the diseased tissue. After the obstruction and diseased tissue is removed, an ileostomy or colostomy is created. Ileostomy is a surgical procedure in which the small intestine is attached to the abdominal wall; waste then exits the body through an artificial opening called a stoma and collects in a bag attached to the skin with adhesive. Colostomy is a similar procedure with the exception that the colon is the part of the digestive tract that is attached to the abdominal wall.

## Diagnosis/Preparation

To diagnose an intestinal obstruction, the physician first gives a **physical examination** to determine the severity of the patient’s condition. The abdomen is examined for evidence of scars, hernias, distension, or pain. The patient’s medical history is also taken, as certain factors increase a person’s risk of developing a bowel obstruction (including previous surgery, older age, and a history of constipation). A series of x rays

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Ileocolic anastomoses are usually performed in a hospital operating room. Surgery may be performed by a general surgeon or a colorectal surgeon, a medical doctor who focuses on the surgical treatment of diseases of the colon, rectum, and anus.

may be taken of the abdomen, as a definitive diagnosis of obstruction can be made by x ray in 50–60% of patients. Computed tomography (CT; an imaging technique that uses x rays to produce two-dimensional cross-sections on a viewing screen) or ultrasonography (an imaging technique that uses high-frequency sound waves to visualize structures inside the body) may also be used to diagnose intestinal obstruction.

Unless a patient presents with symptoms that indicate immediate surgery may be necessary (high fever, severe pain, a rapid heart rate, etc.), a course of IV fluids, NG decompression, and antibiotic therapy is usually prescribed in an effort to avoid surgery.

### Aftercare

After surgery, the patient's NG tube remains until bowel function returns. The patient is closely monitored for signs of infection, leakage from an anastomosis, or other complications.

### Risks

Complications associated with intestinal obstruction repair include excessive bleeding; infection; formation of abscesses (pockets of pus); leakage of stool from an anastomosis; adhesion formation; paralytic ileus (temporary paralysis of the intestines); and recurrence of the obstruction.

### Normal results

Most patients who undergo surgical repair of an intestinal obstruction have an uneventful recovery and do not experience a recurrence of the obstruction.

### Morbidity and mortality rates

The mortality rate of strangulated small bowel obstruction is 100% in untreated patients. In patients who receive treatment within 6 hours, mortality drops to 8%. If treatment is delayed to over 36 hours, mortality rises again to 25%. Large bowel obstruction

## QUESTIONS TO ASK THE DOCTOR

- Why are you recommending intestinal obstruction repair?
- What diagnostic tests will be performed to determine if an obstruction is present?
- Will an ileostomy or colostomy be created? Will it be temporary or permanent?
- Are any nonsurgical treatments available?
- How soon after surgery may normal diet and activities be resumed?

carries a mortality rate of 2% for volvulus to 40% if part of the bowel is gangrenous.

### Alternatives

Such nonsurgical techniques as the administration of IV fluids and bowel decompression with a NG tube are often successful in relieving an intestinal obstruction. Patients who present with more severe symptoms that are indicative of a bowel perforation or strangulation, however, require immediate surgery.

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- American Society of Colon and Rectal Surgeons. 85 W. Algonquin Rd., Suite 550, Arlington Heights, IL 60005. (847) 290 9184. [www.fascrs.org](http://www.fascrs.org).



United Ostomy Association, Inc. 19772 MacArthur Blvd.,  
Suite 200, Irvine, CA 92612 2405. (800) 826 0826.  
www.uoa.org.

Stephanie Dionne Sherk

## Intra-Operative Parathyroid Hormone Measurement

### Definition

Intra-Operative Parathyroid Hormone (IOPTH) Measurement is a method of monitoring the blood for levels of parathyroid hormone (PTH) during surgery to remove abnormal parathyroid glands (**parathyroidectomy**). The blood level of PTH drops after the abnormal parathyroid glands are removed, and indicates to the surgeon that the diseased glands have all been found.

### Demographic

IOPTH measurement can be done on any patient having a parathyroidectomy. This procedure is done because of one or more abnormal parathyroid glands. The surgical procedure and IOPTH measurement are usually performed on patients with parathyroid adenomas (benign tumors). Parathyroid cancer is considered extremely rare, and adenomas make up most of the demographic for IOPTH measurement during parathyroidectomy.

### Description

IOPTH is measured to monitor the activity of hyperfunctional parathyroid glands during a parathyroidectomy. IOPTH measurement helps surgeons determine whether they have removed all pathological tissue (abnormal parathyroid glands).

### *Calcium and the Parathyroid Glands*

The regulation of calcium is an important aspect of our physiology because it has significant impact on many body systems. Calcium is necessary for nervous system function. It is responsible for the electrical impulses that travel along our nerve endings. Calcium is also critical for muscle contraction, including the heart muscle. Additionally calcium stored in the bones increases their strength. Calcium levels are very tightly regulated in the body, because too much or too little may have a serious impact on health. For this reason calcium is the only mineral present in our bodies that

has its own set of glands to regulate blood levels called the parathyroid glands.

The parathyroid glands are located in the neck area usually behind or within the thyroid gland. There are usually four glands located in parallel pairs around the superior and inferior portion of the trachea. There may be up to six glands in an individual, but this is unusual and only one is necessary to maintain body physiology. The glands are tiny, usually between the size of a grain of rice and a pea. Parathyroid glands are part of the body's endocrine system, and release hormones necessary for modulation of calcium in normal physiological functioning. The sole function of the parathyroid glands is to keep calcium levels within a narrow, safe, and functional range in the blood. The parathyroid glands monitor present levels of blood calcium and use PTH to increase or decrease levels as necessary throughout the day. PTH impacts the release of calcium from the bones and the absorption of calcium back into the bones to modulate the blood level.

### *Normal Parathyroid Function*

A normal blood calcium level is 8.4 to 10.2 mg/dl. Blood calcium levels are always kept in this narrow range by PTH. The parathyroid gland releases PTH in response to low blood calcium. Accordingly, PTH release is decreased in response to high blood calcium. PTH travels to the skeletal system and causes the release of calcium from bone, to supply the muscles and nervous system. PTH also travels to the intestine, where it influences the absorption of calcium from ingested food. A normal blood PTH level ranges from 14 to 65 pg/ml.

### *Abnormal Parathyroid Function*

One form of abnormal parathyroid function is hyperparathyroidism. In this disorder, one or more of the parathyroid glands secretes too much PTH despite high blood calcium levels. The normal regulatory mechanisms have lost control, and calcium levels fluctuate wildly. The most common cause of hyperparathyroidism is a parathyroid adenoma. An adenoma is a benign tumor and is not cancerous. It is merely a group of cells that grows and behaves without the normal regulatory control mechanisms. Parathyroid adenomas may grow to the size of a walnut. With some parathyroid adenomas, blood levels may exceed 200 pg/ml, while others may be present with blood PTH still within the normal range. While hyperparathyroidism may present with levels of PTH within the normal range, the diseased glands do not down regulate their activity even when blood calcium levels are high. Hyperparathyroidism

causes a variety of medical problems such as damage to the kidneys, liver, and skeletal system. Patients may develop kidney stones, osteoporosis, high blood pressure, depression, difficulty sleeping, fatigue, and irritability. The heart rhythm is also affected, and heart complications such as arrhythmias may ensue.

### *IOPTH Measurement and Scanning for Pathology*

Parathyroid glands can be very difficult to locate. Approximately 85% of parathyroid glands are found behind the thyroid gland, but they can be located anywhere between the jaw and the chest (very rarely). Their variation in size, number, and location make them very difficult for surgeons to find for parathyroidectomy, with more experienced surgeons having a higher success rate. The preferred way to scan for a parathyroid adenoma is through a **sestamibi scan**. A sestamibi scan is a type of radioimaging used to visualize certain types of abnormal cells in the body. One of the uses for a sestamibi scan is identification of a parathyroid adenoma. Sestamibi scans identify overactive parathyroid glands rather than larger sized ones. Pre-operative identification of the abnormal gland allows for a less invasive surgical procedure than an exploratory one would have been.

While sestamibi scanning is an important part of finding the location of abnormal parathyroid glands that need parathyroidectomy, it is often coupled with IOPTH measurement for confirmation that no glands were missed during the procedure. IOPTH measurement is done during surgery because parathyroid adenomas release excessive amounts of PTH. The half-life (amount of time it takes for half the present hormone to be metabolized or excreted) of PTH is less than 5 minutes. Because it takes so little time for the hormone to be metabolized, when the original source of the PTH is taken away, the remaining PTH takes very little time to drop off. When an abnormal adenoma is removed during a parathyroidectomy, a drop in PTH is observed in 10 to 15 minutes. If the PTH does drop off, it is likely that the surgeon removed all the abnormal parathyroid tissue. If the PTH level does not drop off into the expected range, then there is an additional abnormal parathyroid gland present in the body. If an additional abnormal gland was missed during the sestamibi scan, the IOPTH measurement has identified the mistake. More invasive types of surgery may be necessary to find the remaining abnormal tissue. Since parathyroid adenomas are often singular, IOPTH measurement often prevents unnecessary exploratory surgical procedures. IOPTH measurement may be done until all the abnormal glands are found and removed.

## QUESTIONS TO ASK YOUR DOCTOR

- Why do I need a parathyroidectomy?
- What symptoms do I have that are indicative of hyperparathyroidism?
- How experienced is my surgeon with this procedure?
- How often does the radiology department do sestamibi scans successfully?
- What are the chances that the IOPTH will find any abnormal glands that may have been missed in the scan?
- What are the risks associated with the procedure?

### How IOPTH Measurement is Performed

IOPTH measurement is done from blood drawn during the surgical procedure, and sent it to the hospital's lab for quick analysis. A response from the lab is called into the **operating room** in a timely manner, while the surgery is ongoing. The blood samples required for IOPTH assays are usually taken from an indwelling intravenous catheter. The concentration of PTH is relatively constant in most peripheral veins. Which vein the blood is drawn from does not matter, as long as the same location is used for all the blood draws. After the anesthesia is administered, the blood is tested for a baseline value of PTH to use as comparison to PTH levels after the abnormal tissue is removed. Additional blood samples are taken at 5, 10, and 15 minutes post-removal. A decrease of greater than or equal to 50% of baseline within 10 to 15 minutes after removal is usually indicative of successful removal of the abnormal tissue.

### IOPTH Measurement for Predicting Post-operative Hypoparathyroidism

IOPTH is also a useful tool in predicting the occurrence of symptomatic hypocalcemia following parathyroidectomy. In chronic hyperparathyroidism the normal parathyroid glands become inactive over time in response to the high levels of calcium in the blood caused by excretion of excessive of PTH from the parathyroid adenoma. When the parathyroid adenoma is removed, the remaining healthy glands do not immediately return to normal function and secretion of PTH. Because the abnormal hormone-secreting parathyroid gland has been removed and the remaining normal glands are relatively inactive, many patients experience

## KEY TERMS

**Adenoma**—A benign tumor that may contain many uncontrolled and overly active cells, but which is not cancerous.

**Catheter**—A flexible tube inserted into the body to allow passage of fluids in or out.

**Hyperparathyroidism**—An endocrine disorder involving secretion of excessive amounts of PTH by the parathyroid gland.

**Hypoparathyroidism**—An endocrine disorder involving a deficiency of secretion of PTH from the parathyroid gland.

**Parathyroidectomy**—A surgical procedure in which one or more parathyroid glands are removed.

**Radioimaging**—The process of using a radioactively labeled compound to visualize specific types of body tissue.

**Sestamibi**—A type of radioimaging pharmaceutical compound that has been deemed medically safe to use in the human body for sestamibi scans.

a temporary state of blood calcium deficiency. Having a level of calcium in the blood that is too low is called hypocalcemia. If the levels are low enough, it can cause medically adverse effects.

To predict whether a patient will have post-operative symptomatic hypocalcemia, an IOPTH measurement is done following skin closure at the end of the surgical procedure. Studies have shown that a post-operative PTH level less than 10 pg/ml is predictive of symptomatic hypocalcemia. Patients with PTH levels this low are immediately given calcium and vitamin D supplementation. This supplementation is continued until the normal parathyroid glands return to full function. Measuring blood calcium levels after parathyroidectomy may also correlate with symptomatic hypocalcemia. However, the high levels of calcium that may be present from the excised parathyroid adenoma take longer to decrease than the PTH. Blood calcium measurement is usually not useful until 12 to 24 hours after surgery, and such a delay in calcium therapy may be detrimental. IOPTH is an effective predictive tool that has provided the necessary information before the patient leaves the operating room.

### Risks Associated with IOPTH Measurement

There is very little risk associated with having blood drawn for an IOPTH measurement. Most people have no side effects from a blood draw, or a small

bruise. However, with any blood draw there is a small chance that the area around the punctured vein may develop phlebitis, the inflammation of a vein. Phlebitis may also involve a bacterial infection if the site of the blood draw was not appropriately cleaned before the needle was inserted. Phlebitis can be locally painful but usually resolves in a short period of time. Additionally, patients with disorders involving the inability of the blood to form normal blood clots should discuss their condition and their medications with the physician before the procedure is done.

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American Academy of Otolaryngology—Head and Neck Surgery, One Prince Street, Alexandria, Virginia, 22314-3357, (703)836-4444, <http://www.entnet.org/contactus.cfm>.

American Association of Endocrine Surgeons, 3550 Terrace Street, Pittsburgh, Pennsylvania, 15261, (412)647-0467, (412)648-9551, <http://www.endocrinesurgery.org/contact/contact.html>.

Maria Basile, PhD

Intracranial aneurysm repair see **Cerebral aneurysm repair**

## Intravenous rehydration

### Definition

Intravenous (IV) rehydration is a treatment for fluid loss in which a sterile water solution containing small amounts of salt or sugar is injected into the patient's bloodstream.

### Purpose

Rehydration is usually performed to treat the symptoms associated with dehydration, or excessive loss of body water. Fever, vomiting, and diarrhea can cause a person to become dehydrated fairly quickly. Infants and children are especially vulnerable to dehydration. Patients can become dehydrated due to an illness, surgery, metabolic disorder, hot weather, or accident. Athletes who have overexerted themselves may also require rehydration with IV fluids. An IV for rehydration can be used for several hours to several days, and is generally used if a patient is unable to keep down oral fluids due to excessive vomiting.

### Description

A basic IV rehydration solution consists of sterile water with small amounts of sodium chloride (NaCl; salt) and/or dextrose (sugar) added. It is supplied in bottles or thick plastic bags that can hang on a pole or rolling stand mounted next to a patient's bed. Additional electrolytes (i.e., potassium, calcium, bicarbonate, phosphate, magnesium, chloride), vitamins, or drugs can be added as needed either in a separate minibag or via an injection into the intravenous line.

### Diagnosis/Preparation

Signs and symptoms of dehydration include:

- extreme thirst
- sunken eyes
- reduced urine output; urine that is dark in color
- weakness and fatigue
- rapid weight loss
- dry, warm skin
- skin that is wrinkled or has little elasticity
- rapid pulse
- dry mouth
- “tearless” crying
- muscle cramps
- headache

## KEY TERMS

**Dehydration**—A condition that results from excessive loss of body water. The water may be lost through the digestive system, through sweating, or through the urinary tract.

**Hypodermoclysis**—A technique for restoring the body's fluid balance by injecting a solution of salt and water into the tissues beneath the skin rather than directly into a vein.

**Intravenous**—Into a vein; a needle is inserted into a vein in the back of the hand, inside the elbow, or some other location on the body.

In infants, dehydration may also be indicated by a sunken fontanelle (the soft spot on the head).

A doctor orders the IV solution and any additional nutrients or drugs to be added to it. The doctor also specifies the rate at which the IV will be infused. The intravenous solutions are prepared under the supervision of a pharmacist using sanitary techniques that prevent bacterial contamination. Just like a prescription, the IV is clearly labeled to show its contents and the amounts of any additives. A nurse will examine the patient's arm to find a suitable vein for insertion of the intravenous line. Once the vein is located, the skin around the area is cleaned and disinfected. The needle is inserted and is taped to the skin to prevent it from moving out of the vein.

Patients receiving IV therapy must be monitored to ensure that the IV solutions are providing the correct amounts of fluids and minerals needed. People with kidney and heart disease are at increased risk for overhydration, so they must be carefully monitored when receiving IV therapy.

### Aftercare

Patients must be able to take (and keep down) fluids by mouth before an IV rehydration solution is discontinued. After the needle is removed, the insertion site should be inspected for any signs of bleeding or infection.

### Risks

As with any invasive procedure, there is a small risk of infection or bruising at the injection site. It is possible that the IV solution may not provide all of the nutrients needed, leading to a deficiency or an imbalance. If the needle becomes dislodged, the solution



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Intravenous rehydration is typically prescribed by a doctor and administered by a nurse, physician's assistant, or home health care aide. It may be performed in a hospital setting, an ambulatory care center, or a home care setting.

may flow into tissues around the injection site rather than into the vein, resulting in swelling.

### Morbidity and mortality rates

According to the United Nations Children's Fund (UNICEF), over two million children die of diarrhea-related dehydration each year. Eighty percent of these children were two years of age or younger. In the United States, an estimated 300 people (children and adults) die of dehydration annually.

### Alternatives

For patients who are able to tolerate fluids by mouth, oral rehydration therapy (ORT) with oral rehydration salts (ORS) in solution is the preferred treatment alternative. Another technique in which fluid replacement is injected subcutaneously (under the skin into tissues) rather than into a vein is called hypodermoclysis. Hypodermoclysis is easier to administer than IV therapy, especially in the home setting. It may be used to treat mild to moderate dehydration in patients who are unable to take in adequate fluids by mouth and who prefer to be treated at home (geriatric or terminally ill patients).

### Resources

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## QUESTIONS TO ASK THE DOCTOR

- Can I take rehydration therapy orally instead of intravenously?
- What are the warning signs that might indicate a problem with the IV therapy?
- How should I treat the underlying disorder (e.g., gastroenteritis) that caused the dehydration?

### PERIODICALS

Suhayda, Rosemarie, and Jane C. Walton. "Preventing and Managing Dehydration." *MedSurg Nursing* 11 (December 2002): 267-78.

### ORGANIZATIONS

Infusion Nurses Society. 315 Norwood Park South, Norwood, MA 02062. (781) 440.9408. <http://www.insl.org>.  
League Of Intravenous Therapy Education. Empire Building, Suite 3, 3001 Jacks Run Road. White Oak, PA 15131. (412) 678 5025. <http://www.lite.org/>.

### OTHER

Rehydration Project. P. O. Box 1, Samara, 5235, Costa Rica. (506) 656 0504. [www.rehydrate.org](http://www.rehydrate.org).

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## Intussusception reduction

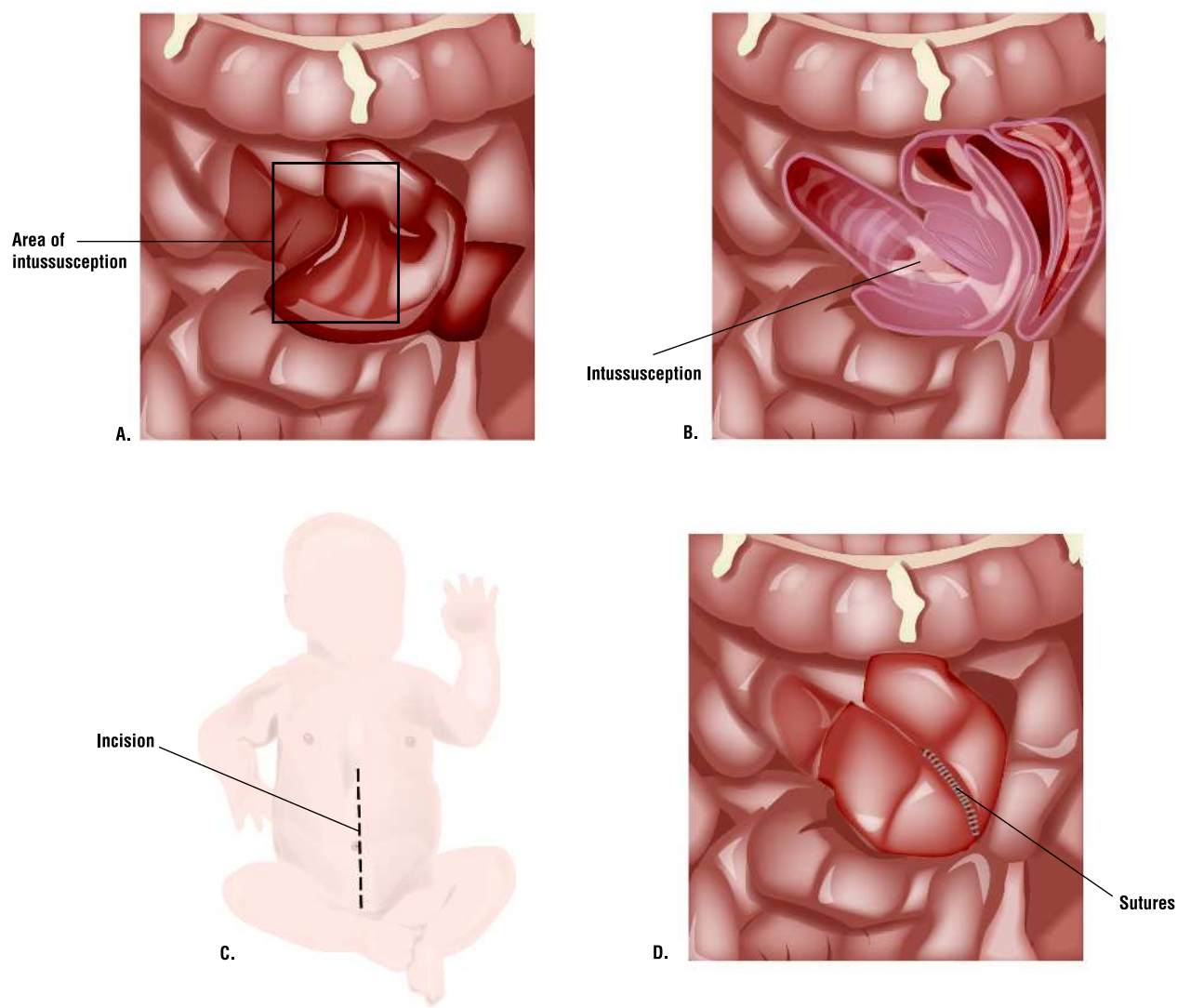
### Definition

Intussusception is a condition in which one portion of the intestine "telescopes" into or folds itself inside another portion. The term comes from two Latin words, *intus*, which means "inside" and *suscipere*, which means "to receive." The outer "receiving" portion of an intussusception is called the intussusciens; the part that has been received inside the intussusciens is called the intussusceptum. The result of an intussusception is that the bowel is obstructed and its blood supply gradually cut off. Surgery is sometimes necessary to relieve the obstruction.

### Purpose

The purpose of an intussusception reduction is to prevent gangrene of the bowel, which may lead to perforation of the bowel, severe infection, and **death**.

## Intussusception reduction



**Intussusception of the bowel results in the bowel telescoping onto itself (A and B). An incision is made in the baby's abdomen to expose the bowel (C). If the surgeon cannot manipulate the bowel into a normal shape manually, the area of intussusception will be removed and remaining bowel sutured together (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)**

The cause of intussusception is idiopathic in most children diagnosed with the condition (88–99%). Idiopathic means that the condition has developed spontaneously or that the cause is unknown. In the remaining 1–12% of child patients, certain conditions called lead points have been associated with intussusception. These lead points include cystic fibrosis; recent upper respiratory or gastrointestinal illness; congenital abnormalities of the digestive tract; benign or malignant tumors; chemotherapy; or the presence of foreign bodies.

In contrast to children, there is a lead point in 90% of adults diagnosed with intussusception.

### Demographics

About 95% of all cases of intussusception occur in children. Children under two years of age are most likely to be affected by the condition; the average age at diagnosis is seven to eight months. Among children, the rate of intussusception is one to four per 1,000. Conversely, only two to three adults out of every

## KEY TERMS

**Adhesion**—A fibrous band of tissue that forms an abnormal connection between two adjacent organs or other structures.

**Anastomosis**—The connection of separate parts of a body organ or an organ system.

**Benign tumor**—A noncancerous growth that does not have the potential to spread to other parts of the body.

**Congenital**—Present at birth.

**Gangrene**—The death of a considerable mass of tissue, usually associated with loss of blood supply and followed by bacterial infection.

**Idiopathic**—Having an unknown cause or arising spontaneously. Most cases of intussusception in children are idiopathic.

**Lead point**—A well-defined abnormality in the area where the intussusception begins.

**Malignant tumor**—A cancerous growth that has the potential to spread to other parts of the body.

**Stoma (plural, stomata)**—A surgically created opening in the abdominal wall to allow digestive wastes to pass to the outside of the body.

**Strangulation**—A condition in which the blood circulation in a part of the body is shut down by pressure. Intussusception can lead to strangulation of a part of the intestine.

1,000,000 are diagnosed with intussusception each year. Intussusception is more likely to affect males than females in all age groups. Among children, the male to female ratio is three to two; in persons over the age of four, the male to female ratio is eight to one.

As of 2003, racial or ethnic differences do not appear to affect the occurrence of intussusception.

## Description

Surgical correction of an intussusception is done with the patient under **general anesthesia**. The surgeon usually enters the abdominal cavity by way of a laparotomy, a large incision made through the abdominal wall. The intestines are examined until the intussusception is identified and brought through the incision for closer examination. The surgeon first attempts to reduce the intussusception by “milking” or applying gentle pressure to ease the intussusceptum out of the intussusciptens; this technique is called

manual reduction. If manual reduction is not successful, the surgeon may perform a resection of the intussusception. Resect means to remove part or all of a tissue or structure; resection of the intussusception, therefore, involves the removal of the area of the intestine that has prolapsed. The two cut ends of the intestine may then be reconnected with sutures or surgical **staples**; this reconnection is called an end-to-end anastomosis.

More rarely, the segment of bowel that is removed is too large to accommodate an end-to-end anastomosis. These patients may require a temporary or permanent enterostomy. In this procedure, the surgeon creates an artificial opening in the abdomen wall called a stoma, and attaches the intestine to it. Waste then exits the body through the stoma and empties into a collection bag.

An alternative to the traditional abdominal incision is **laparoscopy**, a surgical procedure in which a laparoscope (a thin, lighted tube) and other instruments are inserted into the abdomen through small incisions. The internal operating field is then visualized on a video monitor that is connected to the scope. In some patients, the surgeon may perform a laparoscopy for abdominal exploration in place of a laparotomy. Laparoscopy is associated with speedier recoveries, shorter hospital stays, and smaller surgical scars; on the other hand, however, it requires costly equipment and advanced training on the surgeon’s part. In addition, it offers a relatively limited view of the operating field.

## Diagnosis/Preparation

The diagnosis of intussusception is usually made after a complete **physical examination**, medical history, and series of imaging studies. In children, the pediatrician may suspect the diagnosis on the basis of such symptoms as abdominal pain, fever, vomiting, and “currant jelly” stools, which consist of blood-streaked mucus and pieces of the tissue that lines the intestine. When the doctor palpates (feels) the child’s abdomen, he or she will typically find a sausage-shaped mass in the right lower quadrant of the abdomen. Diagnosis of intussusception in adults, however, is much more difficult, partly because the disorder is relatively rare in the adult population.

X rays may be taken of the abdomen with the patient lying down or sitting upright. Ultrasonography (an imaging technique that uses high-frequency sound waves to visualize structures inside the body) and computed tomography (an imaging technique that uses x rays to produce two-dimensional cross-

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Intussusception reduction is usually performed in a hospital operating room under general anesthesia. The operation may be performed by a general surgeon, a pediatric surgeon (in the case of pediatric intussusception), or a colorectal surgeon (a medical doctor who focuses on the surgical treatment of diseases of the colon, rectum, and anus).

sections on a viewing screen) are also used to diagnose intussusception. A contrast enema is a diagnostic tool that has the potential to reduce the intussusception; during this procedure, x-ray photographs are taken of the intestines after a contrast material such as barium or air is introduced through the anus.

Children diagnosed with intussusception are started on intravenous (IV) fluids and nasogastric decompression (in which a flexible tube is inserted through the nose down to the stomach) in an effort to avoid surgery. An enema may also be given to the patient, as 40–90% of cases are successfully treated by this method. If these noninvasive treatments fail, surgery becomes necessary to relieve the obstruction.

There is some controversy among doctors about the usefulness of barium enemas in reducing intussusceptions in adults. In general, enemas are less successful in adults than in children, and surgical treatment should not be delayed.

### Aftercare

After surgical treatment of an intussusception, the patient is given fluids intravenously until bowel function returns; he or she may then be allowed to resume a normal diet. Follow-up care may be indicated if the intussusception occurred as a result of a specific condition (e.g., cancerous tumors).

### Risks

Complications associated with intussusception reduction include reactions to general anesthesia; perforation of the bowel; wound infection; urinary tract infection; excessive bleeding; and formation of adhesions (bands of scar tissue that form after surgery or injury to the abdomen).

## QUESTIONS TO ASK THE DOCTOR

- What diagnostic tests will be needed to confirm the presence of an intussusception?
- Is there a lead point in this case?
- Can the intussusception be treated successfully without surgery?
- If resection becomes necessary, will an enterostomy be performed?
- How soon after surgery may normal diet and activities be resumed?

### Normal results

If intussusception is treated in a timely manner, most patients are expected to recover fully, retain normal bowel function, and have only a small chance of recurrence. The mortality rate is lowest among patients who are treated within the first 24 hours.

### Morbidity and mortality rates

Intussusception recurs in approximately 1–4% of patients after surgery, compared to 5–10% after non-surgical reduction. Adhesions form in up to 7% of patients who undergo surgical reduction. The rate of intussusception-related deaths in Western countries is less than 1%.

### Alternatives

Such nonsurgical techniques as the administration of IV fluids, bowel decompression with a nasogastric tube, or a therapeutic enema are often successful in reducing intussusception. Patients whose symptoms point to bowel perforation or strangulation, however, require immediate surgery. If left untreated, gangrene of the bowel is almost always fatal.

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American Academy of Family Physicians. PO Box 11210, Shawnee Mission, KS 66207. (800) 274-2237. [www.aafp.org](http://www.aafp.org).

American Academy of Pediatrics. 141 Northwest Point Blvd., Elk Grove Village, IL 60007-1098. (847) 434-4000. [www.aap.org](http://www.aap.org).

American College of Radiology. 1891 Preston White Dr., Reston, VA 20191-4397. (800) 227-5463. [www.acr.org](http://www.acr.org).

Stephanie Dionne Sherk

## Iridectomy

### Definition

An iridectomy is an eye surgery procedure in which the surgeon removes a small full-thickness piece of the iris, which is the colored circular membrane behind the cornea of the eye. An iridectomy is also known as a corectomy. In recent years, lasers have also been used to perform iridectomies.

### Purpose

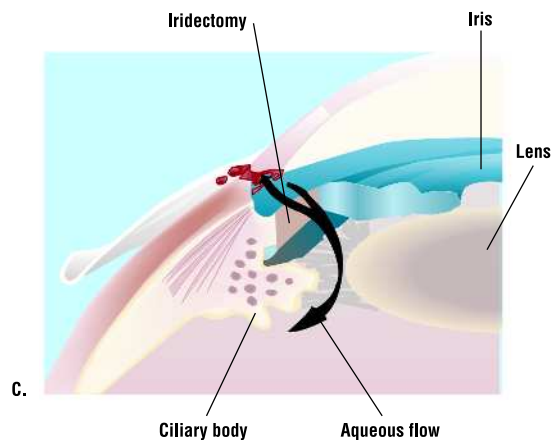
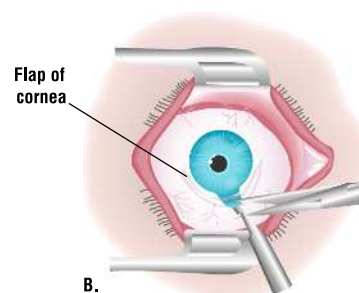
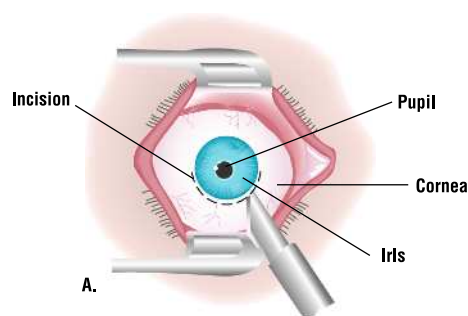
Today, an iridectomy is most often performed to treat closed-angle glaucoma or melanoma of the iris. An iridectomy performed to treat glaucoma is sometimes called a peripheral iridectomy, because it removes a portion of the periphery or root of the iris.

In some cases, an iridectomy is performed prior to cataract surgery in order to make it easier to remove the lens of the eye. This procedure is referred to as a preparatory iridectomy.

#### *Closed-angle glaucoma*

Closed-angle glaucoma is a condition in which fluid pressure builds up inside the eye because the fluid, or aqueous humor, that is produced in the anterior chamber at the front of the eye cannot leave the chamber through

### Iridectomy



For an iridectomy, an incision is made in the cornea just below the iris (A). A piece of the iris is removed (B). This allows fluid to flow between the areas to the front and rear of the iris (C). (Illustration by GGS Information Services. Cengage Learning, Gale.)

the usual opening. This opening lies at the angle where the iris meets the cornea, which is the clear front portion of the exterior cover of the eye. In closed-angle glaucoma, the fluid is blocked because a part of the iris has

## KEY TERMS

**Angle**—The open point in the anterior chamber of the eye at which the iris meets the cornea. Blockage of the angle prevents fluid from leaving the anterior chamber, resulting in closed-angle glaucoma.

**Aqueous humor**—The watery fluid produced in the eye that ordinarily leaves the eye through the angle of the anterior chamber.

**Corectomy**—Another term for iridectomy.

**Cornea**—The transparent front portion of the exterior cover of the eye.

**Enucleation**—Surgical removal of the eyeball.

**Glaucoma**—A group of eye disorders characterized by increased fluid pressure inside the eye that eventually damages the optic nerve. As the cells in the optic nerve die, the patient gradually loses vision.

**Gonioscopy**—A technique for examining the angle between the iris and the cornea with the use of a special mirrored lens applied to the cornea.

**Iridotomy**—A procedure in which a laser is used to make a small hole in the iris to relieve fluid pressure in the eye.

**Iris (plural, irides)**—The circular pigmented membrane behind the cornea of the eye that gives the eye

its color. The iris surrounds a central opening called the pupil.

**Ocular melanoma**—A malignant tumor that arises within the structures of the eye. It is the most common eye tumor in adults.

**Ophthalmology**—The branch of medicine that deals with the diagnosis and treatment of eye disorders.

**Pupil**—The opening in the center of the iris of the eye that allows light to enter the eye.

**Tonometry**—Measurement of the fluid pressure inside the eye.

**Tunica (plural, tunicae)**—The medical term for a membrane or piece of tissue that covers or lines a body part. The eyeball is surrounded by three tunicae.

**Uvea**—The middle of the three tunicae surrounding the eye, comprising the choroid, iris, and ciliary body. The uvea is pigmented and well supplied with blood vessels.

**Uveitis**—Inflammation of any part of the uvea.

**Vitrectomy**—Surgical removal of the vitreous body.

**Vitreous body**—The transparent gel that fills the inner portion of the eyeball between the lens and the retina. It is also called the vitreous humor or crystalline humor.

moved forward and closed off the angle. As a result, fluid pressure in the eye rises rapidly, which can damage the optic nerve and lead to blindness. About 10% of all cases of glaucoma reported in the United States is closed-angle. This type of glaucoma is also called angle-closure glaucoma, acute congestive glaucoma, narrow-angle glaucoma, and pupillary block glaucoma. It usually develops in only one eye at a time.

There are two major types of closed-angle glaucoma: primary and secondary. Primary closed-angle glaucoma most commonly results from pupillary block, in which the iris closes off the angle when the pupil of the eye becomes dilated. In some cases, the blockage happens only occasionally, as when the pupil dilates in dim light, in situations of high stress or anxiety, or in response to the drops instilled by a doctor during an eye examination. This condition is referred to as intermittent, subacute, or chronic open-angle glaucoma. In other cases, the blockage is abrupt and complete, leading to an attack of acute closed-angle glaucoma. In primary glaucoma, the difference

between the chronic or intermittent forms and an acute attack is usually due to small variations in the anatomical structure of the eye. These include an unusually shallow anterior chamber; a lens that is thicker than average and situated further forward in the eye; or a cornea that is smaller in diameter than average. Any of these differences can narrow the angle between the iris and the cornea, which is about 45° in the normal eye. In addition, as people age, the lens tends to grow larger and thicker; this change may cause fluid pressure to build up behind the iris. Eventually, pressure from the aqueous humor may force the iris forward, blocking the drainage angle.

Secondary closed-angle glaucoma results from changes in the angle caused by disorders, medications, trauma, or surgery, rather than by the anatomy of the eye itself. In some cases, the iris is pulled up into the angle by scar tissue resulting from the abnormal formation of blood vessels in diabetes. Another common cause of secondary closed-angle glaucoma is uveitis, or inflammation of the uvea, which is the covering of the

eye that includes the iris. Cases have been reported in which uveitis related to HIV infection has led to closed-angle glaucoma. Melanoma of the iris has also been associated with closed-angle glaucoma.

Any medication that causes the pupil of the eye to dilate, including antihistamines and over-the-counter cold preparations, may cause an acute attack of closed-angle glaucoma. Medications that are given to treat anxiety and depression, particularly the tricyclic antidepressants and the selective serotonin reuptake inhibitors (SSRIs), may trigger the onset of closed-angle glaucoma in some patients. In other instances, anesthesia for procedures on other parts of the body may produce an acute attack of closed-angle glaucoma.

In terms of trauma, a direct blow to the eye can dislocate the lens, bringing it forward and blocking the angle; overly vigorous **exercise** may have the same effect. Lastly, certain types of eye surgery performed to treat other conditions may result in secondary closed-angle glaucoma. These procedures include implantation of an intraocular lens; cataract surgery; **scleral buckling** to treat retinal detachment; and injection of silicone oil to replace the vitreous body in front of the retina following a vitrectomy.

#### *Melanoma of the iris*

Melanoma of the iris is a malignant tumor that develops within the pigmented cells of the iris; it is not a cancer that has developed elsewhere in the body and then spread to the eye. Melanoma of the iris can, however, enlarge and gradually destroy the patient's vision. If left untreated, it can also metastasize or spread to other organs—most commonly the liver—and eventually cause **death**.

#### **Demographics**

Closed-angle glaucoma affects between 350,000 and 400,000 people in the United States; in some Asian countries such as China, however, it is more common than open-angle glaucoma.

Risk factors for closed-angle glaucoma include:

- a family history of this type of glaucoma
- farsightedness
- small eyes
- age over 40
- scarring inside the eye from diabetes or uveitis
- a cataract in the lens that is growing
- Inuit or Asian heritage (Inuits have the highest rate of closed-angle glaucoma of any ethnic group.)

Melanoma of the iris is a relatively rare form of cancer, representing only about 10% of cases of intraocular melanoma. The American Cancer Society estimates that about 220 cases of melanoma of the iris are diagnosed in the United States each year. People over 50 are the most likely to develop this form of cancer, although it can occur at any age. It appears to affect men and women equally. Melanoma of the iris is more common in Caucasians and in people with light-colored irides than in people of Asian or African descent. Suspected causes include genetic mutations and exposure to sunlight.

#### **Description**

##### *Laser iridotomy/iridectomy*

A person who is at risk for an acute episode of closed-angle glaucoma or who has already had emergency medical treatment for an attack may be treated with a **laser iridotomy** to reduce the level of fluid pressure in the affected eye. The drawback of a laser iridotomy in treating closed-angle glaucoma is that the hole may not remain open, requiring repeated iridotomies, a laser iridectomy, or a surgical iridectomy. In addition, laser iridotomies have a higher rate of success when used preventively rather than after the patient has already had an acute attack.

To perform a laser iridotomy, the ophthalmologist uses a laser, usually an argon or an Nd:YAG laser, to burn a small hole into the iris to relieve fluid pressure behind the iris. If the procedure is an iridectomy, the laser is used to remove a full-thickness section of the iris. The patient sits in a special chair with his or her chin resting on a frame or support to prevent the head from moving. The ophthalmologist numbs the eye with anesthetic eye drops. After the anesthetic has taken effect, the doctor shines the laser beam into the affected eye. The entire procedure takes 10–30 minutes.

##### *Conventional (surgical) iridectomy*

Melanoma of the iris is usually treated by surgical iridectomy to prevent the tumor from causing secondary closed-angle glaucoma and from spreading to other parts of the body.

A surgical iridectomy is a more invasive procedure that requires an **operating room**. The patient lies on an operating table with a piece of sterile cloth placed around the eye. The procedure is usually done under **general anesthesia**. The surgeon uses a microscope and special miniature instruments to make an incision in the cornea and remove a section of the iris, usually at the 12 o'clock position. The incision in the cornea is self-sealing.

## Diagnosis/Preparation

### *Closed-angle glaucoma*

Closed-angle glaucoma may be diagnosed in the course of a routine eye examination or during emergency treatment for symptoms of an acute attack. A doctor who is performing a standard eye examination may notice that the patient's eye has a shallow anterior chamber or a narrow angle between the iris and the cornea. He or she may perform one or both of the following tests to evaluate the patient's risk of developing closed-angle glaucoma. One test, called tonometry, measures the amount of fluid pressure in the eye. It is a painless procedure that involves blowing a puff of pressurized air toward the patient's eye as the patient sits near a lamp and measuring the changes in the light reflections on the patient's corneas. Other methods of tonometry involve the application of a local anesthetic to the outside of the eye and touching the cornea briefly with an instrument that measures the fluid pressure directly. The second test, gonioscopy, involves the use of a special mirrored contact lens to evaluate the anatomy of the angle between the iris and the cornea. The doctor numbs the outside of the eye with a local anesthetic and touches the outside of the cornea with the gonioscopic lens. He or she can use a slit lamp to magnify what appears on the lens. Patients with subacute, intermittent, or chronic closed-angle glaucoma can then be treated before they develop acute symptoms.

If the patient is having a sudden attack of closed-angle glaucoma, he or she will feel intense pain, and is likely to be seen on an emergency basis with the following symptoms:

- nausea and vomiting
- severe pain in or above the eye
- visual disturbances that include seeing halos around lights and hazy or foggy vision
- headache
- redness and watering in the affected eye
- a dilated pupil that does not close normally in bright light

These symptoms are produced by the sharp rise in intraocular pressure (IOP) that occurs when the angle is completely blocked. This increase can occur in a matter of hours and cause permanent loss of vision in as little as two to five days. *An acute attack of closed-angle glaucoma is a medical emergency requiring immediate treatment.* Emergency treatment includes application of eye drops to reduce the pressure in the eye quickly, other eye drops to shrink the size of the pupil, and acetazolamide or a similar medication to stop the

production of aqueous humor. In severe cases, the patient may be given drugs intravenously to lower the intraocular pressure. After the pressure has been relieved with medications, the eye will require surgical treatment.

### *Melanoma of the iris*

Melanoma of the iris is usually discovered in the course of a routine eye examination because it will be visible to the ophthalmologist as he or she looks through the pupil in the center of the iris. A melanoma on the iris may look like a dark spot or ring, or it may resemble tapioca. The doctor can perform a gonioscopy, and use specialized imaging studies to rule out other possible eye disorders. An **ultrasound** study can be made by using a small probe placed on the eye that directs sound waves in the direction of the tumor. Another test is called fluorescein **angiography**, which involves injecting a fluorescent dye into a vein in the patient's arm. As the dye circulates throughout the body, it is carried to the blood vessels in the back of the eye. These blood vessels can be photographed through the pupil.

In a minority of patients, melanoma of the iris is discovered because the patient is experiencing eye pain resulting from a rise in IOP caused by tumor growth.

### *Preparation for treatment*

Patients scheduled for a laser iridotomy or iridectomy are not required to fast or make other special preparations before the procedure. They may, however, be given a sedative to help them relax. Patients scheduled for a conventional iridectomy are asked to avoid eating or drinking for about eight hours before the procedure.

### *Aftercare*

Short-term aftercare following laser iridectomy or iridotomy is minimal. Patients are asked to make arrangements for someone to drive them home after surgery, but can usually go to work the next day and resume other activities with no restrictions. They should not need any medication stronger than **aspirin** for discomfort.

Short-term aftercare following a surgical iridectomy includes wearing a patch over the affected eye for several days and using eye drops to minimize the risk of infection. The surgeon may also prescribe medication for discomfort. It will take about six weeks for vision to return to normal. Long-term aftercare following an iridectomy for closed-angle glaucoma usually involves taking medications to help control the



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Iridectomies are performed by ophthalmologists, who are physicians who have completed four to five years of specialized training in the medical and surgical treatment of eye disorders. Ophthalmology is one of 24 specialties recognized by the American Board of Medical Specialties.

Laser iridotomies or iridectomies are done as an outpatient procedure, either in the ophthalmologist's office or in an ambulatory surgery center. Surgical iridectomy is done in an operating room, either in a surgery center that specializes in ophthalmology or in a specialized eye hospital.

fluid pressure in the eye and seeing the ophthalmologist for periodic checkups.

Aftercare for melanoma of the iris includes eye checkups to be certain that the tumor has not recurred. In addition, patients are advised to reduce their exposure to sunlight and other sources of ultraviolet light.

### Risks

The risks of a laser iridotomy or iridectomy include the following:

- irritation in the eye for two to three days after the procedure
- bleeding
- scarring
- failure to relieve fluid pressure in the eye

The risks of a conventional iridectomy include:

- infection
- bleeding
- scarring in the area of the incision
- failure to relieve fluid pressure
- formation of a cataract

The risks of an iridectomy for melanoma of the iris include glaucoma resulting from the formation of new blood vessels near the angle; cataract formation; and recurrence of the tumor. In the event of a recurrence, the standard treatment is enucleation, or surgical removal of the entire eye.

## QUESTIONS TO ASK THE DOCTOR

- What are the alternatives to a surgical iridectomy for my condition?
- What are the risks of my having an acute attack of closed-angle glaucoma?
- What further treatment would you recommend if an iridectomy is unsuccessful?

### Normal results

Normal results for a laser-assisted or conventional iridectomy are long-term lowering of IOP and/or complete removal of a melanoma on the iris.

### Morbidity and mortality rates

About 60% of patients who have had conventional iridectomies consider the operation a success; 15%, on the other hand, maintain that their vision was better before the procedure.

Fortunately for patients, melanoma of the iris is a relatively slow-growing form of cancer; it metastasizes to the liver in only 2–4% of cases. If treated promptly, it has a high survival rate of 95–97% after five years.

### Alternatives

Alternatives to a conventional iridectomy for the treatment of closed-angle glaucoma include repeated laser iridotomies or the long-term use of such medications as pilocarpine. Another surgical alternative, which is most commonly done when the size of the lens is a factor in pupillary block, is removal of the lens.

Alternatives to iridectomy in the treatment of melanoma of the iris include watchful waiting, periodic eye examinations, and the use of medication to control any symptoms of closed-angle glaucoma.

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## ORGANIZATIONS

American Academy of Ophthalmology. P. O. Box 7424, San Francisco, CA 94120 7424. (415) 561 8500. <http://www.aao.org>.

Canadian Ophthalmological Society (COS). 610 1525 Carling Avenue, Ottawa ON K1Z 8R9 Canada. <http://www.eyesite.ca>.

National Eye Institute. 2020 Vision Place, Bethesda, MD 20892 3655. (301) 496 5248. <http://nei.nih.gov>.

Prevent Blindness America. 500 East Remington Road, Schaumburg, IL 60173. (800) 331 2020. <http://www.preventblindness.org>.

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Iridotomy see **Laser iridotomy**

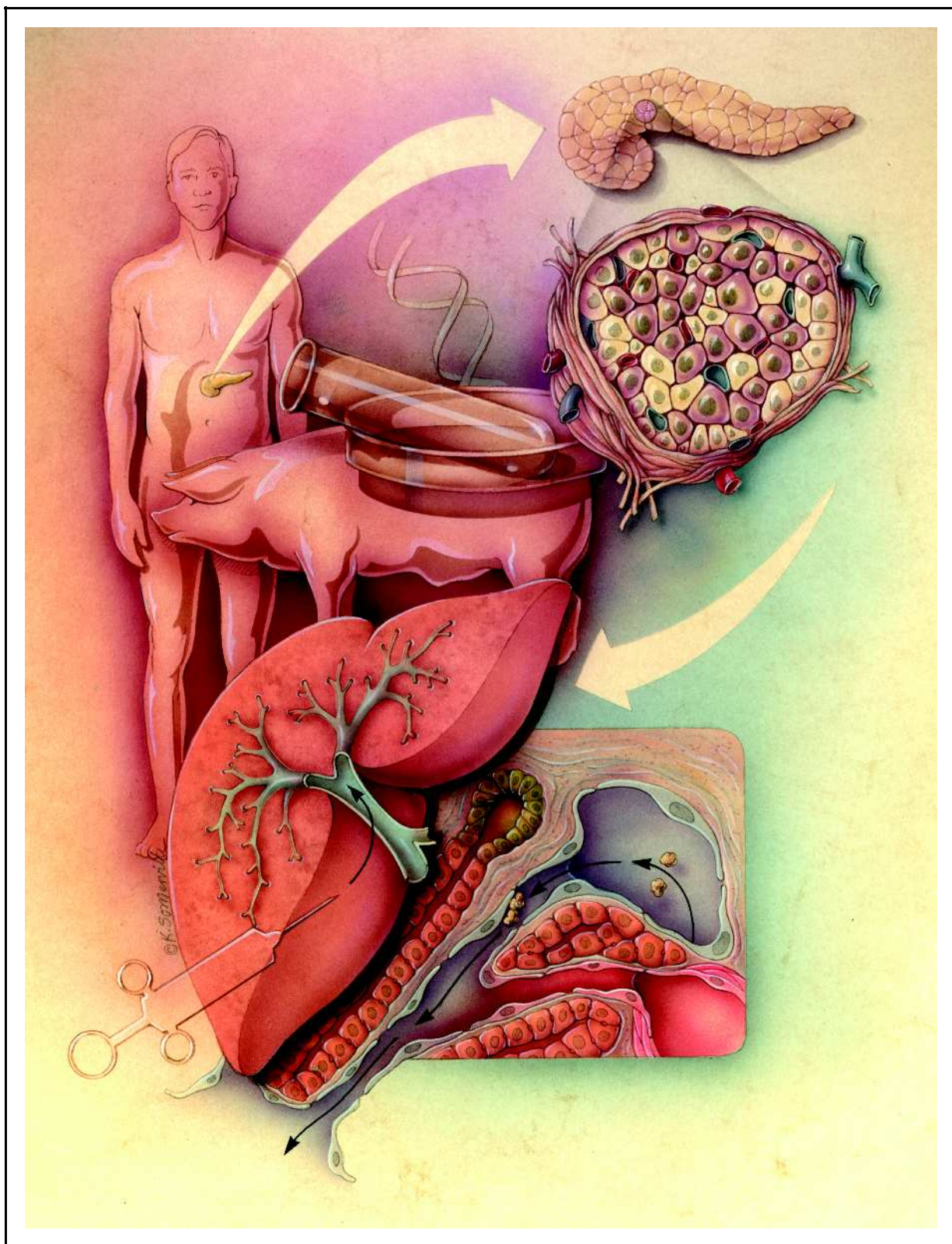
## Islet cell transplantation

### Definition

Pancreatic islet cell transplantation involves taking the cells that produce insulin from a second source, such as a donor pancreas, and transplanting them into a patient.

### Purpose

Once transplanted, the new islet cells make and release insulin. Islet cell transplantation is primarily a treatment method for type 1 diabetes, but it can also be used to treat patients who have had their pancreas



**Islet cell transplantation.** (Kevin A. Somerville/Phototake. Reproduced by permission.)



## KEY TERMS

**Immunosuppression**—A drug-induced state that prevents rejection of transplanted body parts.

**Invasive**—Used to describe a procedure that involves surgical cutting into the body.

**Islet cell**—The cell type within the pancreas that produces insulin.

**Portal vein**—The main vessel that carries blood to the liver.

**Steroids**—A component of commonly used immunosuppressive drugs that have negative effects on insulin production.

removed or damaged from other medical conditions or injuries.

## Demographics

An estimated 120–140 million people worldwide suffer from type 1 diabetes and might possibly benefit from this procedure, however, islet cell transplantation remains highly experimental at this time and occurs only as part of a clinical trial. The latest available data from the International Islet Transplant Registry indicate that, as of December 2000, about 500 procedures had been performed.

## Description

The transplantation procedure is very straightforward, relatively noninvasive, and takes less than an hour to complete. After the patient is given light sedation, the surgeon begins by using an **ultrasound** machine to guide the placement of a small plastic tube, known as a catheter, through the upper abdomen and into the liver. The liver is used as the site for transplantation because the portal vein of liver is large and therefore, easier to access than smaller veins that supply the pancreas. In addition, it is known that islet cells that grow in the liver closely mimic normal insulin secretion.

Once the catheter is in place, the surgeon takes the cells that have been extracted from the donor pancreas and infuses them into the liver. Extraction is done as close as possible to the time of transplantation because of the fragility of the islet cells. The extraction process uses specialized enzymes to isolate the islet cells from the other cell types found in the pancreas. During the infusion process, the cells travel through the portal vein and become lodged in the capillaries of the liver, where they remain to produce insulin as they normally would in the pancreas. Only 1–2% of the pancreas is made up of islet

cells, an average of two pancreases are needed for one successful transplant.

Recent study has shown that the use of perfluorocarbon in the solution that preserves the pancreas before transplant allows older organs to be used as islet cell donors. New techniques have also been developed that allow the organs to be transported before being used for transplantation. These developments are initial steps to relieving the extreme shortage of donor pancreases needed for the procedure.

## Diagnosis/Preparation

To qualify as a candidate for islet cell transplantation, the patient must suffer from type 1 diabetes and current insulin treatment methods must be insufficient. For example, some participants suffer from hypoglycemic unawareness, a condition where low blood sugar will cause very dangerous, unpredictable blackouts that cannot be controlled with insulin injections. The potential patient must also undergo extensive medical and psychological tests to determine their physical and mental appropriateness for enrollment in the trial. If the results of these tests support the candidacy, then sufficient donor pancreas tissue in the patient's blood type must be located. The patient is placed on an organ donor list. Waiting for more than a year is common.

In response to this long wait, research is ongoing to provide alternative sources of donor islet cells such as animal cells, a process known as a xenograft. Pigs are a particularly advantageous source of islet cells because human and pig insulin proteins differ by only one amino acid, and there is an extensive amount of fresh pancreas organs available from the pork industry. Other potential sources of donor islets cells include embryonic stem cells and cell lines of islet beta cells.

Prior to the transplantation, the patient must undergo a drug regime that suppresses the immune system so that the new cells will be accepted. Although only cells are being transplanted, the amount of immunosuppression is the same as that required for a whole organ transplant. Current protocols for islet transplantation include a mixture of non-steroidal drugs, as those that include steroids have been shown to aggravate the diabetic condition of the patient and inhibit the insulin-producing function of the transplanted cells.

Future research in this area may include the use of monoclonal antibody therapy to induce tolerance in patients prior to transplantation.

## Aftercare

Recovery time from the procedure itself is minimal. However, current technology requires that patients



## WHO PERFORMS THIS PROCEDURE AND WHERE IS IT PERFORMED?

A specialist in transplantation would perform this procedure, and it would be done in a specialized center for diabetic research. Currently, about 15 centers around the world are performing this procedure.

continuously remain on immunosuppressive drugs to avoid rejection of the new islet cells. Side effects from these drugs can increase the amount of time that the patient must remain hospitalized.

It takes some time for the cells to attach to the liver blood vessels and begin producing insulin. Until that occurs, numerous blood **glucose tests** are performed, and injected insulin is used to keep blood glucose levels within normal ranges.

### Risks

Until recently, success rates for this procedure were not promising. With success being defined as not requiring insulin for a full year after transplantation, the success rate from 1998–2000 was only about 14% of patients transplanted. However, newer procedures have been achieving at least short-term success rates approaching 80–100%, making the possibility of widespread use of this procedure much more feasible in the near future.

Because of the newness of the procedure, the long-term success rate of these new protocols is not yet known. Graft death is a significant risk even years after a successful transplant. The longest reported successful graft using older protocols has been six years. Over time, the ability of grafts transplanted using new protocols and then sustained by the new immunosuppressive drug mixtures, will be determined.

The long-term use of immunosuppressive drugs by the patient poses an additional risk. There is relatively little experience and therefore, little data to date, pertaining to the long-term use of these drugs. It is difficult then, to predict what exact physical effects long-term immunosuppression may have. Some known side effects include high blood pressure, toxicity of the kidneys, and opportunistic infections.

### Alternatives

One alternative to islet cell transplantation is transplantation of an entire pancreas, a much more invasive procedure. Whole organ transplant has historically had a better success rate than islet transplantation.

## QUESTIONS TO ASK THE DOCTOR

- What are the chances that the procedure will allow me to no longer require insulin?
- If I do still require insulin after this procedure, will I be able to at least reduce the amount of insulin that I currently use?
- Will the immunosuppression before my procedure involve the use of steroids?
- What are my risks concerning long-term use of immunosuppressive drugs?

However, newer islet cell transplant protocols are approaching whole organ results, thus overcoming one of the most important differences between the two procedures.

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- Immune Tolerance Network (ITN). 5743 South Drexel Avenue, Suite 200, Chicago, IL 60637. (773) 834 5341. <http://www.immunetolerance.org>.
- International Pancreas Transplant Registry (IPTR). University of Minnesota Department of Surgery, Mayo Mail Code 280, 420 Delaware Street SE, Minneapolis, MN 55455 0392. <http://www.iptr.umn.edu/>.

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IV rehydration see **Intravenous rehydration**





# K

Keratoplasty see **Corneal transplantation**

Ketone test see **Urinalysis**

## Kidney dialysis

### Definition

Dialysis treatment replaces the function of the kidneys, which normally serve as the body's natural filtration system. Through the use of a blood filter and a chemical solution known as dialysate, the treatment removes waste products and excess fluids from the bloodstream, while maintaining the proper chemical balance of the blood. There are two types of dialysis treatment: hemodialysis and peritoneal dialysis.

### Purpose

Dialysis is most commonly prescribed for patients with temporary or permanent kidney failure. People with end-stage renal disease (ESRD) have kidneys that are no longer capable of adequately removing fluids and wastes from their body or of maintaining the proper level of certain kidney-regulated chemicals in the bloodstream. For these individuals, dialysis is the only treatment option available outside of **kidney transplantation**. Dialysis may also be used to simulate kidney function in patients awaiting a transplant until a donor kidney becomes available. Also, dialysis may be used in the treatment of patients suffering from poisoning or overdose in order to quickly remove drugs from the bloodstream.

### Demographics

As of 2003, in the United States, over 287,494 people were undergoing regular dialysis treatments to manage their ESRD. Diabetes mellitus is the leading single cause of ESRD: 40% of dialysis patients in the United States have ESRD caused by diabetes, 28%

by hypertension, 11.6% by glomerulonephritis, and 4.7% by cystic (bladder) or other urologic conditions.

Among children and young adults under 20 on dialysis, glomerulonephritis is the leading cause of ESRD (31%), and hereditary, cystic, and congenital diseases account for 37%. Pediatric patients typically spend less time on dialysis than adults; according to the USRDS the average waiting period for a kidney transplant for patients under age 20 is 10 months, compared to the adult wait of approximately two years.

### Description

There are two types of dialysis treatment: hemodialysis and peritoneal dialysis.

#### *Hemodialysis*

Hemodialysis is the most frequently prescribed type of dialysis treatment in the United States. The treatment involves circulating the patient's blood outside of the body through an extracorporeal circuit (ECC), or dialysis circuit. Two needles are inserted into the patient's vein, or access site, and are attached to the ECC, which consists of plastic blood tubing, a filter known as a dialyzer (artificial kidney), and a dialysis machine that monitors and maintains blood flow and administers dialysate. Dialysate is a chemical bath that is used to draw waste products out of the blood.

Since the 1980s, the majority of hemodialysis treatments in the United States have been performed with hollow fiber dialyzers. A hollow fiber dialyzer is composed of thousands of tube-like hollow fiber strands encased in a clear plastic cylinder several inches in diameter. There are two compartments within the dialyzer (the blood compartment and the dialysate compartment).

The membrane that separates these two compartments is semipermeable. This means that it allows the passage of certain sized molecules across it, but prevents the passage of other, larger molecules. As blood



## KEY TERMS

**Access site**—The vein tapped for vascular access in hemodialysis treatments. For patients with temporary treatment needs, access to the bloodstream is gained by inserting a catheter into the subclavian vein near the patient's collarbone. Patients in long-term dialysis require stronger, more durable access sites, called fistulas or grafts, that are surgically created.

**Dialysate**—A chemical bath used in dialysis to draw fluids and toxins out of the bloodstream and supply electrolytes and other chemicals to the bloodstream.

**Dialysis prescription**—The general parameters of dialysis treatment that vary according to each patient's individual needs. Treatment length, type of dialyzer and dialysate used, and rate of ultrafiltration are all part of the dialysis prescription.

**Dialyzer**—An artificial kidney usually composed of hollow fiber which is used in hemodialysis to eliminate waste products from the blood and remove excess fluids from the bloodstream.

**Erythropoietin**—A hormone produced by the kidneys that stimulates the production of red blood cells by bone marrow.

**ESRD**—End-stage renal disease; chronic or permanent kidney failure.

**Extracorporeal circuit (ECC)**—The path the hemodialysis patient's blood takes outside of the body. It typically consists of plastic tubing, a hemodialysis machine, and a dialyzer.

**Glomerulonephritis**—A disease of the kidney that causes inflammation and scarring and impairs the kidney's ability to filter waste products from the blood.

**Hematocrit (Hct) level**—A measure of red blood cells.

**Glomerulonephritis**—Kidney disease caused by scarring of the glomeruli, the small blood vessels in the nephrons, or filtering centers, of the kidneys.

**Peritoneum**—The abdominal cavity; the peritoneum acts as a blood filter in peritoneal dialysis.

is pushed through the blood compartment in one direction, suction or vacuum pressure pulls the dialysate through the dialysate compartment in a countercurrent, or opposite direction. These opposing pressures work to drain excess fluids out of the bloodstream and into the dialysate, a process called ultrafiltration.

A second process called diffusion moves waste products in the blood across the membrane and into the dialysate compartment, where they are carried out of the body. At the same time, electrolytes and other chemicals in the dialysate solution cross the membrane into the blood compartment. The purified, chemically balanced blood is then returned to the body.

Most hemodialysis patients require treatment three times a week, for an average of three to four hours per dialysis "run." Specific treatment schedules depend on the type of dialyzer used and the patient's current physical condition.

Blood pressure changes associated with hemodialysis may pose a risk for patients with heart problems. Peritoneal dialysis may be the preferred treatment option in these cases.

### *Peritoneal dialysis*

In peritoneal dialysis, the patient's peritoneum, or lining of the abdomen, acts as a blood filter. A catheter

is surgically inserted into the patient's abdomen. During treatment, the catheter is used to fill the abdominal cavity with dialysate. Waste products and excess fluids move from the patient's bloodstream into the dialysate solution. After a waiting period of six to 24 hours, depending on the treatment method used, the waste-filled dialysate is drained from the abdomen and replaced with clean dialysate.

There are three types of peritoneal dialysis:

- **Continuous ambulatory peritoneal dialysis (CAPD).** CAPD is a continuous treatment that is self-administered and requires no machine. The patient inserts fresh dialysate solution into the abdominal cavity, waits four to six hours, and removes the used solution. The solution is immediately replaced with fresh dialysate. A bag attached to the catheter is worn under clothing.
- **Continuous cyclic peritoneal dialysis (CCPD).** Also called automated peritoneal dialysis (APD), CCPD is an overnight treatment that uses a machine to drain and refill the abdominal cavity, CCPD takes 10 to 12 hours per session.
- **Intermittent peritoneal dialysis (IPD).** This hospital-based treatment is performed several times a week. A machine administers and drains the dialysate solution, and sessions can take 12 to 24 hours.

Peritoneal dialysis is often the treatment option of choice in infants and children, whose small size can make vascular (through a vein) access difficult to maintain. Peritoneal dialysis can also be done outside of a clinical setting, which is more conducive to regular school attendance.

Peritoneal dialysis is not recommended for patients with abdominal adhesions or other abdominal defects, such as a hernia, that might compromise the efficiency of the treatment. It is also not recommended for patients who suffer frequent bouts of **diverticulitis**, an inflammation of small pouches in the intestinal tract.

### Diagnosis/Preparation

Patients are weighed immediately before and after each hemodialysis treatment to evaluate their fluid retention. Blood pressure and temperature are taken and the patient is assessed for physical changes since their last dialysis run. Regular blood tests monitor chemical and waste levels in the blood. Prior to treatment, patients are typically administered a dose of heparin, an anticoagulant that prevents blood clotting, to ensure the free flow of blood through the dialyzer and an uninterrupted dialysis run for the patient.

### Aftercare

Both hemodialysis and peritoneal dialysis patients need to be vigilant about keeping their access sites and catheters clean and infection-free during and between dialysis runs.

Dialysis is just one facet of a comprehensive treatment approach for ESRD. Although dialysis treatment is very effective in removing toxins and fluids from the body, there are several functions of the kidney it cannot mimic, such as regulating high blood pressure and red blood cell production. Patients with ESRD need to watch their dietary and fluid intake carefully and take medications as prescribed to manage their disease.

### Risks

Many of the risks and side effects associated with dialysis are a combined result of both the treatment and the poor physical condition of the ESRD patient. Dialysis patients should always report side effects to their healthcare provider.

#### *Anemia*

**Hematocrit** (Hct) levels, a measure of red blood cells, are typically low in ESRD patients. This

deficiency is caused by a lack of the hormone erythropoietin, which is normally produced by the kidneys. The problem is elevated in hemodialysis patients, who may incur blood loss during hemodialysis treatments. Epoetin alfa, or EPO (sold under the trade name Epogen), a hormone therapy, and intravenous or oral iron supplements are used to manage anemia in dialysis patients.

#### *Cramps, nausea, vomiting, and headaches*

Some hemodialysis patients experience cramps and flu-like symptoms during treatment. These can be caused by a number of factors, including the type of dialysate used, composition of the dialyzer membrane, water quality in the dialysis unit, and the ultrafiltration rate of the treatment. Adjustment of the dialysis prescription often helps alleviate many symptoms.

#### *Hypotension*

Because of the stress placed on the cardiovascular system with regular hemodialysis treatments, patients are at risk for hypotension, a sudden drop in blood pressure. This can often be controlled by medication and adjustment of the patient's dialysis prescription.

#### *Infection*

Both hemodialysis and peritoneal dialysis patients are at risk for infection. Hemodialysis patients should keep their access sites clean and watch for signs of redness and warmth that could indicate infection. Peritoneal dialysis patients must follow the same precautions with their catheter. Peritonitis, an infection of the peritoneum, causes flu-like symptoms and can disrupt dialysis treatments if not caught early.

#### *Infectious diseases*

Because there is a great deal of blood exposure involved in dialysis treatment, a slight risk of contracting hepatitis B and hepatitis C exists. The hepatitis B vaccination is recommended for most hemodialysis patients. As of 2001, there has only been one documented case of HIV being transmitted in a United States dialysis unit to a staff member, and no documented cases of HIV ever being transmitted between dialysis patients in the United States. The strict standards of infection control practiced in modern hemodialysis units minimizes the chance of contracting one of these diseases.

### Normal results

Because dialysis is an ongoing treatment process for many patients, a baseline for normalcy can be

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The dialysis treatment prescription and regimen is usually overseen by a nephrologist (a doctor that specializes in the kidney). The hemodialysis treatment itself is typically administered by a nurse or patient care technician in outpatient clinics known as dialysis centers, or in hospital-based dialysis units. In-home hemodialysis treatment is also an option for some patients, although access to this type of treatment may be limited by financial and lifestyle factors. An investment in equipment is required and another person in the household should be available for support and assistance with treatments. Peritoneal dialysis is also performed at home by the patient, perhaps with the aide of a home health-care worker.

difficult to gauge. Puffiness in the patient related to edema, or fluid retention, may be relieved after dialysis treatment. The patient's overall sense of physical well being may also be improved.

Monthly blood tests to check the levels of urea, a waste product, help to determine the adequacy of the dialysis prescription. Another test, called Kt/V (dialyzer clearance multiplied by time of treatment and divided by the total volume of water in the patient's body), is also performed to assess patient progress. A urea reduction ratio (URR) of 65% or higher, and a Kt/V of at least 1.2 are considered the benchmarks of dialysis adequacy by the Kidney Disease Outcomes Quality Initiative (K/DOQI) of the National Kidney Foundation.

### Morbidity and mortality rates

The USRDS reports that mortality rates for individuals on dialysis are also significantly higher than both kidney transplant patients and the general population, and expected remaining lifetimes of chronic dialysis patients are only one-fourth to one-fifth that of the general population. The hospitalization rates for people with ESRD are four times greater than that of the general population.

### Alternatives

The only alternative to dialysis for ESRD patients is a successful kidney transplant. However, demand for donor kidneys has traditionally far exceeded supply. As of 2006, there were 70,000 patients on the United Network for Organ Sharing (UNOS) waiting

## QUESTIONS TO ASK THE DOCTOR

- When and where will my dialysis treatments be scheduled?
- How should my diet change now that I'm on dialysis?
- What kind of vascular access will I get?
- Does my new dialysis center have a dialyzer reuse program? If so, what safety checks are in place to ensure I receive a properly treated dialyzer?
- What can I do to make dialysis more effective?
- Can you refer me to any ESRD patient support groups?
- Should I change my medication routine?

list for a kidney transplant. In 2005, about 16,000 patients received a kidney.

For patients with diabetes, the number one cause of chronic kidney failure in adults, the best way to avoid ESRD and subsequent dialysis is to maintain tight control of blood glucose levels through diet, **exercise**, and medication. Controlling high blood pressure is also important.

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- National Kidney Foundation. 30 East 33rd St., Suite 1100, New York, NY 10016. (800) 622 9010. <http://www.kidney.org>.
- United States Renal Data System (USRDS), Coordinating Center. The University of Minnesota, 914 South 8th Street, Suite D 206, Minneapolis, MN 55404. 1 888 99USRDS. <http://www.usrds.org>.

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## Kidney function tests

### Definition

Kidney function tests include a variety of individual tests and procedures that can be done to evaluate how well the kidneys are functioning. A doctor who orders kidney function tests and uses the results to assess the functioning of the kidneys is called a nephrologist.

### Purpose

The kidneys, the body's natural filtration system, perform many vital functions, including removing metabolic waste products from the bloodstream, regulating the body's water balance, and maintaining the pH (acidity/alkalinity) of the body's fluids. Approximately one and a half quarts of blood per minute are circulated through the kidneys, where waste chemicals are filtered out and eliminated from the body (along with excess water) in the form of urine. Kidney function tests help to determine if the kidneys are performing their tasks adequately.

### Precautions

The doctor should take a complete history prior to conducting kidney function tests to evaluate the patient's food and drug intake. A wide variety of prescription and over-the-counter medications can affect blood and urine kidney function test results, as can some food and beverages.

### Description

Many conditions can affect the ability of the kidneys to carry out their vital functions. Some conditions can lead to a rapid (acute) decline in kidney function; others lead to a gradual (chronic) decline in function. Both can result in a buildup of toxic waste substances in the blood. A number of clinical laboratory tests that measure the levels of substances normally regulated by the kidneys can help to determine the cause and extent of kidney dysfunction. Urine and blood samples are used for these tests.

The nephrologist uses these results in a number of ways. Once a diagnosis is made that kidney disease is present and what kind of kidney disease is causing the problem, the nephrologist may recommend a specific treatment. Although there is no specific drug therapy that will prevent the progression of kidney disease, the doctor will make recommendations for treatment to slow the disease as much as possible. For instance, the doctor might prescribe blood pressure medications, or treatments for patients with diabetes. If kidney disease

KEY TERMS
<b>Blood urea nitrogen (BUN)</b> —The nitrogen portion of urea in the bloodstream. Urea is a waste product of protein metabolism in the body.
<b>Creatinine</b> —The metabolized by-product of creatinine, an organic compound that assists the body in producing muscle contractions. Creatinine is found in the bloodstream and in muscle tissue. It is removed from the blood by the kidneys and excreted in the urine.
<b>Creatinine clearance rate</b> —The clearance of creatinine from the plasma compared to its appearance in the urine. Since there is no reabsorption of creatinine, this measurement can estimate glomerular filtration rate.
<b>Diuretic</b> —A drug that increases the excretion of salt and water, increasing the output of urine.
<b>Kilogram</b> —Metric unit of weight.
<b>Osmolality</b> —A measurement of urine concentration that depends on the number of particles dissolved in it. Values are expressed as milliosmols per kilogram (mOsm/kg) of water.
<b>Nephrologist</b> —A doctor specializing in kidney disease.
<b>Specific gravity</b> —The ratio of the weight of a body fluid when compared with water.
<b>Urea</b> —A by-product of protein metabolism that is formed in the liver. Because urea contains ammonia, which is toxic to the body, it must be quickly filtered from the blood by the kidneys and excreted in the urine.
<b>Uric acid</b> —A product of purine breakdown that is excreted by the kidney. High levels of uric acid, caused by various diseases, can cause the formation of kidney stones.
<b>Urine</b> —A fluid containing water and dissolved substances excreted by the kidney.

is getting worse, the nephrologist may discuss hemodialysis (blood cleansing by removal of excess fluid, minerals, and wastes) or **kidney transplantation** (surgical procedure to implant a healthy kidney into a patient with kidney disease or kidney failure) with the patient.

### Laboratory tests

There are a number of urine tests that can be used to assess kidney function. A simple, inexpensive screening



test—a routine urinalysis—is often the first test conducted if kidney problems are suspected. A small, randomly collected urine sample is examined physically for things like color, odor, appearance, and concentration (specific gravity); chemically, for substances such as protein, glucose, and pH (acidity/ alkalinity); and microscopically for the presence of cellular elements (red blood cells [RBCs], white blood cells [WBCs], and epithelial cells), bacteria, crystals, and casts (structures formed by the deposit of protein, cells, and other substances in the kidneys's tubules). If results indicate a possibility of disease or impaired kidney function, one or more of the following additional tests is usually performed to pinpoint the cause and the level of decline in kidney function.

- **Creatinine clearance test.** This test evaluates how efficiently the kidneys clear a substance called creatinine from the blood. Creatinine, a waste product of muscle energy metabolism, is produced at a constant rate that is proportional to the individual's muscle mass. Because the body does not recycle it, all creatinine filtered by the kidneys in a given amount of time is excreted in the urine, making creatinine clearance a very specific measurement of kidney function. The test is performed on a timed urine specimen—a cumulative sample collected over a two to 24-hour period. Determination of the blood creatinine level is also required to calculate the urine clearance.
- **Urea clearance test.** Urea is a waste product that is created by protein metabolism and excreted in the urine. The urea clearance test requires a blood sample to measure the amount of urea in the bloodstream and two urine specimens, collected one hour apart, to determine the amount of urea that is filtered, or cleared, by the kidneys into the urine.
- **Urine osmolality test.** Urine osmolality is a measurement of the number of dissolved particles in urine. It is a more precise measurement than specific gravity for evaluating the ability of the kidneys to concentrate or dilute the urine. Kidneys that are functioning normally will excrete more water into the urine as fluid intake is increased, diluting the urine. If fluid intake is decreased, the kidneys excrete less water and the urine becomes more concentrated. The test may be done on a urine sample collected first thing in the morning, on multiple timed samples, or on a cumulative sample collected over a 24-hour period. The patient will typically be prescribed a high-protein diet for several days before the test and be asked to drink no fluids the night before the test.
- **Urine protein test.** Healthy kidneys filter all proteins from the bloodstream and then reabsorb them, allowing

no protein, or only slight amounts of protein, into the urine. The persistent presence of significant amounts of protein in the urine, then, is an important indicator of kidney disease. A positive screening test for protein (included in a routine urinalysis) on a random urine sample is usually followed up with a test on a 24-hour urine sample that more precisely measures the quantity of protein.

There are also several blood tests that can aid in evaluating kidney function. These include:

- **Blood urea nitrogen test (BUN).** Urea is a byproduct of protein metabolism. Formed in the liver, this waste product is then filtered from the blood and excreted in the urine by the kidneys. The BUN test measures the amount of nitrogen contained in the urea. High BUN levels can indicate kidney dysfunction, but because BUN is also affected by protein intake and liver function, the test is usually done together with a blood creatinine, a more specific indicator of kidney function.
- **Creatinine test.** This test measures blood levels of creatinine, a byproduct of muscle energy metabolism that, similar to urea, is filtered from the blood by the kidneys and excreted into the urine. Production of creatinine depends on a person's muscle mass, which usually fluctuates very little. With normal kidney function, then, the amount of creatinine in the blood remains relatively constant and normal. For this reason, and because creatinine is affected very little by liver function, an elevated blood creatinine level is a more sensitive indicator of impaired kidney function than the BUN.
- **Other blood tests.** Measurement of the blood levels of other elements regulated in part by the kidneys can also be useful in evaluating kidney function. These include sodium, potassium, chloride, bicarbonate, calcium, magnesium, phosphorus, protein, uric acid, and glucose.

## Results

Normal values for many tests are determined by the patient's age and gender. Reference values can also vary by laboratory, but are generally within the following ranges:

### Urine tests

- **Creatinine clearance.** For a 24-hour urine collection, normal results are 90 mL/min–139 mL/min for adult males younger than 40, and 80–125 mL/min for adult females younger than 40. For people over 40, values decrease by 6.5 mL/min for each decade of life.

- Urine osmolality. With restricted fluid intake (concentration testing), osmolality should be greater than 800 mOsm/kg of water. With increased fluid intake (dilution testing), osmolality should be less than 100 mOsm/kg in at least one of the specimens collected. A 24-hour urine osmolality should average 300–900 mOsm/kg. A random urine osmolality should average 500–800 mOsm/kg.
- Urine protein. A 24-hour urine collection should contain no more than 150 mg of protein.
- Urine sodium. A 24-hour urine sodium should be within 75–200 mmol/day.

#### Blood tests

- Blood urea nitrogen (BUN) should average 8–20 mg/dL.
- Creatinine should be 0.8–1.2 mg/dL for males, and 0.6–0.9 mg/dL for females.
- Uric acid levels for males should be 3.5–7.2 mg/dL and for females 2.6–6.0 mg/dL.

Low clearance values for creatinine indicate a diminished ability of the kidneys to filter waste products from the blood and excrete them in the urine. As clearance levels decrease, blood levels of creatinine, urea, and uric acid increase. Because it can be affected by other factors, an elevated BUN, alone, is suggestive, but not diagnostic for kidney dysfunction. An abnormally elevated plasma creatinine is a more specific indicator of kidney disease than is BUN.

Low clearance values for creatinine and urea indicate a diminished ability of the kidneys to filter these waste products from the blood and to excrete them in the urine. As clearance levels decrease, blood levels of creatinine and urea nitrogen increase. Since it can be affected by other factors, an elevated BUN alone is certainly suggestive for kidney dysfunction. However, it is not diagnostic. An abnormally elevated blood creatinine, a more specific and sensitive indicator of kidney disease than the BUN, is diagnostic of impaired kidney function.

The inability of the kidneys to concentrate the urine in response to restricted fluid intake, or to dilute the urine in response to increased fluid intake during osmolality testing, may indicate decreased kidney function. Because the kidneys normally excrete almost no protein in the urine, its persistent presence, in amounts that exceed the normal 24-hour urine value, usually indicates some type of kidney disease.

#### Patient education

Some kidney problems are the result of another disease process, such as diabetes or hypertension.

Doctors should take the time to inform patients about how their disease or its treatment will affect kidney function, as well as the different measures patients can take to help prevent these changes.

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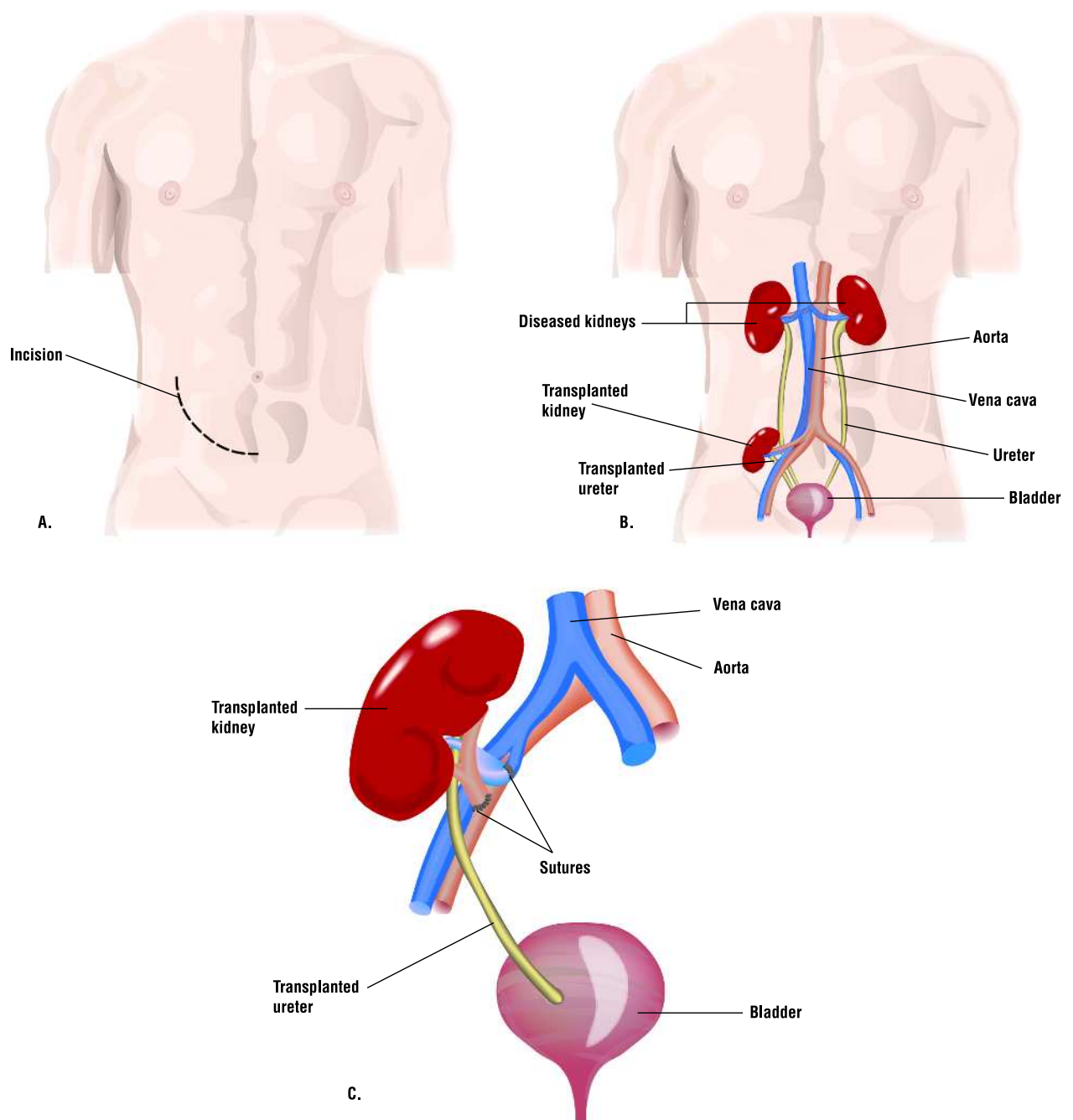
Kidney removal see **Nephrectomy**

## Kidney transplantation

### Definition

Kidney transplantation is a surgical procedure to remove a healthy, functioning kidney from a living or brain-dead donor and implant it into a patient with non-functioning kidneys.

## Kidney transplantation



For a kidney transplant, an incision is made in the lower abdomen (A). The donor kidney is connected to the patient's blood supply lower in the abdomen than the native kidneys, which are usually left in place (B). A transplanted ureter connects the donor kidney to the patient's bladder (C). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## Purpose

Kidney transplantation is performed on patients with chronic kidney failure, or end-stage renal disease (ESRD). ESRD occurs when a disease, disorder, or congenital condition damages the kidneys so that they are no longer capable of adequately removing fluids and wastes from the body or of maintaining the proper level of certain kidney-regulated chemicals in the bloodstream. Without long-term dialysis or a kidney transplant, ESRD is fatal.

## Demographics

Diabetes mellitus is the leading single cause of ESRD. Hypertension (high blood pressure) is the second leading cause of ESRD in adults, followed by glomerulonephritis. African Americans are more likely to develop hypertension-related ESRD than Caucasians and Hispanics. People of Native American and Hispanic descent are at an elevated risk for both kidney disease and diabetes.

Among children and young adults under 20 on dialysis, glomerulonephritis is the leading cause of ESRD, followed by hereditary, cystic, and congenital diseases account. According to USRDS, the average waiting period for a kidney transplant for patients under age 20 is 10 months, compared to the adult wait of approximately two years.

## Description

Kidney transplantation involves surgically attaching a functioning kidney, or graft, from a brain-dead organ donor (a cadaver transplant) or from a living donor to a patient with ESRD. Living donors may be related or unrelated to the patient, but a related donor has a better chance of having a kidney that is a stronger biological match for the patient.

### *Open nephrectomy*

The surgical procedure to remove a kidney from a living donor is called a **nephrectomy**. In a traditional, open nephrectomy, the kidney donor is administered **general anesthesia** and a 6–10-in (15.2–25.4-cm) incision through several layers of muscle is made on the side or front of the abdomen. The blood vessels connecting the kidney to the donor are cut and clamped, and the ureter is also cut and clamped between the bladder and kidney. The kidney and an attached section of ureter are removed from the donor. The vessels and ureter in the donor are then tied off and the incision is sutured together again. A similar procedure

## KEY TERMS

**Arteriogram**—A diagnostic test that involves viewing the arteries and/or attached organs by injecting a contrast medium, or dye, into the artery and taking an x ray.

**Congenital**—Present at birth.

**Dialysis**—A blood filtration therapy that replaces the function of the kidneys, filtering fluids, and waste products out of the bloodstream. There are two types of dialysis treatment: hemodialysis, which uses an artificial kidney, or dialyzer, as a blood filter; and peritoneal dialysis, which uses the patient's abdominal cavity (peritoneum) as a blood filter.

**Glomerulonephritis**—A disease of the kidney that causes inflammation and scarring and impairs the kidney's ability to filter waste products from the blood.

**Iliac artery**—Large blood vessel in the pelvis that leads into the leg.

**Immunosuppressive medication**—Drugs given to a transplant recipient to prevent his or her immune system from attacking the transplanted organ.

**Rejection**—The process in which the immune system attacks foreign tissue such as a transplanted organ.

**Videoscope**—A surgical camera.

is used to harvest cadaver kidneys, although both kidneys are typically removed at once, and blood and cell samples for tissue typing are also taken.

### *Laparoscopic nephrectomy*

Laparoscopic nephrectomy is a form of minimally invasive surgery using instruments on long, narrow rods to view, cut, and remove the donor kidney. The surgeon views the kidney and surrounding tissue with a flexible videoscope. The videoscope and **surgical instruments** are maneuvered through four small incisions in the abdomen, and carbon dioxide is pumped into the abdominal cavity to inflate it for an improved visualization of the kidney. Once the kidney is freed, it is secured in a bag and pulled through a fifth incision, approximately 3 in (7.6 cm) wide, in the front of the abdominal wall below the navel. Although this surgical technique takes slightly longer than an open nephrectomy, studies have shown that it promotes a faster recovery time, shorter hospital stays, and less post-operative pain for kidney donors.



A modified laparoscopic technique called hand-assisted laparoscopic nephrectomy may also be used to remove the kidney. In the hand-assisted surgery, a small incision of 3–5 in (7.6–12.7 cm) is made in the patient's abdomen. The incision allows the surgeon to place his hand in the abdominal cavity using a special surgical glove that also maintains a seal for the inflation of the abdominal cavity with carbon dioxide. The technique gives the surgeon the benefit of using his or her hands to feel the kidney and related structures. The kidney is then removed through the incision by hand instead of with a bag.

Once removed, kidneys from live donors and cadavers are placed on ice and flushed with a cold preservative solution. The kidney can be preserved in this solution for 24–48 hours until the transplant takes place. The sooner the transplant takes place after harvesting the kidney, the better the chances are for proper functioning.

### *Kidney transplantation*

During the transplant operation, the kidney recipient is typically under general anesthesia and administered **antibiotics** to prevent possible infection. A catheter is placed in the bladder before surgery begins. An incision is made in the flank of the patient, and the surgeon implants the kidney above the pelvic bone and below the existing, non-functioning kidney by suturing the kidney artery and vein to the patient's iliac artery and vein. The ureter of the new kidney is attached directly to the kidney recipient's bladder. Once the new kidney is attached, the patient's existing, diseased kidneys may or may not be removed, depending on the circumstances surrounding the kidney failure. Barring any complications, the transplant operation takes about three to four hours.

Since 1973, **Medicare** has picked up 80% of ESRD treatment costs, including the costs of transplantation for both the kidney donor and the recipient. Medicare also covers 80% of immunosuppressive medication costs for up to three years. To qualify for Medicare ESRD benefits, a patient must be insured or eligible for benefits under Social Security, or be a spouse or child of an eligible American. Private insurance and state **Medicaid** programs often cover the remaining 20% of treatment costs.

Patients with a history of heart disease, lung disease, cancer, or hepatitis may not be suitable candidates for receiving a kidney transplant.

### **Diagnosis/Preparation**

Patients with chronic renal disease who need a transplant and do not have a living donor registered with United Network for Organ Sharing (UNOS) to

be placed on a waiting list for a cadaver kidney transplant. UNOS is a non-profit organization that is under contract with the federal government to administer the Organ Procurement and Transplant Network (OPTN) and the national Scientific Registry of Transplant Recipients (SRTR).

Kidney allocation is based on a mathematical formula that awards points for factors that can affect a successful transplant, such as time spent on the transplant list, the patient's health status, and age. The most important part of the equation is that the kidney be compatible with the patient's body. A human kidney has a set of six antigens, substances that stimulate the production of antibodies. (Antibodies then attach to cells they recognize as foreign and attack them.) Donors are tissue matched for 0–6 of the antigens, and compatibility is determined by the number and strength of those matched pairs. Blood type matching is also important. Patients with a living donor who is a close relative have the best chance of a close match.

Before being placed on the transplant list, potential kidney recipients must undergo a comprehensive physical evaluation. In addition to the compatibility testing, radiological tests, urine tests, and a psychological evaluation will be performed. A panel of reactive antibody (PRA) is performed by mixing the patient's serum (white blood cells) with serum from a panel of 60 randomly selected donors. The patient's PRA sensitivity is determined by how many of these random samples his or her serum reacts with; for example, a reaction to the antibodies of six of the samples would mean a PRA of 10%. High reactivity (also called sensitization) means that the recipient would likely reject a transplant from the donor. The more reactions, the higher the PRA and the lower the chances of an overall match from the general population. Patients with a high PRA face a much longer waiting period for a suitable kidney match.

Potential living kidney donors also undergo a complete medical history and **physical examination** to evaluate their suitability for donation. Extensive blood tests are performed on both donor and recipient. The blood samples are used to tissue type for antigen matches, and confirm that blood types are compatible. A PRA is performed to ensure that the recipient antibodies will not have a negative reaction to the donor antigens. If a reaction does occur, there are some treatment protocols that can be attempted to reduce reactivity, including immunosuppressant drugs and plasmapheresis (a blood filtration therapy).

The donor's kidney function will be evaluated with a urine test as well. In some cases, a special dye that shows up on x rays is injected into an artery, and x rays are taken to show the blood supply of the donor kidney (a procedure called an arteriogram).

Once compatibility is confirmed and the physical preparations for kidney transplantation are complete, both donor and recipient may undergo a psychological or psychiatric evaluation to ensure that they are emotionally prepared for the transplant procedure and aftercare regimen.

### Aftercare

A typical hospital stay for a transplant recipient is about five days. Both kidney donors and recipients will experience some discomfort in the area of the incision after surgery. Pain relievers are administered following the transplant operation. Patients may also experience numbness, caused by severed nerves, near or on the incision.

A regimen of immunosuppressive, or anti-rejection, medication is prescribed to prevent the body's immune system from rejecting the new kidney. Common immunosuppressants include cyclosporine, prednisone, tacrolimus, mycophenolate mofetil, sirolimus, baxsiliximab, daclizumab, and azathioprine. The kidney recipient will be required to take a course of **immunosuppressant drugs** for the lifespan of the new kidney. Intravenous antibodies may also be administered after **transplant surgery** and during rejection episodes.

Because the patient's immune system is suppressed, he or she is at an increased risk for infection. The incision area should be kept clean, and the transplant recipient should avoid contact with people who have colds, viruses, or similar illnesses. If the patient has pets, he or she should not handle animal waste. The transplant team will provide detailed instructions on what should be avoided post-transplant. After recovery, the patient will still have to be vigilant about exposure to viruses and other environmental dangers.

Transplant recipients may need to adjust their dietary habits. Certain immunosuppressive medications cause increased appetite or sodium and protein retention, and the patient may have to adjust his or her intake of calories, salt, and protein to compensate.

### Risks

As with any surgical procedure, the kidney transplantation procedure carries some risk for both a living donor and a graft recipient. Possible complications include infection and bleeding (hemorrhage). A lymphocele, a pool of lymphatic fluid around the kidney that is generated by lymphatic vessels damaged in surgery, occurs in up to 20% of transplant patients and can obstruct urine flow and/or blood flow to the kidney if not diagnosed and drained promptly. Less

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A kidney transplant is performed by a transplant surgeon in one of more than 200 UNOS-approved hospitals nationwide. If the patient has no living donor, he or she must go through an evaluation procedure to get on the UNOS national waiting list and the UNOS Organ Center's UNet database.

common is a urine leak outside of the bladder, which occurs in approximately 3% of kidney transplants when the ureter suffers damage during the procedure. This problem is usually correctable with follow-up surgery.

A transplanted kidney may be rejected by the patient. Rejection occurs when the patient's immune system recognizes the new kidney as a foreign body and attacks the kidney. It may occur soon after transplantation, or several months or years after the procedure has taken place. Rejection episodes are not uncommon in the first weeks after transplantation surgery, and are treated with high-dose injections of immunosuppressant drugs. If a rejection episode cannot be reversed and kidney failure continues, the patient will typically go back on dialysis. Another transplant procedure can be attempted at a later date if another kidney becomes available.

The biggest risk to the recovering transplant recipient is not from the operation or the kidney itself, but from the immunosuppressive medication he or she must take. Because these drugs suppress the immune system, the patient is susceptible to infections such as cytomegalovirus (CMV) and varicella (chickenpox). Other medications that fight viral and bacterial infections can offset this risk to a degree. The immunosuppressants can also cause a host of possible side effects, from high blood pressure to osteoporosis. Prescription and dosage adjustments can lessen side effects for some patients.

### Normal results

The new kidney may start functioning immediately, or may take several weeks to begin producing urine. Living donor kidneys are more likely to begin functioning earlier than cadaver kidneys, which frequently suffer some reversible damage during the kidney transplant and storage procedure. Patients may have to undergo

## QUESTIONS TO ASK THE DOCTOR

- How many kidney transplants have both you and the hospital performed?
- What are your transplant success rates? How about those of the hospital?
- Who will be on my transplant team?
- Can I get on the waiting list at more than one hospital?
- Will my transplant be performed with a laparoscopic or an open nephrectomy?
- What type of immunosuppressive drugs will I be on post-transplant?

dialysis for several weeks while their new kidney establishes an acceptable level of functioning.

Studies have shown that after they recover from surgery, kidney donors typically have no long-term complications from the loss of one kidney, and their remaining kidney will increase its functioning to compensate for the loss of the other.

### Morbidity and mortality rates

Survival rates for patients undergoing kidney transplants are 89–98% one year post-transplant, and 67.4–91.4% five years after transplant. About 4,000 patients on the transplant waiting list die annually while awaiting a kidney. The success of a kidney transplant graft depends on the strength of the match between donor and recipient and the source of the kidney. Transplantations using living donor kidneys have a higher rate of success than do cadaver kidney transplantations.

### Alternatives

Patients who develop chronic kidney failure must either go on dialysis treatment or receive a kidney transplant to survive.

### Resources

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- American Association of Kidney Patients. 3505 E. Frontage Rd., Suite 315, Tampa, FL 33607. (800) 749 2257. E mail: [info@aakp.org](mailto:info@aakp.org). <http://www.aakp.org>.
- American Kidney Fund (AKF). Suite 1010, 6110 Executive Boulevard, Rockville, MD 20852. (800) 638 8299. E mail: [helpline@akfinc.org](mailto:helpline@akfinc.org). <http://www.akfinc.org>.
- National Kidney Foundation. 30 East 33rd St., Suite 1100, New York, NY 10016. (800) 622 9010. <http://www.kidney.org>.
- United Network for Organ Sharing (UNOS). 700 North 4th St., Richmond, VA 23219. (888) 894 6361. <http://www.transplantliving.org>.
- United States Renal Data System (USRDS). USRDS Coordinating Center, 914 S. 8th St., Suite D 206, Minneapolis, MN 55404. (612) 347 7776. <http://www.usrds.org>.

### OTHER

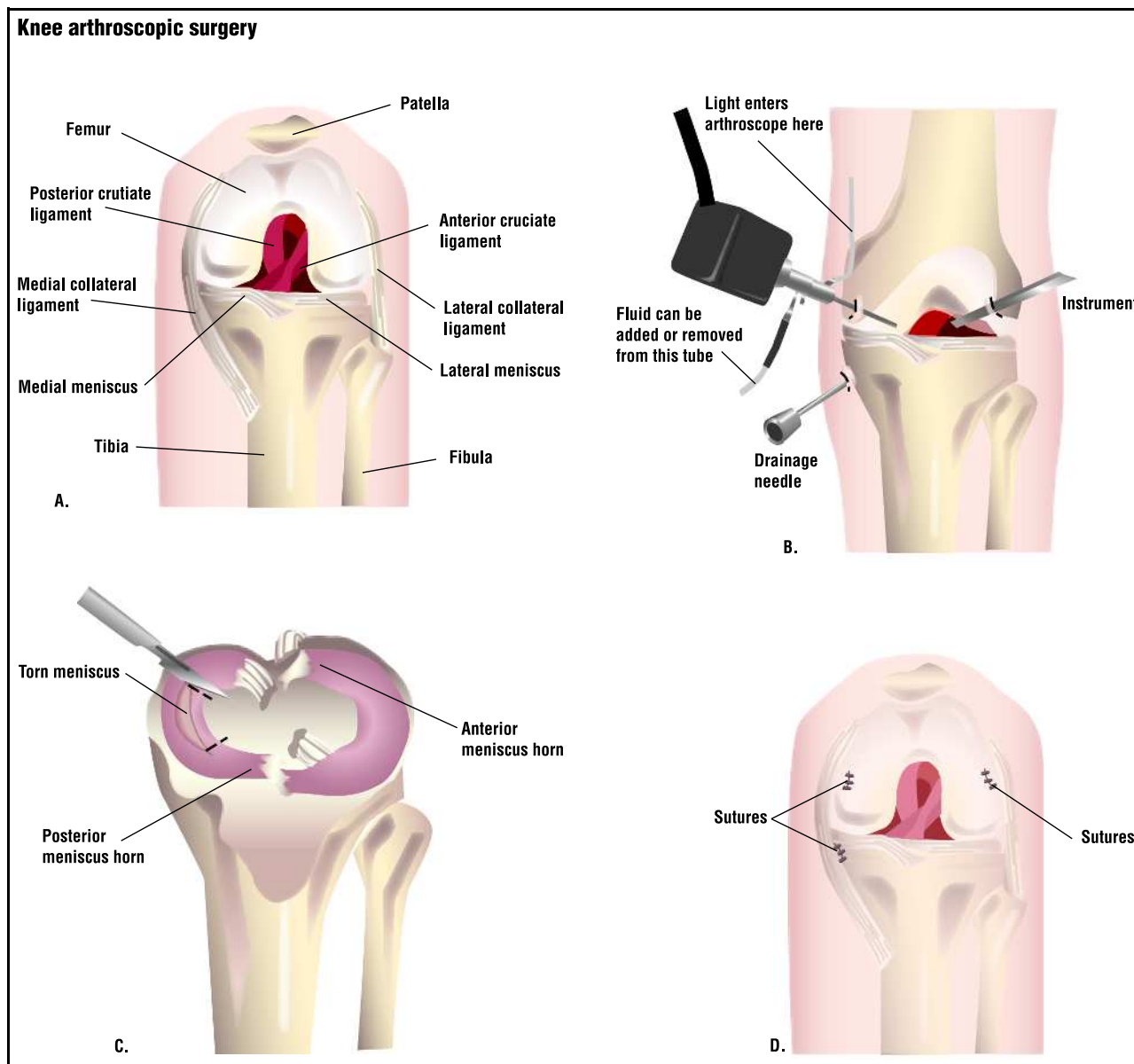
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Paula Anne Ford-Martin

## Knee arthroscopic surgery

### Definition

Knee **arthroscopic surgery** is a procedure performed through small incisions in the skin to repair injuries to tissues such as ligaments, cartilage, or bone within the knee joint area. The surgery is conducted with the aid of an arthroscope, which is a very small instrument guided by a lighted scope attached to a television monitor. Other instruments are inserted through three incisions around the knee. Arthroscopic surgeries range from minor procedures such as flushing or smoothing out bone surfaces or tissue fragments (lavage and **debridement**) associated with osteoarthritis, to the realignment of a dislocated knee and ligament grafting surgeries. The range of surgeries represents very different procedures, risks, and after-care requirements.



Step A shows the anatomy of the knee from the front with the leg bent. To repair a torn meniscus, three small incisions are made into the knee to admit laparoscopic instruments (B). Fluid is injected into the joint to aid in the operation. The injury is visualized via the instruments, and the torn area is removed (C). (Illustration by GGS Information Services. Cengage Learning, Gale.)

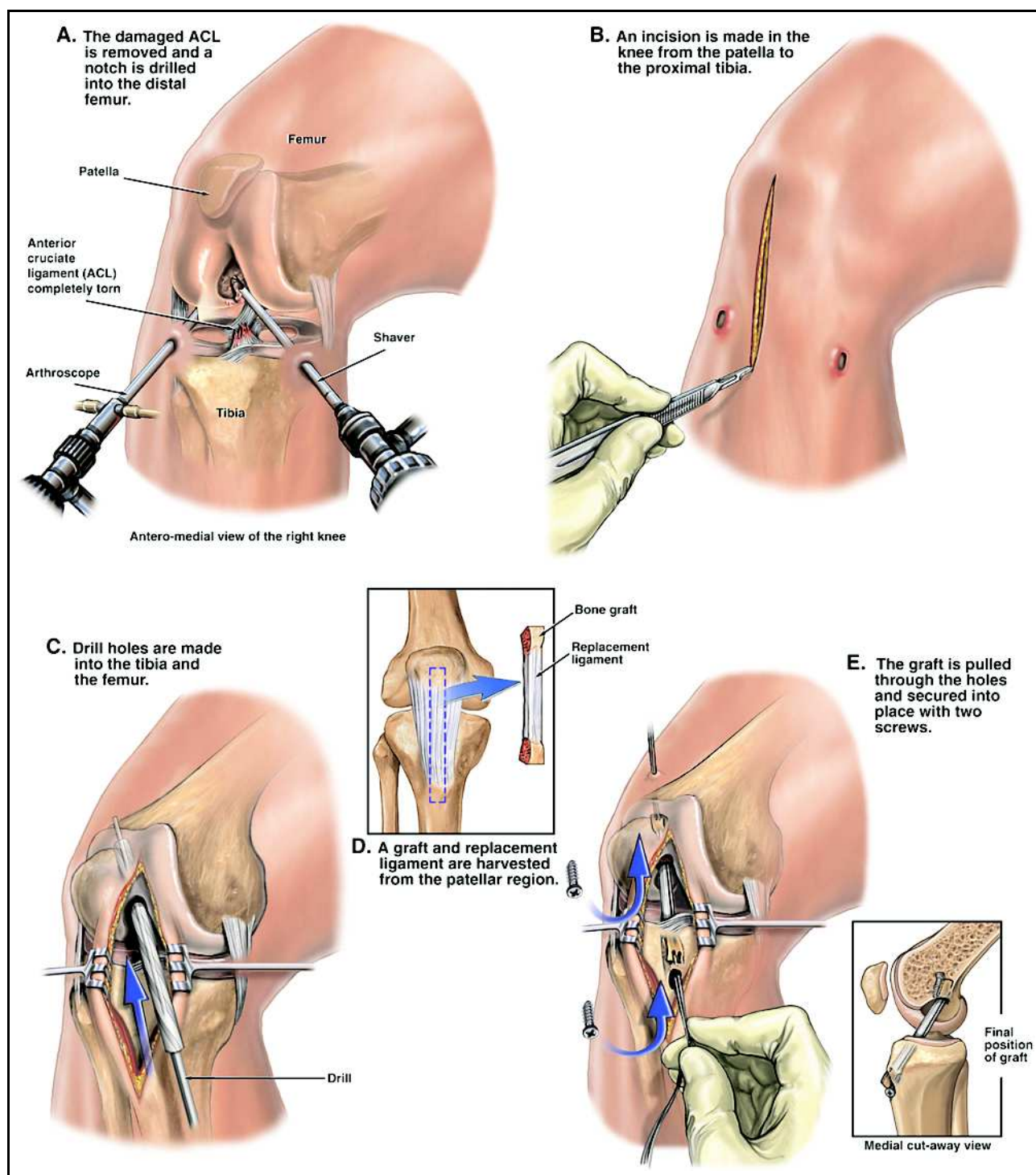
While the clear advantages of arthroscopic surgery lie in surgery with less anesthetic, less cutting, and less recovery time, this surgery nonetheless requires a very thorough examination of the causes of knee injury or pain prior to a decision for surgery.

### Purpose

There are many procedures that currently fall under the general surgical category of knee arthroscopy. They fall into roughly two groups—acute injuries that

destabilize the knee, and **pain management** for floating or displaced cartilage and rough bone. Acute injuries are usually the result of traumatic injury to the knee tissues such as ligaments and cartilage through accidents, sports movements, and some overuse causes. Acute injuries involve damage to the mechanical features, including ligaments and patella of the knee. These injuries can result in knee instability, severe knee dislocations, and complete lack of knee mobility. Ligament, tendon, and patella placements are key elements of the surgery. The type of





The surgical reconstruction of the anterior cruciate ligament of the knee. (Nucleus Medical Art, Inc./Alamy)

treatment for acute injuries depends in large part on a strict grading system that rates the injury. For instance, grades I and II call for rest, support by crutches or leg

brace, pain management, and rehabilitation. Grades III and IV indicate the need for surgery. Acute injuries to the four stabilizing ligaments of the knee joint—the anterior

## KEY TERMS

**Anterior cruciate ligament (ACL)**—A crossing ligament that attaches the femur to the tibia and stabilizes the knee against forward motion of the tibia.

**Knee surgery**—Refers primarily to knee repair, replacement or revision of parts of the knee, both tissue and bond, and includes both arthroscopic and open surgeries.

**Lateral release surgery**—Release of tissues in the knee that keep the kneecap from tracking properly in its groove (sulcus) in the femur; by realigning or tightening tendons, the kneecap can be forced to track properly.

**Meniscus**—The fibrous cartilage within the knee joint that covers the surfaces of the femur and the tibia as they join the patella.

cruciate ligament (ACL), the posterior cruciate ligament (PCL), the medial collateral ligament (MCL), and the lateral collateral ligament (LCL)—as well as to the “tracking,” or seating of the patella, can be highly debilitating.

Treatment of these acute injuries include such common surgeries as:

- Repairs of a torn ligament or reconstruction of the ligament.
- Release of a malaligned kneecap. This involves tendon surgery to release and fit the patella better into its groove.
- Grafts to ligaments to support smoother tracking of the knee with the femur.

Pain management surgeries, on the other hand, are used to relieve severe discomfort of the knee due to osteoarthritis conditions. These treatments aim at relieving pain and instability caused by more chronic, “wear and tear” kinds of conditions and involve minor and more optional surgical procedures to treat cartilage and bone surfaces. These include arthroscopic techniques to remove detached or obtruding pieces of cartilage in the joint space such as the meniscus (a fibrous cushion for the patella), to smooth aged, rough surface bone, or to remove parts of the lining of the joint that are inflamed.

Treatment distinctions between arthroscopic surgery for acute injuries and those for pain management are important and should be kept in mind. They have implications for the necessity for surgery, risks of surgery, complications, aftercare, and expectations for improvement. Arthroscopic surgery for acute injuries is less controversial because clear dysfunction and/or severe instability are measurable indications for surgery and

easily identifiable. Surgery indications for pain management are largely for chronic damage and for the milder grades or stages of acute injuries (severity Grade I and II). These are controversial due to the existence of pain management and rehabilitation alternatives. Arthroscopic surgery for pain management is currently under debate.

## Demographics

More than five and a half million people visit orthopedic surgeons each year because of knee problems. Over 650,000 arthroscopic surgeries are performed annually; 85% of them are for knee surgery. One very common knee injury is a torn anterior cruciate ligament (ACL) that often occurs in athletic activity. The most common source of ACL injury is skiing. Approximately 350,000 people in the United States sustain a torn or ruptured ACL each year. Research indicates that ACL injuries are on the rise in the United States due to the increase in sport activity.

The incidence of ACL injuries in women is two to eight times greater than in men. While the exact causes are not clear, differences in anatomy, strength, or conditioning are thought to play major roles. Women also seem to be more prone to patella-femoral syndrome (PFS), which is the inability of the patella to track smoothly with the femur. PFS is due primarily to development of tendons that influence the ways in which the knee tracks in movement. It can also be due to misalignments to other parts of the lower body like foot pronation. Other ligament surgeries can be caused by injury or overuse.

Knee dislocations are a focus of recent research because of their increasing frequency. Incidences range from 0.001% to 0.013% of all patients evaluated for orthopedic injuries. Many of these injuries heal without treatment and go undetected. Many people with multiple traumas in accidents have knee dislocations that go undiagnosed. Knee dislocations are of special concern, especially in traumatic injury, because their early diagnosis is required if surgery is to be effective. Knee dislocations in the morbidly obese individuals often occur spontaneously and may be associated with artery injury. This surgery involves complications related to the obesity. Finally, knee dislocations have been reported to occur in up to 6% of trampoline-associated accidents.

## Description

### *Arthroscopic surgery for acute injuries*

The knee bone sits between the femur and the tibia, attached by four ligaments that keep the knee

stable as the leg moves. These ligaments can be damaged or torn through injuries and accidents. Once damaged, they do not offer stability to the knee and can cause buckling, or allow the knee to “give way.” Ligaments can also “catch” and freeze the knee or make the knee track in a different direction than its leg movement, causing the knee to dislocate. Traumatic injuries such as automobile accidents may cause more than one ligament injury, necessitating multiple repairs to ligaments.

Four arthroscopic procedures relate to damage to each of the four ligaments that stabilize the knee joint movement. The four procedures are:

- **Anterior cruciate ligament (ACL).** A front-crossing ligament attaching the femur to the tibia through the knee; this ligament keeps the knee from hyperextension or being displaced back from the femur. The ACL is a rather large ligament that can withstand 500 lbs (227 kg) of pressure. If it is torn or becomes detached, it remains that way and surgery is indicated. In the most severe cases, a graft to the ligament is necessary to reattach it to the bone. The surgery can use tissue from the patient, called an autograft, or from a cadaver, called an allograft. The patella tendon, which connects the patella to the tibia, is the most commonly used autograft. ACL reconstructive surgery involves drilling a tunnel into the tibia and the femur. The graft is then pushed through the tunnels and secured by stapling or sutures.
- **Posterior cruciate ligament (PCL).** A back-crossing ligament that attaches the front of the femur to back of the tibia behind the knee that keeps the knee from hyperextension or being displaced backward. PCL injuries are not as frequent as ACL injuries. These injuries are largely due to falls directly on the knee or hitting the knee on the dashboard of a car in an accident. Both displace the tibia too far back and tear the ligament. Surgery to the PCL is rare, because the tear can usually be treated with rest and with rehabilitation. If surgery is required, it is usually to reattach the PCL to the tibia bone.
- **Medial collateral ligament (MCL).** This is an inside lateral ligament connecting the femur and tibia and stabilizing the knee against lateral dislocation to the left or to the right. The injury is usually due to external pressure against the inside of the knee. In the case of a grade I or II collateral ligament tear, doctors are likely to brace the knee for four to six weeks. A grade III tear may require surgery to repair ligament tear and is followed by three months of bracing. Physical therapy may be necessary before resuming full activity.

- **Lateral collateral ligament (LCL).** An outside lateral ligament connecting the femur and tibia and stabilizing the knee against lateral dislocation. In the case of a grade I or II collateral ligament tear, doctors are likely to brace the knee for four to six weeks. A Grade III tear may require surgery to reattach the ligament to bone. Surgery will be followed by three months of bracing. Physical therapy may be necessary before resuming full activity.

### *Patello-femoral syndrome (PFS)*

The patella rests in a groove on the femur. Anything but a good fit can cause the patella to be unstable in its movement and very painful. Some individuals have chronic problems with the proper tracking of the patella with the femur. This may be associated with conditions related to physical features like foot pronation, or to types of body development in exercising or overuse of muscles. In the case of damage, an examination of the cartilage surrounding the patella can identify cartilage that increases friction as the patella moves. Smoothing the damaged cartilage can increase the ease of movement and eliminate pain. Finally, a tendon can occasionally make the patella track off center of the femur. By moving where the tendon is attached through lateral release surgery, the patella can be forced back into its groove.

### *Pain management with lavage and debridement*

In addition to the ligament and patella surgeries that are largely required for traumatic injuries, arthroscopic surgery treats the wear and tear injuries related to a torn meniscus, which is the crescent-shaped cartilage that cushions the knee, as well as injuries to the surface of bone that makes joint movement painful. These are related to osteoarthritis and rheumatoid arthritis.

In lavage and debridement, the surgeon identifies floating or displaced tissue pieces and either flushes them out with a solution applied with arthroscopy or smooths the surface of bone to decrease pain. These two surgical treatments are controversial because research has not indicated that alternatives to surgery are not as successful.

All of the above procedures are conducted through the visualization offered by the lighted arthroscope that allows the surgeon to follow the surgery on a television monitor. Instruments only about 0.15 in (4 mm) thick are inserted in a triangular fashion around the knee. The arthroscope goes in one incision, and instruments to cut and/or smooth and to engage in other maneuvers are put through the other incisions. In this fashion, the surgeon



has magnification, perspective, and the ability to make tiny adjustments to the tissue without open surgery. The triangular approach is highly effective and safe.

## Diagnosis/Preparation

Disease and injury can damage joints, ligaments, cartilage, and bone surfaces. Because the knee carries most of the weight of the body, this damage occurs almost inevitably as people age, due to sports injuries and through accidents.

The diagnosis of knee injuries or damage includes a medical history, **physical examination**, x rays, and the additional, more detailed imaging techniques with **MRI** or **CT scan**. Severe or chronic pain and/or knee instability initially brings the patient to an orthopedic physician. From there, the decision is made for surgery or for rehabilitation. Factors that influence the decision for surgery are the likelihood for repair and recovery of function, the patient's health and age, and, most importantly, the willingness of the patient to consider changes in lifestyle, especially as this relates to sport activity. Arthroscopic viewing is the most accurate tool for diagnosis, as well as for some repairs. The surgeon may provide only a provisional diagnosis until the actual surgery but will apprise the patient of the most likely course the surgery will take.

Arthroscopic surgery can be performed under local, regional, or general anesthetic. The type used depends largely upon the severity of damage, the level of pain after surgery, patient wishes, and patient health. The surgery is brief, less than two hours. After closing the incisions, the leg will be wrapped tightly and the patient is taken to recovery. For most same-day surgeries, individuals are allowed to leave once the anesthetic effects have worn off. Patients are not allowed to drive. Arrangements for pick up after surgery are mandated.

Unlike open surgery, arthroscopic surgery generally does not require a hospital stay. Patients usually go home the same day. Any crutches or canes required prior to surgery will be needed after surgery. Follow-up visits will be scheduled within about a week, at which point **dressings** will be removed.

## Aftercare

### *Ligament- and patella-tracking surgeries*

Arthroscopic surgery for severe ligament damage or knee displacement often involves ligament grafting. In some cases, this includes taking tissue from a tendon to use for the graft and drilling holes in the femur or tibia or both. Aftercare involves the use of crutches for six to

eight weeks. A rehabilitation program for strengthening is usually suggested. Recovery times for resumed athletic activity are highly dependent on age and health. The surgeon often makes very careful assessments about recovery and the need for rehabilitation.

Patella-tracking surgeries offer about a 90% chance that the patella will no longer dislocate. However, many people have continued swelling and pain after surgery. These seem to be dependent upon how carefully the rehabilitation plan is developed and/or adhered to by the patient.

### *Lavage and debridement surgeries*

Elevation of the leg after surgery is usually required for a short period. A crutch or knee immobilizer adds additional stability and assurance when walking. Physical therapy is usually recommended to strengthen the muscles around the knee and to provide extra support. Special attention should be paid to any changes to the leg a few days after surgery. Swelling and pain to the leg can mean a blood clot has been dislodged. If this occurs, the physician should be notified immediately. Getting out of bed shortly after surgery decreases the risk of blood clots.

## Risks

The risks of arthroscopic surgery are much less than open surgery, but they are not nonexistent. The risk of any surgery carries with it danger in the use of anesthesia, including heart attacks, strokes, pneumonia, and blood clots. The risks are rare, but they increase with the age of the patient. Blood clots are the most common dangers, but they occur infrequently in arthroscopic surgery. Other risks include infections at the surgery site or at the skin level, bleeding, and skin scars.

Risks related specifically to arthroscopic surgery are largely ones related to injury at the time of surgery. Arteries, veins, and nerves can be injured, resulting in discomfort in minor cases and leg weakness or decreased sensation in more serious complications. These injuries are rare. One major risk of arthroscopic surgery to the knee for conditions related to tissue tears is that the pain may not be relieved by the operation; it may even become worse.

## Normal results

Normal results of ligament surgery are pain, initial immobility and inflexibility, bracing of the leg, crutch dependence, with increasing mobility and flexibility with rehabilitation. Full recovery to the level of prior physical activity can take up to three months.



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Surgery is performed by an orthopedic surgeon, a specialist in joint and bone surgery, trained in arthroscopic surgery. Arthroscopic surgery is usually performed in a general hospital with an outpatient operating suite.

With ACL surgery, pain in the front of the knee occurs in 10–20% of individuals. Limited range of motion occurs in less than 5% due to inadequate placement of the graft. A second surgery may be necessary.

Research indicates that the pain-relieving effects for arthroscopic partial meniscectomy (removal of torn parts of cartilage) and debridement (the abrasion of cartilage to make it smooth) are not very reliable. Pain relief varies between 50% and 75%, depending upon the age, activity level, degree of damage, and extent of follow-up. One study indicates that the two surgical procedures, lavage and debridement, fared no better than no surgical procedure in relieving pain. The participants were divided into three groups for arthroscopic surgery: one third underwent debridement, a second third underwent lavage, and the remaining third likewise were anesthetized and had three incisions made in the knee area, though no procedure was performed. All three groups reported essentially the same results. Each had slightly less pain and better knee movement. The non-procedure had the best results. Debates about normal expectations from minor arthroscopic surgery continue with many surgeons believing that arthroscopic surgery of the knee should be restricted to acute injuries.

### Morbidity and mortality rates

Complications occur in less than 1% of arthroscopic surgeries. Different procedures have different complications. In general, morbidity results mostly from medically induced nerve and vascular damage; **death** or amputations almost never occur. Graft infection may occur, along with other types of infection largely due to microbes introduced with instruments. The latter cases are becoming increasingly rare as the science of arthroscopic surgery develops.

### Alternatives

Whether or not surgical treatment is the best choice depends on a number of factors and alternatives. Age and the degree of injury or damage are key to deciding

## QUESTIONS TO ASK THE DOCTOR

- Are there rehabilitation alternatives to this surgery?
- Will this surgery allow me to return to sports?
- How much success have you had with this surgery in eliminating pain?
- Is this injury one that I can live with if I pursue a change in lifestyle?
- How long will post-operative rehabilitation take and how can I help in moving it along faster?

whether to have surgery or rehabilitation. The physician calibrates the severity of acute injuries and either proceeds to a determined treatment plan immediately or recommends surgery. Alternatives for acute ligament injuries depend on the severity of injury and whether the patient can make lifestyle changes and is willing to move away from athletic activities. This decision becomes paramount for many people with collateral and cruciate injuries.

According to the American Association of Orthopedic Surgeons, conservative treatment for acute injuries involves RICE: Rest, Ice, Compression, Elevation, as well as a follow-up rehabilitation plan. The RICE protocol involves resting the knee to allow the ligament to heal, applying ice two or three times a day for 15–20 minutes, compression with a bandage or brace, and elevation of the knee whenever possible. Rehabilitation requires range-of-motion exercises to increase flexibility, braces to control joint immobility, **exercise** for quadriceps to support the front of the thigh, and upper thigh exercise with a bicycle.

For arthritis-related damage and pain management, anti-inflammatory medication, weight loss, and exercise can all be crucial to strengthening the knee to relieve pain. Evidence suggests that these alternatives work as well as surgery.

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#### ORGANIZATIONS

- American Academy of Orthopaedic Surgeons (AAOS). 6300 North River Rd. Suite 200, Rosemont, IL 60018. (847) 823 7186 or (800) 346 2267; Fax: (847) 823 8125. <http://www.aaos.org>.
- Arthritis Foundation. P.O. Box 7669, Atlanta, GA 30357 0669. (800) 283 7800. [www.arthritis.org](http://www.arthritis.org).
- National Institute of Arthritis and Musculoskeletal and Skin Diseases Information Clearinghouse. 1 AMS Circle, Bethesda, MD 20892 3675. (301) 495 4484 or (877) 226 4267; Fax: (301) 718 6366; TTY: (301) 565 2966. <http://www.nih.gov/niams>.

#### OTHER

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Nancy McKenzie, PhD

## Knee osteotomy

### Definition

Knee osteotomy is surgery that removes a part of the bone of the joint of either the bottom of the femur (upper leg bone) or the top of the tibia (lower leg bone) to increase the stability of the knee. Osteotomy redistributes the weight-bearing force on the knee by cutting a wedge of bone away to reposition the knee. The angle of deformity in the knee dictates whether the surgery is to correct a knee that angles inward, known as a varus procedure, or one that angles outward, called a valgus procedure. Varus osteotomy involves the medial (inner) section of the knee at the top of the tibia. Valgus osteotomy involves the lateral (outer) compartment of the knee by shaping the bottom of the femur.

### Purpose

Osteotomy surgery changes the alignment of the knee so that the weight-bearing part of the knee is shifted off diseased or deformed cartilage to healthier tissue in order to relieve pain and increase knee stability. Osteotomy is effective for patients with arthritis in one compartment of the knee. The medial compartment is on the inner side of the knee. The lateral compartment is on the outer side of the knee. The primary uses of osteotomy occur as treatment for:

- Knee deformities such as bowleg in which the knee is varus-leaning (high tibia osteotomy, or HTO) and knock-knee (tibial valgus osteotomy), in which the knee is valgus leaning.
- A torn anterior cruciate ligament (ACL), which is a set of ligaments that connects the femur to the tibia behind the patella and offers stability to the knee on the left-right or medial-lateral axis. If this ligament is injured, it must be repaired by surgery. Many ACL injuries cause inflammation of the cartilage of the knee and result in bones extrusions, as well as instability of the knee due to malalignment. Osteotomy is performed to cut cartilage and increase the fit and alignment of the ends of the femur and tibia for smooth articulation. As one very common knee injury that often occurs in athletic activity, HTO is often performed when ACL surgery is used to repair the ligament. The combination of the two surgeries occurs primarily in young people who wish to return to a highly athletic life.
- Osteoarthritis that includes loss of range of motion, stiffness, and roughness of the articular cartilage in the knee joint secondary to the wear and tear of motion, especially in athletes, as well as cartilage breakdown resulting from traumatic injuries to the knee. Surgery for progressive osteoarthritis or injury-induced arthritis is often used to stave off total joint replacement.

### Demographics

According to "Healthy People 2000, Final Review," published by the Centers for Disease Control and Prevention, the various forms of arthritis "the leading cause of disability in the United States" affect more than 15% of the total U.S. population (43 million persons) and more than 20% of the adult population. Osteoarthritis (OA) is the most common form of knee arthritis and involves a slowly progressive degenerative disease in which the joint cartilage gradually wears away. It most often affects middle-aged and older people. The most common source of ACL injury is skiing. Approximately 250,000 people sustain a

torn or ruptured ACL in the United States each year. Research indicates that ACL injuries are on the rise in the United States due to the increase in sport activity.

### Description

Osteotomy is performed as open surgery to the knee assisted by pre-operative arthroscopic diagnostic techniques. Surgery takes place on the tibia end or the femoral end at the knee according to whether the malalignment to be corrected is varus, or inward leaning, or valgus, outward leaning. The surgery involves the gaping or wedging of a piece of bone and its removal to change the pressure points of weight-bearing activity. The cut surfaces of the bone are held together with two **staples**, or a plate and screws. Other devices may be used, especially in tibial osteotomy where a fracture is involved. After surgery, a small plastic suction drain is left in the wound during recovery and early postoperative hospitalization.

### Diagnosis/Preparation

Severe or chronic pain and/or knee instability brings the patient to an orthopedic physician. From there, the decision is made for surgery or for rehabilitation. Patients will undergo an examination and history with their physician. Once rehabilitation or other treatments are ruled out and surgery is indicated, the physician must assess for three factors: pain, instability, and knee alignment. Osteotomy is indicated if malalignment is a factor. **Debridement**, or the shaving of cartilage on the articulate femur or tibia, can usually resolve pain with instability problems. It must be determined whether the instability is related to malalignment and not to other sources such as ACL injury. Since the goal of osteotomy is to shift weight from a symptomatic cartilage to an asymptomatic area to relieve both an instability and pain due to excessive contact, alignment of the knee is assessed for pressure distribution along the mechanical axis and the loading axis. This requires an analysis of gait pattern, range of motion, localized areas of pain, and neurological factors, as well as other technical tests for anterior instability. A diagnostic arthroscopy—examination of the knee joint with a long tube attached to a video camera—is usually indicated before all knee osteotomies. Cartilage surfaces are examined for degenerative or late-stage arthritis. **Magnetic resonance imaging (MRI)** is useful in evaluating any intra-articular pathology such as bone chips, padding tears, or injuries to ligaments.

## KEY TERMS

**High tibial osteotomy (HTO)**—The tibial bone is cut to redistribute weight on the knee for varus alignment deformities or injuries.

**Osteotomy of the knee**—Realignment of the knee, using bone cutting to shift weight bearing from damaged cartilage to healthier cartilage.

**Valgus alignment**—Alignment of the knee that angles outward due to injury or deformity.

**Varus alignment**—Alignment of the knee that angles inward due to injury or deformity.

### Aftercare

After surgery, patients are placed in a hinged brace. Toe-touching is the only weight-bearing activity allowed for four weeks in order to allow the osteotomy to hold its place. Continuous passive motion is begun immediately after surgery and physical therapy is used to establish full range of motion, muscle strengthening, and gait training. After four weeks, patients can begin weight-bearing movement. The brace is worn for eight weeks or until the surgery site is healed and stable. X rays are performed at intervals of two weeks and eight weeks after surgery.

### Risks

The usual general surgical risks of thrombosis and heart attack are possible in this open surgery. Osteotomy surgery itself involves some risk of infection or injury during the procedure. Combined surgery for ACL and osteotomy has higher morbidity rates.

### Normal results

Varus malalignment correction with osteotomy through the high tibia (HTO) is a proven and satisfactory operation. Success rates are high when the patient has a small angle deformity ( $<10^\circ$ ). Knees with more severe deformity have less satisfactory results. Tibial osteotomy for the less common valgus deformity is less satisfactory. Research indicates that only a few individuals are able to return to their previous level of high sports activity after a knee osteotomy, whether done with an ACL repair or not. However, more than half of patients in one study were able to return to leisure sports activities. Reports also indicate that those individuals who had osteotomy without ACL reconstruction had no differences in results with respect to measures of stability. It may take up to a year for the knee to be fully aligned and adapted to its new position after surgery. Most patients, more than 50%, gain

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

An orthopedic surgeon specializing in knee reconstruction surgery performs a knee osteotomy. Surgery takes place in a general hospital.

stability and are able to walk further than they could walk before osteotomy. However, according to one report, 13% of patients had severe pain or needed a total **knee replacement** after five years. In one European review, the results were better. Osteoarthritis was arrested in 105 cases (69%), with 47 cases showing deterioration. The main factors associated with further deterioration were insufficient correction and persistence of malalignment.

### Morbidity and mortality rates

Morbidity rates include bleeding, inflammation of joint tissues, nerve damage, and infection.

### Alternatives

For those individuals suffering from osteoarthritis, muscle-strengthening **exercise**, weight loss, and rehabilitation can be helpful in relieving pain and gaining stability. Anti-inflammatory medications can also be effective in helping pain and stability. For severe varus or valgus deformities, osteotomy or knee replacement may be indicated. For those with severe ACL injury with secondary trauma to knee cartilage, complete knee replacement may be suggested.

### Resources

#### BOOKS

Canale, S. T. *Campbell's Operative Orthopedics*. St. Louis: Mosby, 2003.

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Ruddy, Shaun, et al., eds. *Kelly's Textbook of Rheumatology*, 6th ed. Philadelphia: WB Saunders Publishing, 2001.

Skinner, Harry. *Current Diagnosis & Treatment in Orthopedics*. New York: McGraw Hill, 2006.

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Shubin Stein, B. E., R. J. William, and T. L. Wickiewicz. "Arthritis and Osteotomies in Anterior Cruciate Ligament Reconstruction." *Orthopedic Clinics of North America* 34, no. 1 (January 2003).

## QUESTIONS TO ASK THE DOCTOR

- Are there lifestyle changes, weight, diet, or rehabilitative factors that can help avoid this surgery?
- How many of your patients have been able to return to normal activities such as walking, running, and climbing stairs after surgery?
- How many of your patients have been able to return to exercise and to other athletic activities?
- Is this surgery just putting off my need for knee replacement surgery?
- How many of these surgeries have you performed?

### ORGANIZATIONS

American Academy of Orthopaedic Surgeons. 6300 North River Road, Rosemont, IL 60018 4262. (847) 823 7186 or (800) 346 2267. <http://www.aaos.org/wordhtml/home2.htm>.

American College of Surgeons. 633 North Saint Claire Street, Chicago, IL 60611. (312) 202 5000. <http://www.facs.org/>.

American Society for Bone and Mineral Research. 2025 M Street, NW, Suite 800, Washington, DC 20036 3309. (202) 367 1161. <http://www.asbmr.org/>.

Arthritis Foundation. P.O. Box 7669, Atlanta, GA 30357 0669. (800) 283 7800. <http://www.arthritis.org>.

National Institute of Arthritis and Musculoskeletal and Skin Diseases Information Clearinghouse. 1 AMS Circle, Bethesda, MD 20892 3675. (301) 495 4484, Toll Free (877) 226 4267. Fax: (301) 718 6366. TTY: (301) 565 2966. [www.nih.gov/niams](http://www.nih.gov/niams).

### OTHER

"Osteotomy for Osteoarthritis." *WebMD Health*. <http://www.webmd.com>.

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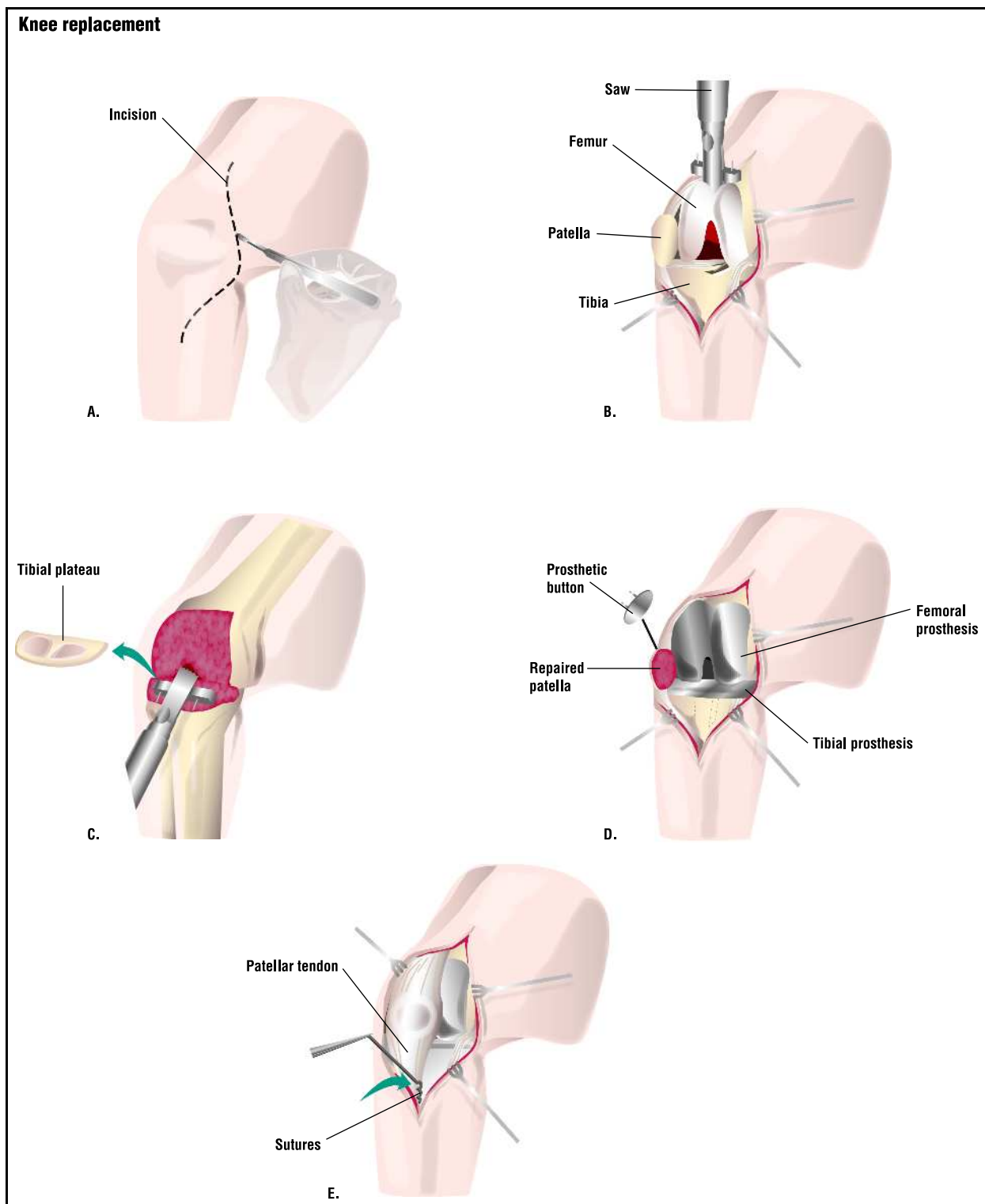
Knee prosthesis surgery see **Knee revision surgery**

## Knee replacement

### Definition

Knee replacement is a procedure in which the surgeon removes damaged or diseased parts of the patient's knee joint and replaces them with new





In a total knee replacement, an incision is made to expose the knee joint (A). The surfaces of the femur are cut with a saw to receive the prosthesis (B). The tibia is cut to create a plateau (C). The prostheses for the femur, tibia, and patella are put in place (D). The incision is closed (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Analgesic**—A medication given to relieve pain.

**Arthroplasty**—The medical term for surgical replacement of a joint. Arthroplasty can refer to hip as well as knee replacement.

**Arthroscope**—An instrument that contains a miniature camera and light source mounted on a flexible tube. It allows a surgeon to see the inside of a joint or bone during surgery.

**Autologous blood**—The patient's own blood, drawn and set aside before surgery for use during surgery in case a transfusion is needed.

**Biomechanics**—The application of mechanical laws to the structures in the human body, such as measuring the force and direction of stresses on a joint.

**Bursitis**—Inflammation of a bursa, which is a sac-like cavity filled with fluid that protects the tissues around certain joints in the body from friction. Bursitis of the knee frequently develops as a result of activities requiring frequent bending and kneeling, such as housecleaning.

**Cartilage**—A whitish elastic connective tissue that allows the bones forming the knee joint to move smoothly against each other.

**Cortisone**—A steroid compound used to treat autoimmune diseases and inflammatory conditions. It is sometimes injected into a joint to relieve the pain of arthritis.

**Debridement**—Surgical removal of foreign material and dead or contaminated tissue from a wound or the area of an incision.

**Disease-modifying antirheumatic drugs (DMARDs)**—A group of medications that can be given to slow or stop the progression of rheumatoid arthritis. DMARDs include such drugs as oral or injectable gold, methotrexate, leflunomide, and penicillamine.

**Fibula**—The smaller of the two bones in the lower leg.

**Ligament**—A band of fibrous tissue that connects bones to other bones or holds internal organs in place.

**Meniscus (plural, menisci)**—One of two crescent-shaped pieces of cartilage attached to the upper surface of the tibia. The menisci act as shock absorbers within the knee joint.

**Nonsteroidal anti-inflammatory drugs (NSAIDs)**—A term used for a group of analgesics that also reduce inflammation when used over a period of time. NSAIDs are often given to patients with osteoarthritis.

**Orthopedics (sometimes spelled orthopaedics)**—The branch of surgery that treats deformities or disorders affecting the musculoskeletal system.

**Orthotics**—Shoe inserts that are intended to correct an abnormal or irregular gait or walking pattern. They are sometimes prescribed to relieve gait-related knee pain.

**Patella**—The medical term for the knee cap. The patella is a triangular bone located at the front of the knee.

**Prosthesis (plural, prostheses)**—An artificial device that substitutes for or supplements a missing or damaged body part. Prostheses may be either external or implanted inside the body.

**Quadriceps muscles**—A set of four muscles on each leg located at the front of the thigh. The quadriceps straighten the knee and are used every time a person takes a step.

**Tibia**—The larger of two leg bones that lie beneath the knee. The tibia is sometimes called the shin bone.

artificial parts. The operation itself is called knee **arthroplasty**. Arthroplasty comes from two Greek words, *arthros* or joint and *plassein*, “to form or shape.” The artificial joint itself is called a prosthesis. Most knee prostheses have four components or parts, and are made of a combination of metal and plastic, or metal and ceramic in some newer models.

### Purpose

Knee arthroplasty has two primary purposes: pain relief and improved functioning of the knee

joint. Because of the importance of the knee to a person's ability to stand upright, improved joint functioning includes greater stability in the knee.

### Pain relief

Total knee replacement, or TKR, is considered major surgery. Therefore, it is usually not considered a treatment option until the patient's pain cannot be managed any longer by more conservative treatment. Alternatives to surgery are described below.

Pain in the knee may be either a sudden or gradual development, depending on the cause of the pain. Knee pain resulting from osteoarthritis and other degenerative disorders may develop gradually over a period of years. On the other hand, pain resulting from an athletic injury or other traumatic damage to the knee, or from such conditions as infectious arthritis or gout, may come on suddenly. Because the structure of the knee is complex and many different disorders or conditions can cause knee pain, the cause of the pain must be diagnosed before joint replacement surgery can be discussed as an option.

### *Joint function*

Restoration of joint function and stability is the other major purpose of knee replacement surgery. It is helpful to have a brief outline of the major structures in the knee joint in order to understand the types of disorders and injuries that can make joint replacement necessary as well as to understand the operation itself.

The knee is the largest joint in the human body, as well as one of the most vulnerable. Unlike the hip joint, which is partly protected by the bony structures of the pelvis, the knee joint is not shielded by any other parts of the skeleton. In addition, the knee joint must bear the weight of the upper body as well as the stresses and shocks carried upward through the feet when a person walks or runs. Moreover, the knee is essentially a hinge joint, designed to move primarily backwards and forwards; it is not a ball-and-socket joint like the hip, which can swivel and rotate in a variety of directions. Many knee injuries result from stresses caused by twisting or turning movements, particularly when the foot remains in one position while the upper body changes direction rapidly, as in basketball, tennis, or skiing.

The normal knee joint consists of a bone, the patella or kneecap, and a set of tendons, ligaments, and cartilage disks that connect the femur, or thigh-bone, to the lower leg. There are two bones in the lower leg, the tibia, which is sometimes called the shinbone; and the fibula, a smaller bone on the outside of the lower leg. There are two collateral ligaments on the outside of the knee joint that connect the femur to the tibia and fibula respectively. These ligaments help to control the stresses of side-to-side movements on the knee. The patella—a triangular bone at the front of the knee—is attached by tendons to the quadriceps muscles of the thigh. This tendon allows a person to straighten the knee. Two additional tendons inside the knee stretch between the femur and the tibia to prevent the tibia from moving out of alignment with the femur. Cartilage, which is a whitish elastic tissue that allows

bones to glide smoothly against each other, covers the ends of the femur, tibia, and fibula as well as the surfaces of the patella. In addition to the cartilage that covers the bones, the knee joint also contains two crescent-shaped disks of cartilage known as menisci (singular, meniscus), which lie between the lower end of the femur and the upper end of the tibia and act as shock absorbers or cushions. The entire joint is surrounded by a thick layer of protective tissue known as the joint capsule.

Disorders and conditions that may lead to knee replacement surgery include:

- **Osteoarthritis (OA).** Osteoarthritis is a disorder in which the cartilage in the knee joint gradually breaks down, allowing the surfaces of the bones to rub directly against each other. The patient experiences swelling, pain, inflammation, and increasing loss of mobility. OA most often affects adults over age 45, and is thought to result from a combination of wear and tear on the joint, lifestyle, and genetic factors. As of 2003, OA is the most common cause of joint damage requiring knee replacement.
- **Rheumatoid arthritis (RA).** Rheumatoid arthritis is a disease that begins earlier in life than OA and affects the whole body. Women are three times as likely as men to develop RA. Its symptoms are caused by the immune system's attacks on the body's own cells and tissues. Patients with RA often suffer intense pain even when they are not putting weight on the affected joints.
- **Trauma.** Damage to the knee from a fall, automobile accident, or workplace or athletic injury may trigger the process of cartilage breakdown inside the joint. Trauma is a common cause of damage to the knee joint. Some traumatic injuries are caused by repetitive motion or overuse of the knee joint; these types of injury include bursitis, or housemaid's knee, and so-called runner's knee. Other traumatic injuries are caused by sudden twisting of the knee, a direct blow to a bent knee, or being tackled from the side in football.

There are several factors that increase a person's risk of eventually requiring knee replacement surgery. While some of these factors cannot be avoided, others can be corrected through lifestyle changes:

- **Genetic.** Both OA and RA tend to run in families. One study done in France reported that the genetic factors affecting osteoarthritis in the knee can be traced back almost 8,000 years. Both OA and RA, however, are polygenic disorders, which means that more than one gene is involved in transmitting susceptibility to these forms of arthritis.

- **Age.** Knee cartilage becomes thinner and weaker with age, even in people who have no family history of arthritis.
- **Sex.** Women athletes have three times as many knee injuries as men. At present, orthopedic specialists are conducting studies to determine the cause(s) of this difference. Some doctors think it is related to the fact that most women have wider hips than most men, which results in a different pattern of stresses on the knee joint. Others think that the ligaments in women's knees tend to loosen more easily.
- **Biomechanical.** Biomechanics refers to the study of body structures in terms of the laws of mechanics, such as measuring the forces that affect the operation of a joint. Biomechanical studies have shown that people with certain types of leg or foot deformities, such as bowlegs or difference in leg length, are at increased risk of knee disorders because the stresses on the knee joint are not distributed normally.
- **Gait-related factors.** Gait refers to a person's pattern of motion when walking or running. Some people walk with their feet turned noticeably outward or inward; others tend to favor either the heel or the toe when they walk, which makes their gait irregular. Any of these factors can increase strain on the knee joint.
- **Shoes.** Poorly fitted or worn-out shoes contribute to knee strain by increasing the force transmitted upward to the knee when the foot strikes the sidewalk or other hard surface. They also introduce or increase irregularities in gait. Women's high-heeled shoes are particularly harmful to the knee joint because they do not cushion the foot; and they cause prolonged tightening and fatigue of the leg muscles.
- **Work or other activities that involve jumping, jogging, or squatting.** Jogging tends to loosen the ligaments that hold the parts of the knee joint in alignment, while jumping increases the shock on the knee joint and the risk of twisting or tearing the knee joint when the person lands. Squatting can increase the forces on the knee joint as much as eight times body weight.

## Demographics

According to the American Academy of Orthopaedic Surgeons (AAOS), there are about 300,000 knee replacement operations performed each year in the United States. Although about 70% of these operations are performed in people over the age of 65, a growing number of knee replacements are being done in younger patients. Most surgeons expect to see the proportion of knee arthroplasties performed in younger patients continue to rise. One reason for this

trend is improvements in surgical technique, as well as the design and construction of knee prostheses since the first knee replacement was performed in 1968. Minimally invasive surgical techniques are allowing knee replacements to be performed with shorter recovery times, fewer complications, and less pain. A second reason is people's changing attitudes toward aging and their expectations of an active life after retirement. Fewer are willing to endure years of discomfort or resign themselves to a restricted level of activity.

In terms of gender and racial differences, women are slightly more likely to seek knee replacement surgery than men, and Caucasians in the United States are more likely to have the operation than African Americans. Researchers have suggested that one reason for the racial difference is a difference in social networks. People in general are influenced in their health care decisions by the experiences and opinions of friends or family members, and Caucasians are more likely than African Americans to know someone who has had knee replacement surgery.

## Description

The length and complexity of a total knee replacement operation depend in part on whether both knee joints are replaced during the operation or only one. Such disorders as osteoarthritis usually affect both knees, and some patients would rather not undergo surgery twice. Replacement of both knees is known as bilateral TKR, or bilateral knee arthroplasty. Bilateral knee replacement seems to work best for patients whose knees are equally weak or damaged. Otherwise most surgeons recommend operating on the more painful knee first so that the patient will have one strong leg to help him or her through the recovery period following surgery on the second knee. The disadvantages of bilateral knee replacement include a longer period of time under anesthesia; a longer hospital stay and recovery period at home; and a greater risk of severe blood loss and other complications during surgery.

If the operation is on only one knee, it will take two to four hours. The patient may be given a choice of general, spinal, or epidural anesthesia. An epidural anesthetic, which is injected into the space around the spinal cord to block sensation in the lower body, causes less blood loss and also lowers the risk of blood clots or breathing problems after surgery. After the patient is anesthetized, the surgeon will make an incision in the skin over the knee and cut through the joint capsule. A standard incision may be used, or minimally invasive surgical techniques may dictate a more limited incision be utilized. In either



case, the surgeon must be careful in working around the tendons and ligaments inside the joint. Knee replacement is a more complicated operation than **hip replacement** because the hip joint does not depend as much on ligaments for stability. The next step is cutting away the damaged cartilage and bone at the ends of the femur and tibia. The surgeon reshapes the end of the femur to receive the femoral component, or shell, which is usually made of metal and attached with bone cement.

After the femoral part of the prosthesis has been attached, the surgeon inserts a metal component into the upper end of the tibia. This part is sometimes pressed rather than cemented in place. If it is a cementless prosthesis, the metal will be coated or textured so that new bone will grow around the prosthesis and hold it in place. A plastic plate called a spacer is then attached to the metal component in the tibia. The plastic allows the femur and tibia to move smoothly against each other.

Lastly, another plastic component is glued to the rear of the patella, or kneecap. This second piece of plastic prevents friction between the kneecap and the other parts of the prosthesis. After all the parts of the prosthesis have been implanted, the surgeon will check them for proper positioning, make certain that the tendons and ligaments have not been damaged, wash out the incision with sterile saline solution, and close the incision.

## Diagnosis/Preparation

### *Patient history*

The first part of a diagnostic interview for knee pain is the careful taking of the patient's history. The doctor will ask not only for a general medical history, but also about the patient's occupation, **exercise** habits, past injuries to the knee, and any gait-related problems. The doctor will also ask detailed questions about the patient's ability to move or flex the knee; whether specific movements or activities make the pain worse; whether the pain is sharp or dull; its location in the knee; whether the knee ever buckles or catches; and whether there are clicking or popping sounds inside the joint.

### *Diagnostic tests*

**PHYSICAL EXAMINATION OF THE KNEE.** Following the history, the doctor will examine the knee itself. The knee will be checked for swelling, reddening, bruises, breaks in the skin, lumps, or other unusual features while the patient is standing. The doctor will also make note of the patient's posture, including whether

the patient is bowlegged or knock-kneed. The patient may be asked to walk back and forth so that the doctor can check for gait abnormalities.

In the second part of the **physical examination**, the patient lies on an examining table while the doctor palpates (feels) the structures of the knee and evaluates the strength or tightness of the tendons and ligaments. The patient may be asked to flex one knee and straighten the leg or turn the knee inward and outward so that the doctor can measure the range of motion in the joint. The doctor will also ask the patient to lie still while he or she moves the knee in different directions.

**IMAGING STUDIES.** The doctor will order one or more imaging studies in order to narrow the diagnosis. A radiograph or x ray is the most common, but is chiefly useful in showing fractures or other damage to bony structures. X-ray studies are usually supplemented by other imaging techniques in diagnosing knee disorders. A computed tomography, or CAT scan, which is a specialized type of x ray that uses computers to generate three-dimensional images of the knee joint, is often helpful in evaluating malformations of the joint. **Magnetic resonance imaging (MRI)** uses a large magnet, radio waves, and a computer to generate images of the knee joint. The advantage of an MRI is that it reveals injuries to ligaments, tendons, and menisci as well as damage to bony structures.

**ASPIRATION.** Aspiration is a procedure in which fluid is withdrawn from the knee joint by a needle and sent to a laboratory for analysis. It is done to check for infection in the joint and to draw off fluid that is causing pain. Aspiration is most commonly done when the knee has swelled up suddenly, but may be performed at any time. Blood in the fluid usually indicates a fracture or torn ligament; the presence of bacteria indicates infection; the presence of uric acid crystals indicates gout. Clear, straw-colored fluid suggests osteoarthritis.

**ARTHROSCOPY.** Arthroscopy can be used to treat knee problems as well as diagnose them. An arthroscope consists of a miniature camera and light source mounted on a flexible fiberoptic tube. It allows the surgeon to look into the knee joint. To perform an arthroscopy, the surgeon will make two to four small incisions known as ports. One port is used to insert the arthroscope; the second port allows insertion of miniaturized **surgical instruments**; the other ports drain fluid from the knee. Sterile saline fluid is pumped into the knee to enlarge the joint space and make it easier for the surgeon to view the knee structures and to cut, smooth, or repair damaged tissue.

### *Preoperative preparation*

Knee replacement surgery requires extensive and detailed preparation on the patient's part because it affects so many aspects of life.

**LEGAL AND FINANCIAL CONSIDERATIONS.** In the United States, physicians and hospitals are required to verify the patient's insurance benefits before surgery and to obtain precertification from the patient's insurer or from **Medicare**. Without health insurance, the total cost of a knee replacement as of early 2003 can run as high as \$38,000. In addition to insurance documentation, patients are legally required to sign an **informed consent** form prior to surgery. Informed consent signifies that the patient is a knowledgeable participant in making healthcare decisions. The doctor will discuss all of the following with the patient before he or she signs the form: the nature of the surgery; reasonable alternatives to the surgery; and the risks, benefits, and uncertainties of each option. Informed consent also requires the doctor to make sure that the patient understands the information that has been given.

**MEDICAL CONSIDERATIONS.** Patients are asked to do the following in preparation for knee replacement surgery:

- Get in shape physically by doing exercises to strengthen or increase flexibility in the knee joint. Specific exercises are described in the books listed below. Many clinics and hospitals also distribute illustrated pamphlets of preoperation exercises.
- Lose weight if the surgeon recommends it.
- Quit smoking. Smoking weakens the cardiovascular system and increases the risks that the patient will have breathing difficulties under anesthesia.
- Make donations of one's own blood for storage in case a transfusion is necessary during surgery. This procedure is known as autologous blood donation; it has the advantage of avoiding the risk of transfusion reactions or transmission of diseases from infected blood donors.
- Check the skin of the knee and lower leg for external infection or irritation, and check the lower leg for signs of swelling. If either is noted, the surgeon should be contacted for instructions about preparing the skin for the operation.
- Have necessary dental work completed before the operation. This precaution is necessary because small numbers of bacteria enter the bloodstream whenever a dentist performs any procedure that causes the gums to bleed. Bacteria from the mouth can be carried to the knee area and cause an infection.
- Discontinue taking birth control pills and any anti-inflammatory medications (aspirin or NSAIDs) two weeks before surgery. Most doctors also recommend discontinuing any alternative herbal preparations at this time, as some of them interact with anesthetics and pain medications.

**LIFESTYLE CHANGES.** Knee replacement surgery requires a long period of **recovery at home** after leaving the hospital. Since the patient's physical mobility will be limited, he or she should do the following before the operation:

- Arrange for leave from work, help at home, help with driving, and similar tasks and commitments.
- Obtain a handicapped parking permit.
- Check the house or apartment thoroughly for needed adjustments to furniture, appliances, lighting, and personal conveniences. People recovering from knee replacement surgery must avoid kneeling, and minimize bending, squatting, and any risk of falling. There are several good guides available that describe household safety and comfort considerations in detail.
- Stock up on nonperishable groceries, cleaning supplies, and similar items in order to minimize shopping.
- Have a supply of easy-care clothing with elastic waistbands and simple fasteners in front rather than complicated ties or buttons in the back. Women may find knit dresses that pull on over the head or wraparound skirts easier to put on than slacks or skirts that must be pulled up over the knees. Shoes should be slip-ons or fastened with Velcro.

Many hospitals and clinics now have "preop" classes for patients scheduled for knee replacement surgery. These classes answer questions about the operation and what to expect during recovery, but in addition they provide an opportunity for patients to share concerns and experiences. Studies indicate that patients who have attended preop classes are less anxious before surgery and generally recover more rapidly.

### **Aftercare**

Aftercare following knee replacement surgery begins while the patient is still in the hospital. Most patients will remain there for five to 10 days after the operation. During this period the patient will be given fluids and antibiotic medications intravenously to prevent infection. Medications for pain will be given every three to four hours, or through a device known as a PCA (patient-controlled anesthesia). The PCA is a small pump that delivers a dose of medication into the IV when the patient pushes a button. To get the lungs back to normal functioning, a respiratory

therapist will ask the patient to cough several times a day or breathe into blow bottles.

Aftercare during the hospital stay is also intended to lower the risk of a venous thromboembolism (VTE), or blood clot in the deep veins of the leg. Prevention of VTE involves medications to thin the blood; exercises for the feet and ankles while lying in bed; and wearing thromboembolic deterrent (TED) or deep vein thrombosis (DVT) stockings. TED stockings are made of nylon (usually white) and may be knee-length or thigh-length; they help to reduce the risk of a blood clot forming in the leg vein by putting mild pressure on the veins.

Physical therapy is also begun during the patient's hospital stay, often on the second day after the operation. The physical therapist will introduce the patient to using a cane or crutches and explain how to manage such activities as getting out of bed or showering without dislocating the new prosthesis. In most cases the patient will spend some time each day on a continuous passive motion (CPM) machine, which is a device that repeatedly bends and straightens the leg while the patient is lying in bed. In addition to increasing the patient's level of physical activity each day, the physical therapist will help the patient select special equipment for recovery at home. Commonly recommended devices include tongs or reachers for picking up objects without bending too far; a sock cone and special shoehorn; and bathing equipment.

Following **discharge from the hospital**, the patient may go to a skilled nursing facility, rehabilitation center, or home. Patients who have had bilateral knee replacement are unlikely to be sent directly home. Ongoing physical therapy is the most important part of recovery for the first four to five months following surgery. Most HMOs in the United States allow home visits by a home health aide, visiting nurse, and physical therapist for three to four weeks after surgery. Some hospitals allow patients to borrow a CPM machine for use at home for a few weeks. The physical therapist will monitor the patient's progress as well as suggest specific exercises to improve strength and range of motion. After the home visits, the patient is encouraged to take up other forms of low-impact physical activity in addition to the exercises; swimming, walking, and pedaling a stationary bicycle are all good ways to speed recovery. The patient may take a mild medication for pain (usually **aspirin** or ibuprofen) 30–45 minutes before an exercise session if needed.

The patient will be instructed to notify his or her dentist about the knee replacement so that extra

precautions can be taken against infection resulting from bacteria getting into the bloodstream during dental work. Some surgeons ask patients to notify them whenever the dentist schedules a **tooth extraction**, root canal, or periodontal work.

## Risks

Serious risks associated with TKR include the following:

- **Loosening or dislocation of the prosthesis.** The risk of dislocation varies, depending on the type of prosthesis used, the patient's level of activity, and the previous condition of the knee joint.
- **Deep vein thrombosis (DVT).** There is some risk (about 1.5% in the United States) of a clot developing in the deep vein of the leg after knee replacement surgery because the blood supply to the leg is cut off by a tourniquet during the operation. The blood-thinning medications and TED stockings used after surgery are intended to minimize the risk of DVT.
- **Infection.** The risk of infection is minimized by storing autologous blood for transfusion and administering intravenous antibiotics after surgery. The rate of infection following knee replacement is about 1.89%. Factors that increase the risk of infection after TKR include poor nutritional status, diabetes, obesity, a weakened immune system, and a history of smoking.
- **Heterotopic bone.** Heterotopic bone is bone that develops at the lower end of the femur after knee replacement surgery. It is most likely to develop in patients whose knee joints developed an infection. Heterotopic bone can cause stiffness and pain, and usually requires revision surgery.

## Normal results

Normal results include relief of chronic pain in the knee and greater range of motion in the knee joint. Realistically, however, the patient should not expect complete restoration of function in the knee, and will usually be advised to avoid contact sports, skiing, jogging, or other athletic activities that strain the knee joint.

Mild swelling of the leg may occur for as long as three to six months after surgery. It can be treated by elevating the leg, applying an ice pack, and wearing compression stockings.

One commonplace side effect of TKR is that knee prostheses sometimes set off metal detectors in airports and high-security buildings because of their large metal content. Patients who fly frequently or

whose occupations require security clearance should ask their doctor for a wallet card certifying that they have a knee prosthesis.

The patient can expect a cemented knee prosthesis to last about 10–15 years, although many still function well as long as 20 years later. Cementless prostheses have not been in use long enough for reliable evaluations of their long-term durability. When the prosthesis wears out or becomes loose, it is replaced in a procedure known as **knee revision surgery**.

### Morbidity and mortality rates

A study published in 2002 reported that the 30-day mortality rate following total knee arthroplasty was 0.5%. The overall frequency of serious complications in this time period was 2.2%. This figure included 0.4% heart attack; 0.7% pulmonary embolism; and 1.5% deep venous thrombosis. The rate of complications was highest in patients over 70, and male patients were more likely to have heart attacks than women.

A 2001 study published by the Mayo Clinic reviewed the records of 22,540 patients who had had knee replacements between 1969 and 1997. The mortality rate within 30 days of surgery was 0.21%, or 47 patients. Forty-three of the 47 patients had had preexisting cardiovascular or lung disease. Patients who had had bilateral knee operations had a higher mortality rate than those who had not.

### Alternatives

#### *Nonsurgical alternatives*

**MEDICATION.** The most common conservative alternatives to knee replacement surgery are **analgesics**, or painkilling medications. Most patients who try medication for knee pain begin with an over-the-counter NSAID such as ibuprofen (Advil). If the pain cannot be controlled by nonprescription analgesics, the doctor may give the patient cortisone injections, which relieve the pain of arthritis by reducing inflammation. Unfortunately, the relief provided by cortisone tends to diminish with each injection; moreover, the drug can produce serious side effects.

If the knee pain is caused by rheumatoid arthritis, a group of medications known as disease-modifying antirheumatic drugs, or DMARDs, may help to slow or stop the progress of the disease. They work by suppressing or interfering with the immune system. DMARDs include such drugs as penicillamine, methotrexate, oral or injectable gold, hydroxychloroquine, leflunomide, and sulfasalazine. DMARDs are

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Knee replacement surgery is performed by an orthopedic surgeon, an MD who has received advanced training in surgical treatment of disorders of the musculoskeletal system. Qualification for this specialty in the United States required a minimum of five years of training after medical school. Most orthopedic surgeons who perform joint replacements have had additional specialized training in these specific procedures.

Knee replacement surgery can be performed in a general hospital with a department of orthopedic surgery, but is also performed in specialized clinics or institutes for joint disorders.

not suitable for all patients with RA, however, as they sometimes have serious side effects. In addition, some of them are slow-acting and may take several months to work before the patient feels some relief.

**LIFESTYLE CHANGES.** A second alternative to knee surgery is lifestyle changes. Losing weight helps to reduce stress on the knee joint. Giving up specific sports or other activities that damage the knee, such as jogging, tennis, high-impact aerobics, or stair-climbing exercise machines, may control the pain enough to make surgery unnecessary. Wearing properly fitted shoes and avoiding high heels and other extreme styles can also help to control pain and minimize further damage to the knee.

**BRACES AND ORTHOTICS.** Some patients with unstable knees are helped by functional braces or knee supports that are designed to keep the kneecap from slipping out of place. Orthotics, which are inserts placed inside shoes, are often helpful to patients whose knee problems are related to their gait. Orthotics are designed either to correct the position of the foot in order to keep it from turning too far outward or inward, or to correct problems in the arch of the foot. Some orthotics are made of soft material that cushions the foot and are particularly helpful for patients with osteoarthritis or diabetes.

#### *Complementary and alternative (CAM) approaches*

Complementary and alternative therapies are not substitutes for arthroscopy or joint replacement surgery, but some have been shown to relieve physical



## QUESTIONS TO ASK THE DOCTOR

- How many knee replacements have you performed?
- Should I consider bilateral knee replacement?
- Will I benefit from arthroscopy or should I have knee replacement surgery now?
- What activities will I have to give up permanently if I have TKR?
- Does the hospital or clinic have preop classes to help me prepare for the operation? If not, are there knee exercises you would recommend before the surgery?

pain before or after surgery, or to help patients cope more effectively with the emotional and psychological stress of a major operation. Acupuncture, chiropractic, hypnosis, and mindfulness meditation have been used successfully to relieve the pain of osteoarthritis as well as postoperative discomfort. According to Dr. Marc Darrow, author of *The Knee Sourcebook*, a plant extract called RA-1, which is used in Ayurvedic medicine to treat arthritis, relieved pain and leg swelling in patients participating in a randomized trial. Alternative approaches that have helped patients maintain a positive mental attitude include meditation, **biofeedback**, and various relaxation techniques.

### Alternative surgical procedures

Arthroscopy is the most common surgical alternative to knee replacement. It should be understood, however, as a way to postpone TKR rather than avoid it completely. The arthroscopic procedure most often used to treat knee pain from osteoarthritis is **debridement**, in which the surgeon cuts or scrapes away damaged structures or tissues until healthy tissue is reached. Most patients who have had arthroscopic debridement have been able to postpone TKR for three to five years.

Cartilage transplantation is a procedure in which small bone plugs with cartilage are removed from a part of the patient's knee where the cartilage is still healthy and transplanted to the area in which cartilage has been damaged. Another form of cartilage transplantation involves two operations, one to remove cartilage cells from the patient's knee for culture in a laboratory, and a second operation to place the new cells within the damaged part of the knee. The cultured cells are covered with a thin layer of tissue to hold

them in place. After surgery, the cartilage cells multiply to form new cartilage inside the knee. Unfortunately, neither form of cartilage transplantation is usually beneficial to patients with osteoarthritis; transplantation has been most successful in treating patients whose knee cartilage was damaged by sudden trauma rather than by gradual degeneration.

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## ORGANIZATIONS

American Academy of Orthopaedic Surgeons (AAOS). 6300 North River Road, Rosemont, IL 60018. (847) 823 7186 or (800) 346 AAOS. <http://www.aaos.org>.

American Physical Therapy Association (APTA). 1111 North Fairfax Street, Alexandria, VA 22314. (703) 684 APTA or (800) 999 2782. <http://www.apta.org>.

Canadian Institute for Health Information/Institut canadien d'information sur la santé (CIHI). 377 Dalhousie Street, Suite 200, Ottawa, ON K1N 9N8. (613) 241 7860. <http://secure.cihi.ca/cihiweb>.

National Center for Complementary and Alternative Medicine (NCCAM) Clearinghouse. P.O. Box 7923, Gaithersburg, MD 20898. (888) 644 6226. TTY: (866) 464 3615. Fax: (866) 464 3616. <http://www.nccam.nih.gov>.

National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS) Information Clearinghouse. National Institutes of Health, 1 AMS Circle, Bethesda, MD 20892. (301) 495 4484. TTY: (301) 565 2966. <http://www.niams.nih.gov>.

Rush Arthritis and Orthopedics Institute. 1725 West Harrison Street, Suite 1055, Chicago, IL 60612. (312) 563 2420. <http://www.rush.edu>.

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# Knee revision surgery

## Definition

Knee revision surgery, which is also known as revision total knee **arthroplasty**, is a procedure in which the surgeon removes a previously implanted artificial knee joint, or prosthesis, and replaces it with a new prosthesis. Knee revision surgery may also involve the use of bone grafts. The bone graft may be an autograft, which means that the bone is taken from another site in the patient's own body; or an allograft, which means that the bone tissue comes from another donor.

## Purpose

Knee revision surgery has three major purposes: relieving pain in the affected hip; restoring the patient's mobility; and removing a loose or damaged prosthesis before irreversible harm is done to the joint. Knee prostheses can come loose for one of two reasons. One is mechanical and is related to the fact that the knee joint bears a great deal of weight when a person is walking or running. It is unusual for the metal part of a knee prosthesis to simply break. This part, however, is inserted into the upper part of the tibia, the larger of the two bones in the lower leg, after the surgeon has removed the upper surface of the tibia. The bone tissue that receives the metal implant is softer than the bone that was removed, which means that the metal implant may sink into the softer bone and gradually loosen.

The second reason for loosening of a knee prosthesis is related to the development of inflammation in the knee joint. The plastic part of a knee prosthesis is made of a material called polyethylene, which can form small particles of debris as a result of wear on the prosthesis over time. If the patient has an uneven gait, or pattern of walking, the debris particles tend to form at a faster rate because one side of the prosthesis will tend to pull away from the bone and the other side will be pushed further into the bone. These tiny fragments of plastic are absorbed by tissue cells around the knee joint, which become inflamed. The inflammatory response begins to dissolve the bone around the prosthesis in a process known as osteolysis. As the osteolysis continues, bone loss accelerates and the prosthesis eventually comes loose.

A knee prosthesis that has become infected or completely dislocated must be removed and replaced to prevent permanent damage to the patient's knee.

## KEY TERMS

**Arthrodesis**—A procedure that is sometimes used as an alternative to knee revision surgery, in which the joint is first fixed in place with a surgical nail and then fused as new bone tissue grows in.

**Arthroscope**—An instrument that contains a miniature camera and light source mounted on a flexible tube. It allows a surgeon to see the inside of a joint or bone during surgery.

**Femur**—The medical name for the thighbone.

**Gait**—A person's habitual pattern of walking. An irregular gait is a risk factor for knee revision surgery.

**Heterotopic bone**—Bone that develops as an excess growth around a joint following joint replacement surgery.

**Impaction grafting**—The use of crushed bone from a donor to fill in the central canal of the tibia during knee revision surgery.

**Osteolysis**—Dissolution and loss of bone resulting from inflammation caused by particles of polyethylene debris from a prosthesis.

**Patella**—The medical term for the knee cap. The patella is a triangular bone located at the front of the knee.

**Prosthesis (plural, prostheses)**—An artificial device that substitutes for or supplements a missing or damaged body part. Prostheses may be either external or implanted inside the body.

**Tibia**—The larger of two leg bones that lie beneath the knee. The tibia is sometimes called the shin bone.

## Demographics

The demographics of knee revision surgery are somewhat difficult to evaluate because the procedure is performed much less frequently than total **knee replacement** (TKR). TKR itself is a relatively new operation; the first total knee replacement was performed in the United Kingdom in 1968 and the first TKR in the United States in 1970. Rates of prosthetic failure run at approximately 10% at 10 years, and 20% at 20 years post-surgery. Because of this high success rate, the number of patients who have had knee revision surgery yields a much smaller database than those who have had TKR. It is estimated that about 22,000 knee revision operations are performed in the United States each year; over half of them are done within two years of the patient's TKR.

Another difficulty in evaluating the demographics of knee revision surgery is the growing trend toward TKR in younger patients. As the number of knee replacement procedures done in younger patients continues to rise, the number of revision surgeries will increase as well. A study done in the United States in 1996 reported that women were almost twice as likely as men to have knee revision surgery, and that Caucasians were 1.5 times as likely as African Americans to have the procedure. This study, however, was limited to patients over the age of 65, so that its findings are not likely to be an accurate picture of younger patient populations.

## Description

Most knee revision operations take about three hours to perform and are similar to knee replacement procedures. After the patient has been anesthetized, the surgeon opens the knee joint by cutting through the joint capsule. The first step in revision surgery is the removal of the old femoral component of the knee prosthesis. After the metal shell has been removed, the damaged bone at the end of the femur is scraped off and the femur is reshaped. If the bone is weak, the surgeon may decide to fill the cavity inside the femur with bone grafts. In some cases, metal wedges may be used to strengthen the attachment of the new femoral component.

After the new femoral component has been glued in place with bone cement, the old implant in the tibia is removed and the bone is reshaped to receive a new implant. If the old implant had loosened because it had moved downward into the softer tissue inside the tibia, the surgeon will pack the space with morselized bone from a donor before putting in the new implant. This technique is known as impaction grafting. The impaction grafting may be reinforced with wire mesh. If the tibia has been shortened by the removal of damaged bone, the surgeon will insert a wedge along with the new tibial implant and secure them to the end of the tibia with bone cement. A new plastic plate will be fastened to the tray at the top of the tibial implant so that the patient's femur can move smoothly over the tibia. If the patient's patella (kneecap) has been damaged, the surgeon will resurface its back surface and attach a plastic component to protect the patella from further bone loss. The tibial and femoral components of the prosthesis are then fitted together, the kneecap is replaced, and the knee tendons reattached with surgical wire. The knee joint is washed out with sterile saline fluid and the various layers of the incision closed.

Revision surgery on an infected knee requires two separate operations. In the first operation, the old

prosthesis is taken out and a block of polyethylene cement known as a spacer block is inserted in the joint. The spacer block has been treated with **antibiotics** to fight the infection. The incision is closed and the spacer block remains inside the patient's knee for about six weeks. The patient is also given intravenous antibiotics during this period. After the infection has cleared, the knee is reopened and the new revision prosthesis is implanted.

### Diagnosis/Preparation

In most cases, increasing pain, stiffness, and loss of mobility in the knee joint are early indications that the patient may benefit from revision surgery. The location of the pain may point to the part of the prosthesis that has been affected by osteolysis. Pain around or in the knee-cap is not always significant by itself because many TKR patients have occasional discomfort in that area after their knee replacement. If the pain is diffuse (felt throughout the knee rather than in only one part of the knee), it may indicate either an infection or loosening of the prosthesis. Pain felt throughout the knee accompanied by tissue fluid accumulating in the joint points to a problem with the polyethylene part of the prosthesis. Pain in the lower thigh or in the part of the leg just below the knee suggests that the metal plate attached to the femur or the metal implant in the tibia may have come loose.

The doctor may take risk factors into account in assessing the likelihood of a failed knee prosthesis. Six factors have been identified as increasing a patient's risk of needing revision surgery within two years of knee replacement surgery:

- age (Younger patients tend to be more active and to wear out knee prostheses more rapidly than older ones.)
- a long hospital stay for the original knee surgery
- concurrent diseases or disorders
- any type of arthritis
- surgical complications during the first knee operation
- having the first knee operation performed at an urban hospital

The doctor will then usually order a series of imaging tests to determine the location of the problem and the extent of bone loss. X-ray studies can be used to check for complete dislocation of the prosthesis as well as loosening. Computed tomography appears to be more effective in detecting the early stages of osteolysis than x-ray studies. If the doctor suspects that the knee prosthesis has become infected, he or she will aspirate the joint. Aspiration is a procedure in which fluid is withdrawn from a joint through a needle and

sent to a laboratory for analysis. The fluid will be cultured in order to identify the specific organism causing the infection.

### Aftercare

Aftercare following knee revision surgery is essentially the same as for knee replacement, consisting of a combination of physical therapy, rehabilitation exercises, pain medication when necessary, and a period of home health care or assistance.

The length of recovery after revision knee surgery varies in comparison to the patient's first knee replacement. Some patients take longer to recover from revision surgery, but others recover more rapidly than they did from TKR, and they experience less discomfort. The reasons for this variation are not yet known.

### Risks

The complications that may follow knee revision surgery are similar to those for knee replacement. They include:

- Deep vein thrombosis.
- Infection in the new prosthesis.
- Loosening of the new prosthesis. The risk of this complication is increased considerably if the patient is overweight.
- Formation of heterotopic bone. Heterotopic bone is bone that develops at the lower end of the femur following knee replacement or knee revision surgery. Patients who have had an infection in the joint have an increased risk of heterotopic bone formation.
- Bone fractures during the operation. These are caused by the force or pressure that the surgeon must sometimes apply to remove the old prosthesis and the cement that may be attached to it.
- Dislocation of the new prosthesis. The risk of dislocation is twice as great for revision surgery as for TKR.
- Difference in leg length resulting from shortening of the leg with the prosthesis.
- Additional or more rapid loss of bone tissue.

### Normal results

Normal results of knee revision surgery are quite similar to those for TKR. Patients have less pain and greater mobility in the affected knee, but not complete restoration of the function of a normal knee. Between 5% and 20% of patients report some pain following either TKR or revision surgery for several years after



their operation. Most patients, however, have considerably less discomfort in the knee after surgery than they did before the procedure. A recent British study found that revision knee surgery patients had the same positive results at six-month follow-up as patients who had had primary knee replacement surgery.

As with knee replacement surgery, patients who have had revision surgery may experience mild swelling of the leg for as long as three to six months after surgery. Swelling can be treated by elevating the leg, applying an ice pack, and wearing compression stockings.

### Morbidity and mortality rates

The 30-day mortality rate following knee revision surgery is low, between 0.1% and 0.2%. The estimated rates of complications are as follows:

- deep infection: 0.97%
- loosening of the new prosthesis: 10–15%.
- dislocation of the new prosthesis: 2–5%.
- deep venous thrombosis: 1.5%

### Alternatives

#### *Nonsurgical alternatives*

**LIFESTYLE CHANGES.** The American Association of Orthopaedic Surgeons (AAOS) has published a fact sheet about the effects of aging on the knee joint aimed at the baby boomer generation. Many adults in their 40s and 50s have been influenced by the contemporary emphasis on youthfulness to keep up athletic activities and forms of **exercise** that are hard on the knee joint. Some of them try to return to a high level of activity even after TKR. As a result, some surgeons are suggesting that adults in this age bracket scale back their athletic workouts or substitute low-impact forms of exercise. Good choices include water aerobics, tai chi, yoga, swimming, cycling, and walking.

**COMPLEMENTARY AND ALTERNATIVE (CAM) APPROACHES.** Complementary and alternative therapies are not substitutes for knee revision surgery, but some have been shown to relieve physical pain before or after surgery, or to help patients cope more effectively with the emotional and psychological stress of a major operation. Acupuncture, chiropractic, hypnosis, and mindfulness meditation have been used successfully to relieve postoperative discomfort following revision surgery. Alternative approaches that have helped patients maintain a positive mental attitude

### WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Knee revision surgery is performed by an orthopedic surgeon, who is an MD and who has received advanced training in surgical treatment of disorders of the musculoskeletal system. Qualification for this specialty in the United States requires a minimum of five years of training after medical school. Most orthopedic surgeons who perform joint replacements and revision operations have had additional specialized training in these specific procedures.

In many cases, knee revision surgery is done by the surgeon who performed the original knee replacement operation. Some surgeons, however, refer patients to colleagues who specialize in revision procedures.

Knee revision surgery can be performed in a general hospital with a department of orthopedic surgery, but is also performed in specialized clinics or institutes for joint disorders.

include meditation, **biofeedback**, and various relaxation techniques.

#### *Alternative surgical procedures*

Arthroscopy is the most common surgical alternative to knee revision surgery. It is a procedure in which a surgeon makes three or four small incisions in the knee in order to insert a device that allows him or her to see the inside of the joint, insert miniaturized instruments to remove or repair damaged tissue, and drain fluid from the joint. Arthroscopy has been used successfully to treat stiffness in the knee following TKR and improve range of motion in the joint. It is not successful in treating infected prostheses unless it is used very early.

Other surgical alternatives to knee revision surgery include manipulation of the joint while the patient is under **general anesthesia**, and arthrodesis of the knee. Arthrodesis is a procedure in which the joint is fixed in place with a long surgical nail until the growth of new bone tissue fuses the knee. It is generally considered a less preferable alternative to knee revision surgery, but is sometimes used in the treatment of elderly patients with infected prostheses or weakened bone structure.

## QUESTIONS TO ASK THE DOCTOR

- How many knee revision operations do you perform each year?
- Would I be likely to benefit from arthroscopy?
- What lifestyle changes can I make to extend the life of the new prosthesis?
- What are my chances of needing another revision operation in the future?

### Resources

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- American Physical Therapy Association (APTA). 1111 North Fairfax Street, Alexandria, VA 22314. (703)684 APTA or (800) 999 2782. <http://www.apta.org>.
- Canadian Institute for Health Information/Institut canadien d'information sur la santé (CIHI). 377 Dalhousie Street, Suite 200, Ottawa, ON K1N 9N8. (613) 241 7860. <http://secure.cihi.ca/cihiweb>.
- Center for Hip and Knee Replacement, Columbia University. Department of Orthopaedic Surgery, Columbia Presbyterian Medical Center, 622 West 168th Street, PH11 Center, New York, NY 10032. (212) 305 5974. [www.hipknee.org](http://www.hipknee.org).
- National Center for Complementary and Alternative Medicine (NCCAM) Clearinghouse. P.O. Box 7923, Gaithersburg, MD 20898. (888) 644 6226. TTY: (866) 464 3615. Fax: (866) 464 3616. <http://www.nccam.nih.gov>.
- National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS) Information Clearinghouse. National Institutes of Health, 1 AMS Circle, Bethesda, MD 20892. (301) 495 4484. TTY: (301) 565 2966. <http://www.niams.nih.gov>.
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## Kneecap removal

### Definition

Kneecap removal, or patellectomy, is the partial or total surgical removal of the patella, commonly called the kneecap.

### Purpose

Kneecap removal is performed under three circumstances:

- The kneecap is fractured or shattered.
- The kneecap dislocates easily and repeatedly.
- Degenerative arthritis of the kneecap causes extreme pain.

### Demographics

A person of any age can break a kneecap in an accident. When the bone is shattered beyond repair, the kneecap has to be removed. No prosthesis or artificial replacement part is put in its place.

Dislocation of the kneecap is most common in young girls between the ages of 10–14. Initially, the kneecap will pop back into place of its own accord, but pain may continue. If dislocation occurs too often, or the kneecap does not go back into place correctly, the patella may rub the other bones in the knee, causing an arthritis-like condition. Some people are also born with birth defects that cause the kneecap to dislocate frequently.

Degenerative arthritis of the kneecap, also called patellar arthritis or chondromalacia patellae, can cause so much pain that it becomes necessary to remove the kneecap. As techniques of joint replacement have improved, arthritis in the knee is more frequently treated with total **knee replacement**.

People who have had their kneecap removed for degenerative arthritis and then later require a total knee replacement are more likely to have problems with the stability of their artificial knee than those who only have total knee replacement. This occurs because the realigned muscles and tendons provide less support once the kneecap is removed.

### Description

**General anesthesia** is typically used for kneecap removal surgery, though in some cases a spinal or epidural anesthetic is used. The surgeon makes a linear incision over the front of the kneecap. The damaged kneecap is examined. If a part or the entire kneecap is

## KEY TERMS

**Degenerative arthritis, or osteoarthritis**—A non-inflammatory type of arthritis, usually occurring in older people, characterized by degeneration of cartilage, enlargement of the margins of the bones, and changes in the membranes in the joints.

**Patella**—The knee cap; the quadriceps tendon attaches to it above and the patellar tendon below.

**Patellectomy**—Surgical removal of the patella, or kneecap removal.

so severely damaged that it cannot be repaired, it may be partially removed (partial patellectomy) or totally removed (full patellectomy). If kneecap removal is total, the muscles and tendons attached to the kneecap are cut and the kneecap is removed. However, the quadriceps tendon above the kneecap, the patellar tendon below, and the other soft tissues around the kneecap are preserved so that the patient may still be able to extend the knee after surgery. Next, the muscles are sewn back together, and the skin is closed with sutures or clips that stay in place for about two weeks.

### Diagnosis/Preparation

Prior to surgery, x rays and other diagnostic tests are done on the knee to determine if removing the kneecap is the appropriate treatment. Preoperative blood and urine tests are also done.

Patients are asked not to eat or drink anything after midnight on the night before surgery. On the day of surgery, patients are directed to the hospital or clinic holding area where the final preparations are made. The knee area is usually shaved and the patient is asked to change into a hospital gown and to remove all jewelry, watches, dentures, and glasses.

### Aftercare

Pain medication may be prescribed for a few days. The patient will initially need to use a cane or crutches to walk. Physical therapy exercises to strengthen the knee should start as soon as tolerated after surgery. Driving should be avoided for several weeks. Full recovery can take months.

### Risks

Risks involved with kneecap removal are similar to those associated with any surgical procedure,

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Kneecap removal surgery is usually performed in an outpatient setting and hospital stays, if any, are short, not exceeding more than a day. An orthopedic surgeon performs the surgery. Orthopedics is the medical specialty that focuses on the diagnosis, care, and treatment of patients with disorders of the bones, joints, muscles, ligaments, tendons, nerves, and skin.

mainly allergic reaction to anesthesia, excessive bleeding, and infection.

Kneecap removal is very delicate surgery because the kneecap is part of the extensor mechanism of the leg, meaning the muscles and ligaments, the patella, the quadriceps tendon, and the patellar tendon; which all allow the knee to extend and remain stable when extended. When the kneecap is removed, the extensor assembly becomes more lax, and it may be impossible to ever regain full extension.

### Normal results

People who undergo kneecap removal because of a broken bone or repeated dislocations have the best chance for complete recovery. Those who have this operation because of arthritis may have less successful results, and later need a total knee replacement.

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## QUESTIONS TO ASK THE DOCTOR

- How is the kneecap removed?
- What type of anesthesia will be used?
- How long will it take for the knee to recover from the surgery?
- When will I be able to walk without crutches?
- What are the risks associated with kneecap removal surgery?
- How many kneecap removal procedures do you perform in a year?

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The American Academy of Orthopaedic Surgeons. 6300 North River Road, Rosemont, IL 60018 4262. (847) 823 7186, (800) 346 AAOS. <http://www.aaos.org>.

The American Association of Hip and Knee Surgeons (AAHKS). 704 Florence Drive, Park Ridge, IL 60068 2104. (847) 698 1200. <<http://www.aahks.org>.

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# L

## Laceration repair

### Definition

Laceration repair includes all the steps required to treat a wound in order to promote healing and minimize the risks of infection, premature splitting of sutures (dehiscence), and poor cosmetic result.

### Purpose

A laceration is a wound caused by a sharp object producing edges that may be jagged, dirty, or bleeding. Lacerations most often affect the skin, but any tissue may be lacerated, including subcutaneous fat, tendon, muscle, or bone.

A laceration should be repaired if it:

- Continues to bleed after application of pressure for 10–15 minutes.
- Is more than one-eighth (0.125 in, or 0.3 cm) to one-fourth inch (0.25 in, or 0.6 cm) deep.
- Exposes fat, muscle, tendon, or bone.
- Causes a change in function surrounding the area of the laceration.
- Is dirty or has visible debris in it.
- Is located in an area where an unsightly scar is undesirable.

Lacerations are less likely to become infected if they are repaired soon after they occur. Many physicians will not repair a laceration that is more than eight hours old because the risk of infection is too great.

### Description

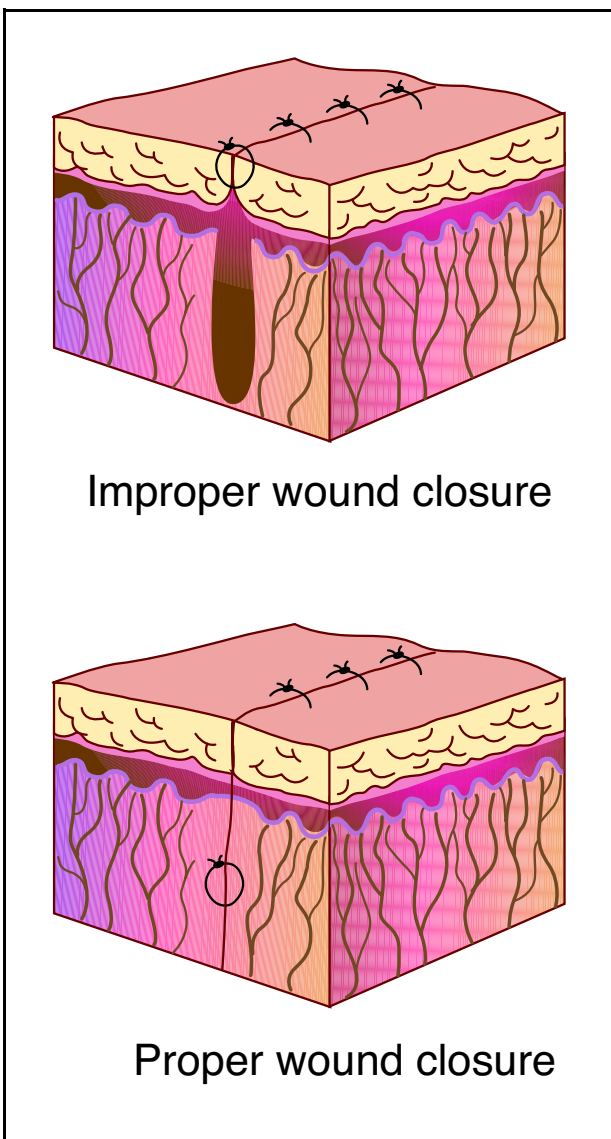
Laceration repair mends a tear in the skin or other tissue. The four goals of laceration repair are to stop bleeding, prevent infection, preserve function, and restore appearance.

The laceration is cleaned by removing any foreign material or debris. Removing foreign objects from penetrating wounds can sometimes cause bleeding, so this type of wound must be cleaned very carefully. The wound is then irrigated with saline solution and a disinfectant. The disinfecting agent may be mild soap or a commercial preparation. An antibacterial agent may be applied.

Once the wound has been cleansed, the physician anesthetizes the area of the repair. Most lacerations are anesthetized by local injection of lidocaine, with or without epinephrine, into the wound edges. Lidocaine without epinephrine is used in areas with limited blood supply such as fingers, toes, ears, penis, and nose, because epinephrine could cause constriction of blood vessels (vasoconstriction) and interfere with the supply of blood to the laceration site. Alternatively, a topical anesthetic combination such as lidocaine, epinephrine, and tetracaine may also be used.

The physician may trim edges that are jagged or extremely uneven. Tissue that is too damaged to heal must be removed (**debridement**) to prevent infection. If the laceration is deep, several absorbable **stitches** (sutures) are placed in the tissue under the skin to help bring the tissue layers together. Suturing also helps eliminate any pockets where tissue fluid or blood can accumulate. The skin wound is closed with sutures. Suture material used on the surface of a wound is usually non-absorbable and will have to be removed later. A light dressing or an adhesive bandage is applied for 24–48 hours. In areas where a dressing is not feasible, an antibiotic ointment can be applied. If the laceration is the result of a human or animal bite, if it is very dirty, or if the patient has a medical condition that alters wound healing, a broad-spectrum antibiotic may be prescribed.

Newer types of laceration repair do not require sutures. Materials such as **staples** or dermabond **glue**



A laceration is a traumatic break in the skin caused by a sharp object producing edges that may be jagged, dirty or bleeding. The underlying tissue may also be severed. In such instances, the physician may place absorbable sutures in the tissue to help bring the edges together before the skin is sutured closed. (Illustration by Electronic Illustrators Group. Cengage Learning, Gale.)

may be used to hold the edges of a laceration together, allowing the edges to knit together.

### Diagnosis/Preparation

Preparation for laceration repair involves inspecting the wound and the underlying tendons or nerves to evaluate the risk of infection, the degree of tissue

damage, the need for debridement, and its complexity. If hair is located in or around the wound, it is usually removed to minimize contamination and allow for good visibility of the wound. If nerves or tendons have been injured, a surgeon may be needed to complete the repair.

### Aftercare

The laceration is kept clean and dry for at least 24 hours after the repair. Light bathing is generally permitted after 24 hours if the wound is not soaked. The physician will provide directions for any special **wound care**. Sutures are removed three to 14 days after the repair is completed. Timing of suture removal depends on the location of the laceration and physician preference.

The repair should be examined frequently for signs of infection, which include redness, swelling, tenderness, drainage from the wound, red streaks in the skin surrounding the repair, chills, or fever. If any of these occur, the physician should be contacted immediately.

### Risks

The most serious risk associated with laceration repair is infection. Risk of infection depends on the nature of the wound and the type of injury sustained. Infection risks are increased in wounds that are contaminated with soil or fecal matter, are the result of bites, have been open longer than one hour, or are located on the extremities or on the region between the thighs, genitalia, or other areas where opposing skin surfaces touch and may rub.

### Normal results

All lacerations will heal with a scar. Wounds that are repaired with sutures are less likely to develop scars that are unsightly, but it cannot be predicted how wounds will heal and who will develop unsightly scars. **Plastic surgery** can improve the appearance of many scars.

### Alternatives

The only alternative to laceration repair is to leave the wound without medical treatment. This increases the risk of infection, poor healing, and an undesirable cosmetic result.



Close-up view of scalp laceration, closed with staples. (Scott Camazine/Phototake. Reproduced by permission.)

## KEY TERMS

**Debridement**—The act of removing any foreign material and damaged or contaminated tissue from a wound to expose surrounding healthy tissue.

**Dehiscence**—A premature bursting open or splitting along natural or surgical suture lines. A complication of surgery that occurs secondary to poor wound healing.

**Laceration**—A torn, ragged, mangled wound.

**Sutures**—Materials used in closing a surgical or traumatic wound.

**Vasoconstriction**—The diminution of the diameter of blood vessels, leading to decreased blood flow to a part of the body.

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### ORGANIZATIONS

The Association of Perioperative Registered Nurses, Inc. (AORN). 2170 South Parker Rd, Suite 300, Denver, CO 80231 5711. (800) 755 2676. <http://www.aorn.org/>.



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Primary care physicians, emergency room physicians, and surgeons usually repair lacerations. All physicians are trained in the basics of wound assessment, cleansing, and anesthesia. They are also familiar with the basic suturing techniques and have the experience required to attend to the details of wound repair, such as proper selection and preparation of equipment, careful wound preparation, appropriate use of specific closure methods, and effective patient education, required to avoid wound infection and excessive scarring.

Laceration repair is routinely performed in hospitals and clinics on an outpatient basis.

## QUESTIONS TO ASK THE DOCTOR

- How will my wound be repaired?
- Will the procedure hurt?
- How can I avoid infection after surgery?
- Will I be able to wash the wound?
- What are the possible complications?
- How long will it take to heal?
- Will there be a scar?
- When can the sutures be removed?

### OTHER

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Lactate dehydrogenase isoenzymes test see  
**Liver function tests**

## Laminectomy

### Definition

A laminectomy is a surgical procedure in which the surgeon removes a portion of the bony arch, or lamina, on the dorsal surface of a vertebra, which is one of the bones that make up the human spinal column. It is done to relieve back pain that has not been helped by more conservative treatments. In most cases a laminectomy is an elective procedure rather than **emergency surgery**. A laminectomy for relief of pain in the lower back is called a lumbar laminectomy or an open decompression.

### Purpose

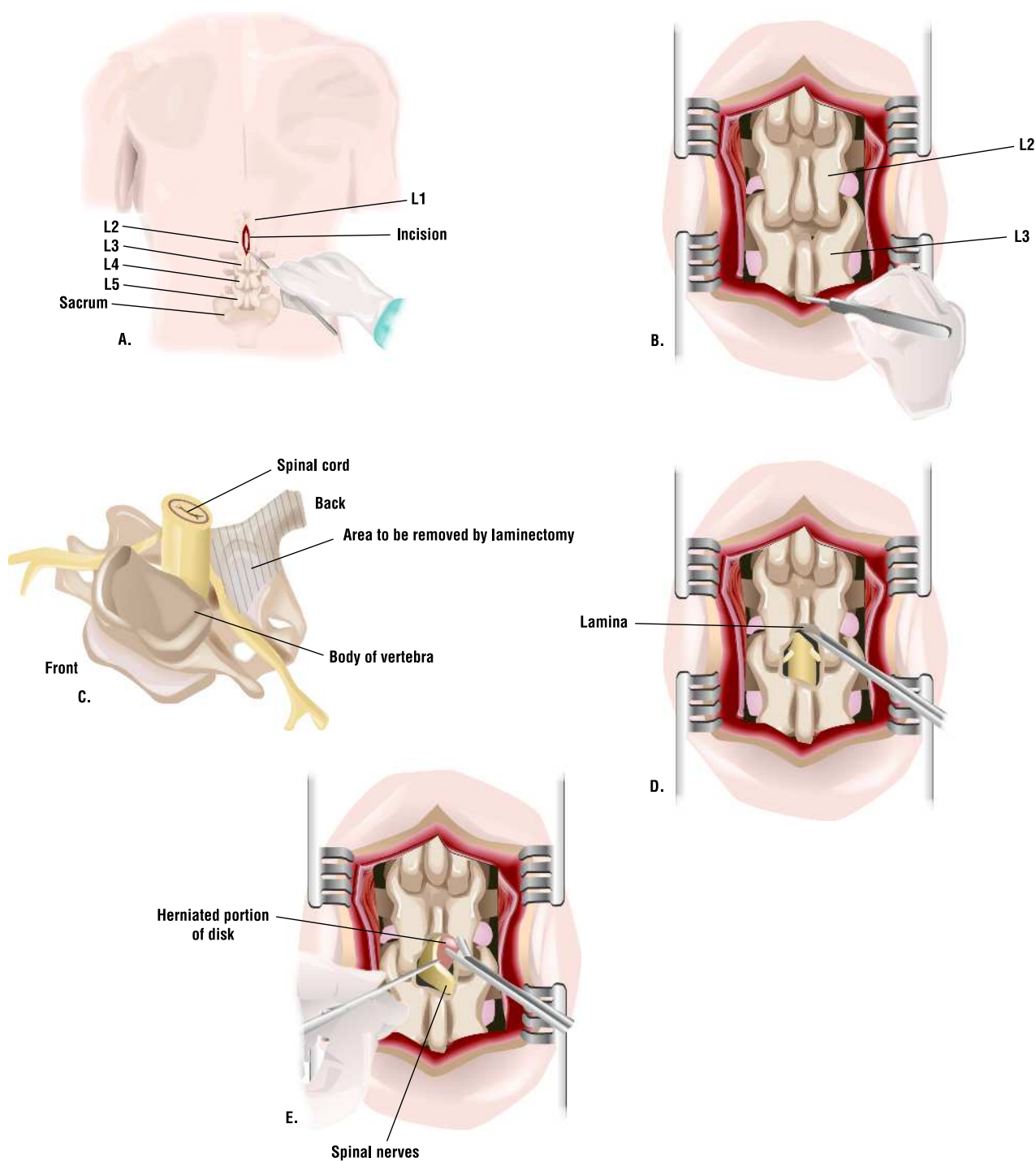
#### *Structure of the spine*

In order to understand why removal of a piece of bone from the arch of a vertebra relieves pain, it is helpful to have a brief description of the structure of the spinal column and the vertebrae themselves. In humans, the spine comprises 33 vertebrae, some of which are fused together. There are seven vertebrae in the cervical (neck) part of the spine; 12 vertebrae in the thoracic (chest) region; five in the lumbar (lower back) region; five vertebrae that are fused to form the sacrum; and four vertebrae that are fused to form the coccyx, or tailbone. It is the vertebrae in the lumbar portion of the spine that are most likely to be affected by the disorders that cause back pain.

The 24 vertebrae that are not fused are stacked vertically in an S-shaped column that extends from the tailbone below the waist up to the back of the head. This column is held in alignment by ligaments, cartilage, and muscles. About half the weight of a person's body is carried by the spinal column itself and the other half by the muscles and ligaments that hold the spine in alignment. The bony arches of the laminae on each vertebra form a canal that contains and protects the spinal cord. The spinal cord extends from the base of the brain to the upper part of the lumbar spine, where it ends in a collection of nerve fibers known as the cauda equina, which is a Latin phrase meaning “horse's tail.” Other nerves branching out from the spinal cord pass through openings formed by adjoining vertebrae. These openings are known as foramina (singular, foramen).

Between each vertebra is a disk that serves to cushion the vertebrae when a person bends, stretches, or twists the spinal column. The disks also keep the foramina between the vertebrae open so that the spinal nerves can pass through without being pinched or

## Laminectomy



In this posterior (from the back) lumbar laminectomy, an incision is made in the patient's back over the lumbar vertebrae (A). The wound is opened with retractors to expose the L2 and L3 vertebrae (B). A piece of bone at the back of the vertebrae is removed (C and D), allowing a damaged disk to be repaired (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Cauda equina**—The collection of spinal nerve roots that lie inside the spinal column below the end of the spinal cord. The name comes from the Latin for “horse’s tail.”

**Cauda equina syndrome (CES)**—A group of symptoms characterized by numbness or pain in the legs and/or loss of bladder and bowel control, caused by compression and paralysis of the nerve roots in the cauda equina. CES is a medical emergency.

**Chiropractic**—A system of therapy based on the notion that health and disease are related to the interactions between the brain and the nervous system. Treatment involves manipulation and adjustment of the segments of the spinal column. Chiropractic is considered a form of alternative medicine.

**Decompression**—Any surgical procedure done to relieve pressure on a nerve or other part of the body. A laminectomy is sometimes called an open decompression.

**Dorsal**—Referring to a position closer to the back than to the stomach. The laminae in the spinal column are located on the dorsal side of each vertebra.

**Dura**—A tough fibrous membrane that covers and protects the spinal cord.

**Foramen (plural, foramina)**—The medical term for a natural opening or passage. The foramina of the spinal column are openings between the vertebrae for the spinal nerves to branch off from the spinal cord.

**Laminae (singular, lamina)**—The broad plates of bone on the upper surface of the vertebrae that fuse together at the midline to form a bony covering over the spinal canal.

**Laminotomy**—A less invasive alternative to a laminectomy in which a hole is drilled through the lamina.

**Ligamenta flava (singular, ligamentum flavum)**—A series of bands of tissue that are attached to the

vertebrae in the spinal column. They help to hold the spine straight and to close the spaces between the laminar arches. The Latin name means “yellow band(s).”

**Lumbar**—Pertaining to the part of the back between the chest and the pelvis.

**Myelogram**—A special type of x ray study of the spinal cord, made after a contrast medium has been injected into the space surrounding the cord.

**Osteopathy**—A system of therapy that uses standard medical and surgical methods of diagnosis and treatment while emphasizing the importance of proper body alignment and manipulative treatment of musculoskeletal disorders. Osteopathy is considered mainstream primary care medicine rather than an alternative system.

**Pain disorder**—A psychiatric disorder in which pain in one or more parts of the body is caused or made worse by psychological factors. The lower back is one of the most common sites for pain related to this disorder.

**Retractor**—An instrument used during surgery to hold an incision open and pull back underlying layers of tissue.

**Sciatica**—Pain in the lower back, buttock, or leg along the course of the sciatic nerve.

**Somatization disorder**—A chronic condition in which psychological stresses are converted into physical symptoms that interfere with work and relationships. Lower back pain is a frequent complaint of patients with somatization disorder.

**Spinal stenosis**—Narrowing of the canals in the vertebrae or around the nerve roots, causing pressure on the spinal cord and nerves.

**Vertebra (plural, vertebrae)**—One of the bones of the spinal column. There are 33 vertebrae in the human spine.

damaged. As people age, the intervertebral disks begin to lose moisture and break down, which reduces the size of the foramina between the vertebrae. In addition, bone spurs may form inside the vertebrae and cause the spinal canal itself to become narrower. Either of these processes can compress the spinal nerves, leading to pain, tingling sensations, or weakness in the lower back and legs. A lumbar laminectomy relieves pressure on the spinal nerves by removing the

disk, piece of bone, tumor, or other structure that is causing the compression.

### *Causes of lower back pain*

The disks and vertebrae in the lower back are particularly vulnerable to the effects of aging and daily wear and tear because they bear the full weight of the upper body, even when one is sitting quietly in a

chair. When a person bends forward, 50% of the motion occurs at the hips, but the remaining 50% involves the lumbar spine. The force exerted in bending is not evenly divided among the five lumbar vertebrae; the segments between the third and fourth lumbar vertebrae (L3-L4) and the fourth and fifth (L4-L5) are most likely to break down over time. More than 95% of spinal disk operations are performed on the fourth and fifth lumbar vertebrae.

Specific symptoms and disorders that affect the lower back include:

- **Sciatica.** Sciatica refers to sudden pain felt as radiating from the lower back through the buttocks and down the back of one leg. The pain, which may be experienced as weakness in the leg, a tingling feeling, or a “pins and needles” sensation, runs along the course of the sciatic nerve. Sciatica is a common symptom of a herniated disk.
- **Spinal stenosis.** Spinal stenosis is a disorder that results from the narrowing of the spinal canal surrounding the spinal cord and eventually compressing the cord. It may result from hereditary factors, from the effects of aging, or from changes in the pattern of blood flow to the lower back. Spinal stenosis is sometimes difficult to diagnose because its early symptoms can be caused by a number of other conditions and because the patient usually has no history of back problems or recent injuries. Imaging studies may be necessary for accurate diagnosis.
- **Cauda equina syndrome (CES).** Cauda equina syndrome is a rare disorder caused when a ruptured disk, bone fracture, or spinal stenosis put intense pressure on the cauda equina, the collection of spinal nerve roots at the lower end of the spinal cord. CES may be triggered by a fall, automobile accident, or penetrating gunshot injury. It is characterized by loss of sensation or altered sensation in the legs, buttocks, or feet; pain, numbness, or weakness in one or both legs; difficulty walking; or loss of control over bladder and bowel functions. *Cauda equina syndrome is a medical emergency requiring immediate treatment.* If the pressure on the nerves in the cauda equina is not relieved quickly, permanent paralysis and loss of bladder or bowel control may result.
- **Herniated disk.** The disks between the vertebrae in the spine consist of a fibrous outer part called the annulus and a softer inner nucleus. A disk is said to herniate when the nucleus ruptures and is forced through the outer annulus into the spaces between the vertebrae. The material that is forced out may put pressure on the nerve roots or compress the spinal cord itself. In other cases, the chemicals leaking from the ruptured nucleus may irritate or inflame the

spinal nerves. More than 80% of herniated disks affect the spinal nerves associated with the L5 vertebra or the first sacral vertebra.

- **Osteoarthritis (OA).** OA is a disorder in which the cartilage in the hips, knees, and other joints gradually breaks down, allowing the surfaces of the bones to rub directly against each other. In the spine, OA may result in thickening of the ligaments surrounding the spinal column. As the ligaments increase in size, they may begin to compress the spinal cord.

Factors that increase a person’s risk of developing pain in the lower back include:

- **Hereditary factors.** Some people are born with relatively narrow spinal canals and may develop spinal stenosis fairly early in life.
- **Sex.** Men are at greater risk of lower back problems than women, in part because they carry a greater proportion of their total body weight in the upper body.
- **Age.** The intervertebral disks tend to lose their moisture content and become thinner as people get older.
- **Occupation.** Jobs that require long periods of driving (long-distance trucking; bus, taxi, or limousine operation) are hard on the lower back because of vibrations from the road surface transmitted upward to the spine. Occupations that require heavy lifting (nursing, child care, construction work, airplane maintenance) put extra stress on the lumbar vertebrae. Other high-risk occupations include professional sports, professional dance, assembly line work, foundry work, mining, and mail or package delivery.
- **Lifestyle.** Wearing high-heeled shoes, carrying heavy briefcases or shoulder bags on one side of the body, or sitting for long periods of time in one position can all throw the spine out of alignment.
- **Obesity.** Being overweight, particularly if the extra pounds are concentrated in the abdomen, adds to the strain on the muscles and ligaments that support the spinal column.
- **Trauma.** Injuries to the back from contact sports, falls, criminal assaults, or automobile accidents may lead to misalignment of the vertebrae or a ruptured disk. Traumatic injuries may also trigger the onset of cauda equina syndrome.

## Demographics

Pain in the lower back is a chronic condition that has been treated in various ways from the beginnings of human medical practice. The earliest description of disorders affecting the lumbar vertebrae was written in 3000 B.C. by an ancient Egyptian surgeon. In the



modern world, back pain is responsible for more time lost from work than any other cause except the common cold. Between 10% and 15% of workers' compensation claims are related to chronic pain in the lower back. It is estimated that the direct and indirect costs of back pain to the American economy range between \$75 and \$80 billion per year.

In the United States, about 13 million people seek medical help each year for the condition. According to the Centers for Disease Control, 14% of all new visits to primary care doctors are related to problems in the lower back. The CDC estimates that 2.4 million adults in the United States are chronically disabled by back pain, with another 2.4 million temporarily disabled. About 80% of people will experience pain in the lower back at some point in their lifetime; on a yearly basis, one person in every five will have some kind of back pain.

Back pain primarily affects the adult population, most commonly people between the ages of 45 and 64. It is more common among men than women, and more common among Caucasians and Hispanics than among African Americans or Asian Americans.

### Description

A laminectomy is performed with the patient under **general anesthesia**, usually positioned lying on the side or stomach. The surgeon begins by making a small straight incision over the damaged vertebra.

The surgeon next uses a retractor to spread apart the muscles and fatty tissue overlying the spine. When the laminae have been reached, the surgeon cuts away part of the bony arch in order to expose the ligamentum flavum, which is a band of yellow tissue attached to the vertebra that helps to support the spinal column and closes in the spaces between the vertebral arches. The surgeon then cuts an opening in the ligamentum flavum in order to reach the spinal canal and expose the compressed nerve. At this point the cause of the compression (herniated disk, tumor, bone spur, or a fragment of the disk that has separated from the remainder) will be visible.

Bone spurs, if any, are removed in order to enlarge the foramina and the spinal canal. If the disk is herniated, the surgeon uses the retractor to move the compressed nerve aside and removes as much of the disk as necessary to relieve pressure on the nerve. The space that was occupied by the disk will be filled eventually by new connective tissue.

If necessary, a **spinal fusion** is performed to stabilize the patient's lower back. A small piece of bone taken from the hip is grafted onto the spine and

attached with metal screws or plates to support the lumbar vertebrae.

Following completion of the spinal fusion, the surgeon closes the incision in layers, using different types of sutures for the muscles, connective tissues, and skin. The entire procedure takes one to three hours.

### Diagnosis/Preparation

#### Diagnosis

The differential diagnosis of lower back pain is complicated by the number of possible causes and the patient's reaction to the discomfort. In many cases the patient's perception of back pain is influenced by poor-quality sleep or emotional issues related to occupation or family matters. A primary care doctor will begin by taking a careful medical and occupational history, asking about the onset of the pain as well as its location and other characteristics. Back pain associated with the lumbar spine very often affects the patient's ability to move, and the muscles overlying the affected vertebrae may feel sore or tight. Pain resulting from heavy lifting usually begins within 24 hours of the overexertion. Most patients who do not have a history of chronic pain in the lower back feel better after 48 hours of bed rest with pain medication and either a heating pad or ice pack to relax muscle spasms.

If the patient's pain is not helped by rest and other conservative treatments, he or she will be referred to an orthopedic surgeon for a more detailed evaluation. An orthopedic evaluation includes a **physical examination**, neurological workup, and imaging studies. In the physical examination, the doctor will ask the patient to sit, stand, or walk in order to see how these functions are affected by the pain. The patient may be asked to cough or to lie on a table and lift each leg in turn without bending the knee, as these maneuvers can help to diagnose nerve root disorders. The doctor will also palpate (feel) the patient's spinal column and the overlying muscles and ligaments to determine the external location of any tender spots, bruises, thickening of the ligaments, or other structural abnormalities. The neurological workup will focus on the patient's reflexes and the spinal nerves that affect the functioning of the legs. Imaging studies for lower back pain typically include an x-ray study and CT scan of the lower spine, which will reveal bone deformities, narrowing of the intervertebral disks, and loss of cartilage. An MRI may be ordered if spinal stenosis is suspected. In some cases the doctor may order a myelogram, which is an x-ray or CT scan of the lumbar

spine performed after a special dye has been injected into the spinal fluid.

Lower back pain is one of several common general medical conditions that require the doctor to assess the possibility that the patient has a concurrent psychiatric disorder. Such diagnoses as somatization disorder or pain disorder do not mean that the patient's physical symptoms are imaginary or that they should not receive surgical or medical treatment. Rather, a psychiatric diagnosis indicates that the patient is allowing the back pain to become the central focus of life or responding to it in other problematic ways. Some researchers in Europe as well as North America think that the frequency of lower back problems in workers' disability claims reflect emotional dissatisfaction with work as well as physical stresses related to specific jobs.

### Preparation

Most hospitals require patients to have the following tests before a laminectomy: a complete physical examination; **complete blood count** (CBC); an **electrocardiogram** (EKG); a urine test; and tests that measure the speed of blood clotting.

**Aspirin** and arthritis medications should be discontinued seven to 10 days before a laminectomy because they thin the blood and affect clotting time. Patients should provide the surgeon and anesthesiologist with a complete list of all medications, including over-the-counter and herbal preparations, that they take on a regular basis.

The patient is asked to stop smoking at least a week before surgery and to take nothing by mouth after midnight before the procedure.

### Aftercare

Aftercare following a laminectomy begins in the hospital. Most patients will remain in the hospital for one to three days after the procedure. During this period the patient will be given fluids and antibiotic medications intravenously to prevent infection. Medications for pain will be given every three to four hours, or through a device known as a PCA (patient-controlled anesthesia). The PCA is a small pump that delivers a dose of medication into the IV when the patient pushes a button. To get the lungs back to normal functioning, a respiratory therapist will ask the patient to do some simple breathing exercises and begin walking within several hours of surgery.

Aftercare during the hospital stay is also intended to lower the risk of a venous thromboembolism (VTE), or blood clot in the deep veins of the leg.

Prevention of VTE involves medications to thin the blood and wearing compression stockings or boots.

Most surgeons prefer to see patients one week after surgery to remove **stitches** and check for any postoperative complications. Patients should not drive or return to work before their checkup. A second follow-up examination is usually done four to eight weeks after the laminectomy.

Patients can help speed their recovery by taking short walks on a daily basis; avoiding sitting or standing in the same position for long periods of time; taking brief naps during the day; and sleeping on the stomach or the side. They may take a daily bath or shower without needing to cover the incision. The incision should be carefully patted dry, however, rather than rubbed.

### Risks

Risks associated with a laminectomy include:

- bleeding
- infection
- damage to the spinal cord or other nerves
- weakening or loss of function in the legs
- blood clots
- leakage of spinal fluid resulting from tears in the dura, the protective membrane that covers the spinal cord
- worsening of back pain

### Normal results

Normal results depend on the cause of the patient's lower back pain; most patients can expect considerable relief from pain and some improvement in functioning. There is some disagreement among surgeons about the success rate of laminectomies, however, which appears to be due to the fact that the operation is generally done to improve quality of life—cauda equina syndrome is the only indication for an emergency laminectomy. Different sources report success rates between 26% and 99%, with 64% as the average figure. According to one study, 31% of patients were dissatisfied with the results of the operation, possibly because they may have had unrealistic expectations of the results.

### Morbidity and mortality rates

The mortality rate for a lumbar laminectomy is between 0.8% and 1%. Rates of complications depend partly on whether a spinal fusion is performed as part of the procedure; while the general rate of complications following a lumbar laminectomy is given as 6–7%, the rate rises to 12% if a spinal fusion has been done.

## Alternatives

### *Conservative treatments*

Surgery for lower back pain is considered a treatment of last resort, with the exception of cauda equina syndrome. Patients should always try one or more conservative approaches before consulting a surgeon about a laminectomy. In addition, most health insurers will require proof that the surgery is necessary, since the average total cost of a lumbar laminectomy is \$85,000.

Some conservative approaches that have been found to relieve lower back pain include:

- **Analgesic or muscle relaxant medications.** Analgesics are drugs given to relieve pain. The most commonly prescribed pain medications are aspirin or NSAIDs. Muscle relaxants include methocarbamol, cyclobenzaprine, or diazepam.
- **Epidural injections.** Epidural injections are given directly into the space surrounding the spinal cord. Corticosteroids are the medications most commonly given by this route, but preliminary reports indicate that epidural injections of indomethacin are also effective in relieving recurrent pain in the lower back.
- **Rest.** Bed rest for 48 hours usually relieves acute lower back pain resulting from muscle strain.
- **Appropriate exercise.** Brief walks are recommended as a good form of exercise to improve blood circulation, particularly after surgery. In addition, there are several simple exercises that can be done at home to strengthen the muscles of the lower back. A short pamphlet entitled *Back Pain Exercises* may be downloaded free of charge from the American Academy of Orthopaedic Surgeons (AAOS) web site.
- **Losing weight.** People who are severely obese may wish to consider weight reduction surgery to reduce the stress on their spine as well as their heart and respiratory system.
- **Occupational modifications or change.** Lower back pain related to the patient's occupation can sometimes be eased by taking periodic breaks from sitting in one position; by using a desk and chair proportioned to one's height; by learning to use the muscles of the thighs when lifting heavy objects rather than the lower back muscles; and by maintaining proper posture when standing or sitting. In some cases the patient may be helped by changing occupations.
- **Physical therapy.** A licensed physical therapist can be helpful in identifying the patient's functional back problems and planning a course of treatment to improve flexibility, strength, and range of motion.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A lumbar laminectomy is performed by an orthopedic surgeon or a neurosurgeon. It is performed as an inpatient procedure in a hospital with a department of orthopedic surgery. Minimally invasive laminotomies and microdiscectomies are usually performed in outpatient surgery facilities.

- **Osteopathic manipulative treatment (OMT).** Osteopathic physicians (DOs) receive the same training in medicine and surgery as MDs; however, they are also trained to evaluate postural and spinal abnormalities and to perform several different manual techniques for relief of back pain. An article published in the *New England Journal of Medicine* in 1999 reported that OMT was as effective as physical therapy and standard medication in relieving lower back pain, with fewer side effects and lower health care costs. OMT is recommended in the United Kingdom as a very low-risk treatment that is more effective than bed rest or mild analgesics.
- **Transcutaneous electrical nerve stimulation (TENS).** TENS is a treatment technique developed in the late 1960s that delivers a mild electrical current to stimulate nerves through electrodes attached to the skin overlying a painful part of the body. It is thought that TENS works by stimulating the production of endorphins, which are the body's natural painkilling compounds.

### *Surgical alternatives*

The most common surgical alternative to laminectomy is a minimally invasive laminotomy and/or microdiscectomy. In this procedure, which takes about an hour, the surgeon makes a 0.5-in (1.3-cm) incision in the lower back and uses a series of small dilators to separate the layers of muscle and fatty tissue over the spine rather than cutting through them with a scalpel. A tube-shaped retractor is inserted to expose the part of the lamina over the nerve root. The surgeon then uses a power drill to make a small hole in the lamina to expose the nerve itself. After the nerve has been moved aside with the retractor, a small grasping device is used to remove the herniated portion or fragments of the damaged spinal disk.

The advantages of these minimally invasive procedures are fewer complications and a shortened

## QUESTIONS TO ASK THE DOCTOR

- What conservative treatments would you recommend for my lower back pain?
- How much time should I allow for conservative therapies to demonstrate effectiveness before considering surgery?
- Am I a candidate for a laminotomy and microdiscectomy?
- How many laminectomies have you performed?

recovery time for the patient. The average postoperative stay is three hours. In addition, 90% of patients are pleased with the results.

### *Complementary and alternative (CAM) approaches*

Two alternative methods of treating back disorders that have been shown to help many patients are acupuncture and chiropractic. Chiropractic is based on the belief that the body has abilities to heal itself provided that nerve impulses can move freely between the brain and the rest of the body. Chiropractors manipulate the segments of the spine in order to bring them into proper alignment and restore the nervous system to proper functioning. Many are qualified to perform acupuncture as well as chiropractic adjustments of the vertebrae and other joints. Several British and Swedish studies have reported that acupuncture and chiropractic are at least as effective as other conservative measures in relieving pain in the lower back.

Movement therapies, including yoga, tai chi, and gentle stretching exercises, may be useful in maintaining or improving flexibility and range of motion in the spine. A qualified yoga instructor can work with the patient's doctor before or after surgery to put together an individualized set of beneficial stretching and breathing exercises. The Alexander technique is a type of movement therapy that is often helpful to patients who need to improve their posture.

### Resources

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#### ORGANIZATIONS

- American Academy of Neurological and Orthopaedic Surgeons (AANOS). 2300 South Rancho Drive, Suite 202, Las Vegas, NV 89102. (702) 388-7390. <http://www.aanos.org>.
- American Academy of Neurology. 1080 Montreal Avenue, Saint Paul, MN 55116. (800) 879-1960 or (651) 695-2717. <http://www.aan.com>.
- American Academy of Orthopaedic Surgeons (AAOS). 6300 North River Road, Rosemont, IL 60018. (847) 823-7186 or (800) 346-AAOS. <http://www.aaos.org>.
- American Chiropractic Association. 1701 Clarendon Blvd., Arlington, VA 22209. (800) 986-4636. <http://www.amerchiro.org>.
- American Osteopathic Association (AOA). 142 East Ontario Street, Chicago, IL 60611. (800) 621-1773 or (312) 202-8000. <http://www.aoa-net.org>.



American Physical Therapy Association (APTA). 1111 North Fairfax Street, Alexandria, VA 22314. (703)684 APTA or (800) 999 2782. <http://www.apta.org>.  
 National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS) Information Clearinghouse. National Institutes of Health, 1 AMS Circle, Bethesda, MD 20892. (301) 495 4484. TTY: (301) 565 2966. <http://www.niams.nih.gov>.

#### OTHER

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Rebecca Frey, Ph.D.

Laparoscopic cholecystectomy see  
**Cholecystectomy**

## Laparoscopy

### Definition

Laparoscopy is a minimally invasive procedure used as a diagnostic tool and surgical procedure that is performed to examine the abdominal and pelvic organs, or the thorax, head, or neck. Tissue samples can also be collected for biopsy using laparoscopy and malignancies treated when it is combined with other therapies. Laparoscopy can also be used for some cardiac and vascular procedures.

### Purpose

Laparoscopy is performed to examine the abdominal and pelvic organs to diagnose certain conditions and—depending on the condition—can be used to perform surgery. Laparoscopy is commonly used in gynecology to examine the outside of the uterus, the fallopian tubes, and the ovaries—particularly in pelvic pain cases where the underlying cause cannot be determined using diagnostic imaging (**ultrasound** and computed tomography). Examples of gynecologic conditions diagnosed using laparoscopy include endometriosis, ectopic pregnancy, ovarian cysts, pelvic inflammatory disease [PID], infertility, and cancer. Laparoscopy is used in **general surgery**

to examine the abdominal organs, including the gallbladder, bile ducts, the liver, the appendix, and the intestines.

During the laparoscopic surgical procedure, certain conditions can be treated using instruments and devices specifically designed for laparoscopy. Medical devices that can be used in conjunction with laparoscopy include surgical lasers and electrosurgical units. Laparoscopic surgery is now preferred over open surgery for several types of procedures because of its minimally invasive nature and its association with fewer complications.

Minilaparoscopy can be performed in the physician's office using smaller laparoscopes. Common clinical applications in gynecology include pain mapping (for endometriosis), sterilization, and fertility procedures. Common applications in general surgery include evaluation of chronic and acute abdominal pain (as in appendicitis), basic trauma evaluation, biopsies, and evaluation of abdominal masses.

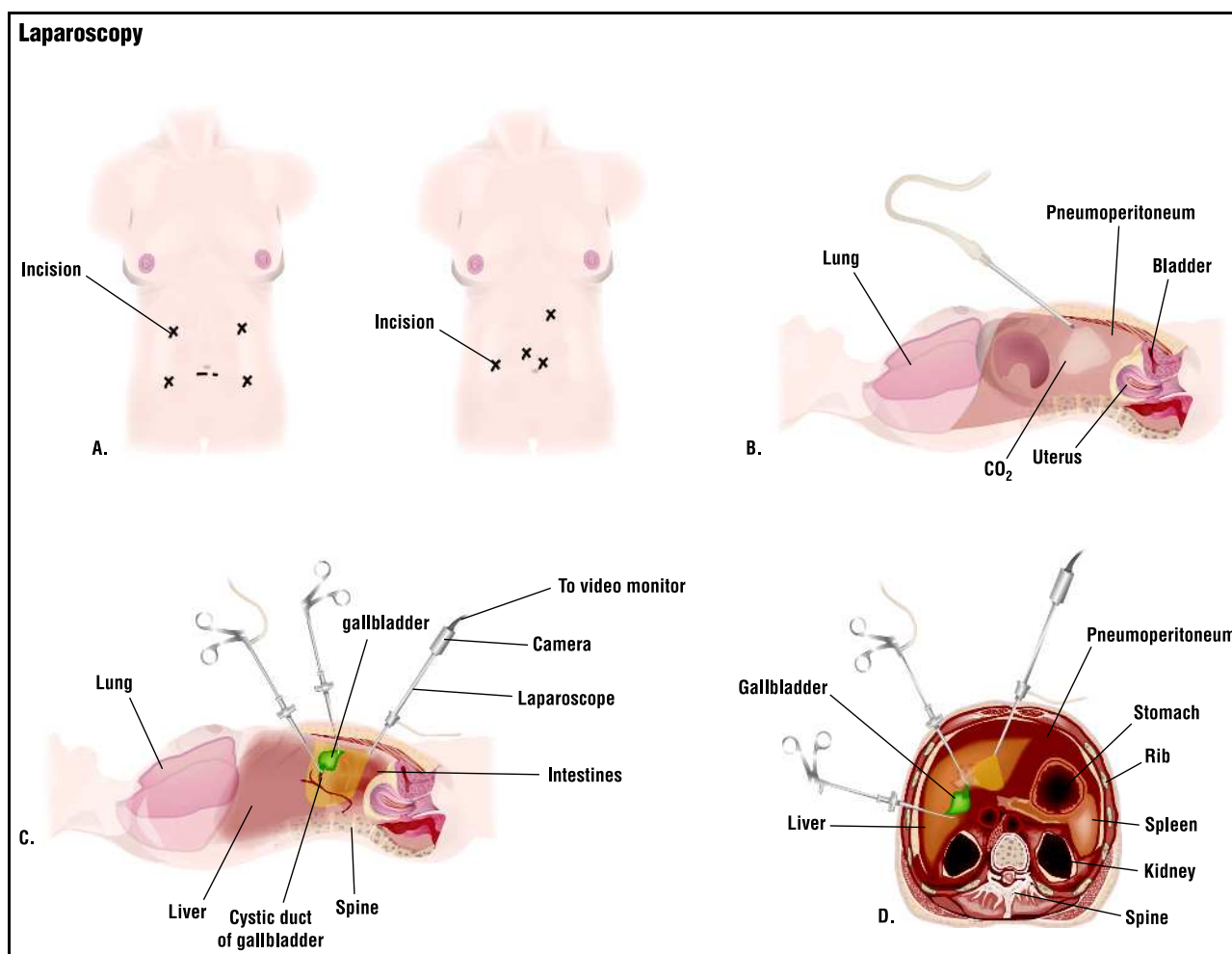
Laparoscopy is commonly used by gynecologists, urologists, and general surgeons for abdominal and pelvic applications. Laparoscopy is also being used by orthopedic surgeons for spinal applications and by cardiac surgeons for **minimally invasive heart surgery**. Newer video-assisted laparoscopic procedures include **thyroidectomy** and **parathyroidectomy**.

### Demographics

At first, laparoscopy was only been performed on young, healthy adults, but the use of this technique has greatly expanded. Populations on whom laparoscopies are now performed include infants, children, the elderly, the obese, and those with chronic disease states, such as cancer. The applications of this type of surgery have grown considerably over the years to include a variety of patient populations, and will continue to do so with the refinement of laparoscopic techniques.

### Description

Laparoscopy is typically performed in the hospital under **general anesthesia**, although some laparoscopic procedures can be performed using local anesthetic agents. Once under anesthesia, a urinary catheter is inserted into the patient's bladder for urine collection. To begin the procedure, a small incision is made just below the navel and a cannula or trocar is inserted into the incision to accommodate the insertion of the laparoscope. Other incisions may be made in the abdomen to allow the insertion of additional laparoscopic instrumentation. A laparoscopic insufflation device is used to inflate the abdomen



The surgeon has a choice of incision options for laparoscopy, depending on the needs of the procedure (A). In this abdominal procedure, carbon dioxide is pumped into the cavity to create a condition called pneumoperitoneum, which allows the surgeon easier access to internal structures. The laparoscope is connected to a video monitor, and special forceps are used to carry out any necessary procedure (C and D) (Illustration by GGS Information Services. Cengage Learning, Gale.)

with carbon dioxide gas to create a space in which the laparoscopic surgeon can maneuver the instruments. After the laparoscopic diagnosis and treatment are completed, the laparoscope, cannula, and other instrumentation are removed, and the incision is sutured and bandaged.

Laparoscopes have integral cameras for transmitting images during the procedure, and are available in various sizes depending upon the type of procedure performed. The images from the laparoscope are transmitted to a viewing monitor that the surgeon uses to visualize the internal anatomy and guide any surgical procedure. Video and photographic equipment are also used to document the surgery, and may be used postoperatively to explain the results of the procedure to the patient.

Robotic systems are available to assist with laparoscopy. A robotic arm, attached to the operating table may be used to hold and position the laparoscope. This serves to reduce unintentional camera movement that is common when a surgical assistant holds the laparoscope. The surgeon controls the robotic arm movement by foot pedal with voice-activated command, or with a handheld control panel.

Microlaparoscopy has become more common over the past few years. The procedure involves the use of smaller laparoscopes (that is, 2 mm compared to 5–10 mm for hospital laparoscopy), with the patient undergoing **local anesthesia** with **conscious sedation** (during which the patient remains awake but very relaxed) in a physician's office. Video and photographic equipment, previously explained, may be used.

## KEY TERMS

**Ascites**—Accumulation of fluid in the abdominal cavity; laparoscopy may be used to determine its cause.

**Cholecystitis**—Inflammation of the gallbladder, often diagnosed using laparoscopy.

**Electrosurgical device**—A medical device that uses electrical current to cauterize or coagulate tissue during surgical procedures; often used in conjunction with laparoscopy.

**Embolism**—Blockage of an artery by a clot, air or gas, or foreign material. Gas embolism may occur as a result of insufflation of the abdominal cavity during laparoscopy.

**Endometriosis**—A disease involving occurrence of endometrial tissue (lining of the uterus) outside the uterus in the abdominal cavity; often diagnosed and treated using laparoscopy.

**Hysterectomy**—Surgical removal of the uterus; often performed laparoscopically.

**Insufflation**—Inflation of the abdominal cavity using carbon dioxide; performed prior to laparoscopy to give the surgeon space to maneuver surgical equipment.

**Oophorectomy**—Surgical removal of the ovaries; often performed laparoscopically.

**Pneumothorax**—Air or gas in the pleural space (lung area) that may occur as a complication of laparoscopy and insufflation.

**Subcutaneous emphysema**—A pathologic accumulation of air underneath the skin resulting from improper insufflation technique.

**Trocar**—A small sharp instrument used to puncture the abdomen at the beginning of the laparoscopic procedure.

Laparoscopy has been explored in combination with other therapies for the treatment of certain types of malignancies, including pelvic and aortic lymph node dissection, ovarian cancer, and early cervical cancer. Laparoscopic radiofrequency ablation is a technique whereby laparoscopy assists in the delivery of radiofrequency probes that distribute pulses to a tumor site. The pulses generate heat in malignant tumor cells and destroys them.

The introduction of items such as temperature-controlled instruments, **surgical instruments** with greater rotation and articulation, improved imaging

systems, and multiple robotic devices will expand the utility of laparoscopic techniques in the future. The skills of surgeons will be enhanced as well, with further development of training simulators and computer technology.

## Diagnosis/Preparation

Before undergoing laparoscopic surgery, the patient should be prepared by the doctor for the procedure both psychologically and physically. It is very important that the patient receive realistic counseling before surgery and prior to giving **informed consent**. This includes discussion about further open abdominal surgery (laparotomy) that may be required during laparoscopic surgery, information about potential complications during surgery, and the possible need for blood transfusions. In the case of diagnostic laparoscopy for chronic pelvic pain, the procedure may simply indicate that all organs are normal and the patient should be prepared for this possibility. The surgery may be explained using pictures, models, videotapes, and movies. It is especially important for the patient to be able to ask questions and express concerns. It may be helpful, for the patient to have a family member or friend present during discussions with the doctor. Such conversations could understandably cause anxiety, and information relayed may not be adequately recalled under such circumstances.

There is usually a presurgical exam two weeks before the surgery to gather a medical history and obtain blood and urine samples for laboratory testing. It is important that the patient inform the doctor completely about any prior surgeries, medical conditions, or medications taken on a regular basis, including **nonsteroidal anti-inflammatory drugs** (NSAIDs), such as **aspirin**. Patients taking blood thinners, like Coumadin or Heparin (generic name: warfarin) should not adjust their medication themselves, but should speak with their prescribing doctors regarding their upcoming surgery. (Patients should never adjust dosage without their doctors' approval. This is especially important for elderly patients, asthmatics, those with hypertension, or those who are on ACE inhibitors.) If a tubal dye study is planned during the procedure, the patient may also be required to provide information on menstrual history. For some procedures, an autologous (self) **blood donation** may be suggested prior to the surgery to replace blood that may be lost during the procedure. Chest x rays may also be required. For some obese patients, weight loss may be necessary prior to surgery.

Immediately before to surgery, there are several pre-operative steps that the patient may be advised to take. The patient should shower at least 24 hours prior to the surgery, and gently but thoroughly cleanse the umbilicus (belly button) with antibacterial soap and water using a cotton-tipped swab. Because laparoscopy requires general anesthesia in most cases, the patient may be asked to eat lightly 24 hours prior to surgery and fast at least 12 hours prior to surgery. Bowel cleansing with a laxative may also be required, allowing it to be more easily visualized and to prevent complications in the unlikely event of bowel injury. Those who have diabetes or have hypoglycemia may wish to schedule their procedures early in the morning to avoid low blood sugar reactions. The patient should follow the directions of the hospital staff, arriving early on the day of surgery to sign paperwork and to be screened by the anesthesiology staff. Questions will be asked regarding current medications and dosages, allergies to medication, previous experiences with anesthesia (that is, allergic reactions, and previous experiences regarding time-to-consciousness), and a variety of other questions. It is often helpful for the patient to make a list of this information beforehand so that the information can be easily retrieved when requested by the hospital staff.

### Aftercare

Following laparoscopy, patients are required to remain in a recovery area until the immediate effects of anesthesia subside and until normal voiding is accomplished (especially if a urinary catheter was used during the surgery). **Vital signs** are monitored to ensure that there are no reactions to anesthesia or internal injuries present. There may be some nausea and/or vomiting, which may be reduced by the use of the propofol anesthetic for healthy patients undergoing elective procedures such as **tubal ligation**, diagnostic laparoscopy, or hernia repair. Laparoscopy is usually an outpatient procedure and patients are discharged from the recovery area within a few hours after the procedure. For elderly patients and those with other medical conditions, recovery may be slower. Patients with more serious medical conditions, or patients undergoing emergency laparoscopy, an overnight hospital stay or a stay of several days may be required.

Discharged patients will receive instructions regarding activity level, medications, postoperative dietary modifications, and possible side effects of the procedure. It may be helpful to have a friend or family member present when these instructions are given, as the aftereffects of anesthesia may cause some temporary confusion. Postoperative instructions may

include information on when one might resume normal activities such as bathing, housework, and driving. Depending on the nature of the laparoscopic procedure and the patient's medical condition, daily activity may be restricted for a few days and strenuous during administration of anesthesia may cause some soreness. Additionally, shoulder pain may persist as long as 36 hours after surgery. Pain-relieving medications and **antibiotics** may be prescribed for several days postoperatively.

Patients will be instructed to watch for signs of a urinary tract infection (UTI) or unusual pain; either may indicate organ injury. It is important to understand the difference between normal discomfort and pain, because pain may indicate a problem. Patients may also experience an elevated temperature, and occasionally "postlaparoscopy syndrome"; this condition is similar in appearance to peritonitis (marked by abdominal pain, constipation, vomiting, and fever) that disappears shortly after surgery without antibiotics. However, any postoperative symptoms that cause concern for the patient should be discussed with the doctor, so that any fears can be alleviated and recovery can be accomplished. Due to the after-effects of anesthesia, patients should not drive themselves home.

It is advisable for someone to stay with the patient for a few hours following the procedure, in case complications arise. Injury to an organ might not be readily apparent for several days after the procedure. The physical signs that should be watched for and reported immediately include:

- fever and chills
- abdominal distension
- vomiting
- difficulty urinating
- sharp and unusual pain in the abdomen or bowel
- redness at the incision site, which indicates infection
- discharge from any places where tubes were inserted or incisions were made

Additional complications may include a urinary tract infection (resulting from catheterization) and minor infection of the incision site. An injury to the ureter may be indicated by abdominal distention or a pain in the flank. Additional testing may be required if a complication is suspected.

### Risks

Complications may be associated with the laparoscopy procedure in general, or may be specific to the type of operation that is performed. Patients should consult with their doctors regarding the types of risks



that are specific for their procedures. The most serious complication that can occur during laparoscopy is laceration of a major abdominal blood vessel resulting from improper positioning, inadequate insufflation (inflation) of the abdomen, abnormal pelvic anatomy, and too much force exerted during scope insertion. Thin patients with well-developed abdominal muscles are at higher risk, since the aorta may only be an inch or so below the skin. Obese patients are also at higher risk because more forceful and deeper needle and scope penetration is required. During laparoscopy, there is also a risk of bleeding from blood vessels, and adhesions may require repair by open surgery if bleeding cannot be stopped using laparoscopic instrumentation. In laparoscopic procedures that use electrosurgical devices, burns to the incision site are possible due to passage of electrical current through the laparoscope caused by a fault or malfunction in the equipment.

Complications related to insufflation of the abdominal cavity include gas inadvertently entering a blood vessel and causing an embolism, pneumothorax, or subcutaneous emphysema. One common but not serious side effect of insufflation is pain in the shoulder and upper chest area for a day or two following the procedure.

Any abdominal surgery, including laparoscopy, carries the risk of unintentional organ injury (punctures and perforations). For example, the bowel, bladder, ureters, or fallopian tubes may be injured during the laparoscopic procedure. Many times these injuries are unavoidable due to the patient's anatomy or medical condition. Patients at higher risk for bowel injury include those with chronic bowel disease, PID, a history of previous abdominal surgery, or severe endometriosis. Some types of laparoscopic procedures have a higher risk of organ injury. For instance, during laparoscopic removal of endometriosis adhesions or ovaries, the ureters may be injured due to their proximity to each other.

Several clinical studies have shown that the complication rate during laparoscopy is associated with inadequate surgeon experience. Surgeons who are more experienced in laparoscopic procedures have fewer complications than those performing their first 100 cases.

### Normal results

In diagnostic laparoscopy, the surgeon will be able to see signs of a disease or condition (for example, endometriosis adhesions; ovarian cysts; diseased gallbladder) immediately, and can either treat the condition surgically or proceed with appropriate medical management. In

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Laparoscopy may be performed by a gynecologist, general surgeon, gastroenterologist, or other physician depending upon the patient's condition. An anesthesiologist is required during the procedure to administer general and/or local anesthesia and to perform patient monitoring. Nurses and surgical technicians/assistants are needed during the procedure to assist with scope positioning, video system adjustments and image recording, and laparoscopic instrumentation.

diagnostic laparoscopy, biopsies may be taken of tissue in questionable areas, and laboratory results will govern medical treatment. In therapeutic laparoscopy, the surgeon performs a procedure that rectifies a known medical problem, such as hernia repair or appendix removal. Because laparoscopy is minimally invasive compared to open surgery, patients may experience less trauma and postoperative discomfort, have fewer procedural complications, have a shorter hospital stay, and return more quickly to daily activities. The results will vary, however, depending on the patients's condition and type of treatment.

### Morbidity and mortality rates

Laparoscopic surgery, like most surgeries, is not without risk. Risks should be thoroughly explained to the patient. Complications from laparoscopic surgeries arise in 1–5% of the cases, with a mortality of about 0.05%. Complications may arise from the laparoscopic entry during procedure, and the risks vary depending on the elements specific to a particular procedure. For example, the risk of injury to the common bile duct in laparoscopic biliary surgery is 0.3–0.6% of cases. The factors that contribute to morbidity are currently under study and debate. Injury may occur to blood vessels and internal organs. Some studies examining malpractice data indicate that trocar injury to the bowel or blood vessels may account up to one-fourth of laparoscopic medical claims. It has been suggested that these injuries can be reduced by alterations in the placement and use of the Verses needle, or by using an open technique of trocar insertion in which a blunt cannula (non-bladed) is inserted into the abdominal cavity through an incision. The insertion of secondary **trocars** may be of particular interest as a risk factor. There is still some debate,

## QUESTIONS TO ASK THE DOCTOR

- Will this surgery be covered by my insurance? Will any postsurgical care that I require also be covered?
- What do I need to do to prepare for the surgery? Are there any restrictions on diet, fluid intake, or other measures?
- Are there any medications that should be stopped prior to the surgery?
- Does my medical history pose any potential problems that need to be considered before undergoing this procedure?
- What is your (the doctor's) training in performing this surgery? Will you perform the actual surgery or will a trainee?
- What aftereffects can I expect?
- Are there any post-surgical symptoms that might indicate a complication that I should report, and to whom should these questions be directed? What post-surgical symptoms should be considered "normal" and how might discomfort be relieved?
- What is the expected recovery period from this procedure?
- What special care or self-care is required following this surgery?

however, as to which method of trocar insertion is most appropriate in a particular situation, as no technique is without risk. The most commonly cited injury in laparoscopic malpractice claims has been injury to the bile duct (66%). Proper identification of this structure by an experienced surgeon, or by a cholangiogram, may reduce this type of injury. Other areas of the body may be injured during access including the stomach, bladder, and liver. Hemorrhages may also occur during the operation.

Laparoscopic entry injuries have been the subject of recent study. Data collected from insurance companies and medical device regulation indicate that bowel and vascular injuries may account for 76% of the injuries that occur when a primary port is created. Delayed recognition of bowel injuries was noted to be an important factor in mortality. The risk of possible injury or **death** in laparoscopy depends on such factors as the anatomy of the patient, the force of entry, and the type operative procedure being performed.

## Alternatives

The alternatives to laparoscopy vary, depending on the medical condition being treated. Laparotomy (open abdominal surgery with larger incision) may be pursued when further visualization is needed to treat the condition, such as in the case of pain of severe endometriosis with deeper lesions. For those female patients with pelvic masses, transvaginal sonography may be a helpful technique in obtaining information about whether such masses are malignant, assisting in the choice between laparoscopy or laparotomy.

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- Society of American Gastrointestinal Endoscopic Surgeons (SAGES). 2716 Ocean Park Boulevard, Suite 3000, Santa Monica, CA 90405. (310) 314-2404. <http://www.endoscopy.sages.com>.
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Jennifer E. Sisk, M.A.  
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## Laparoscopy for endometriosis

### Definition

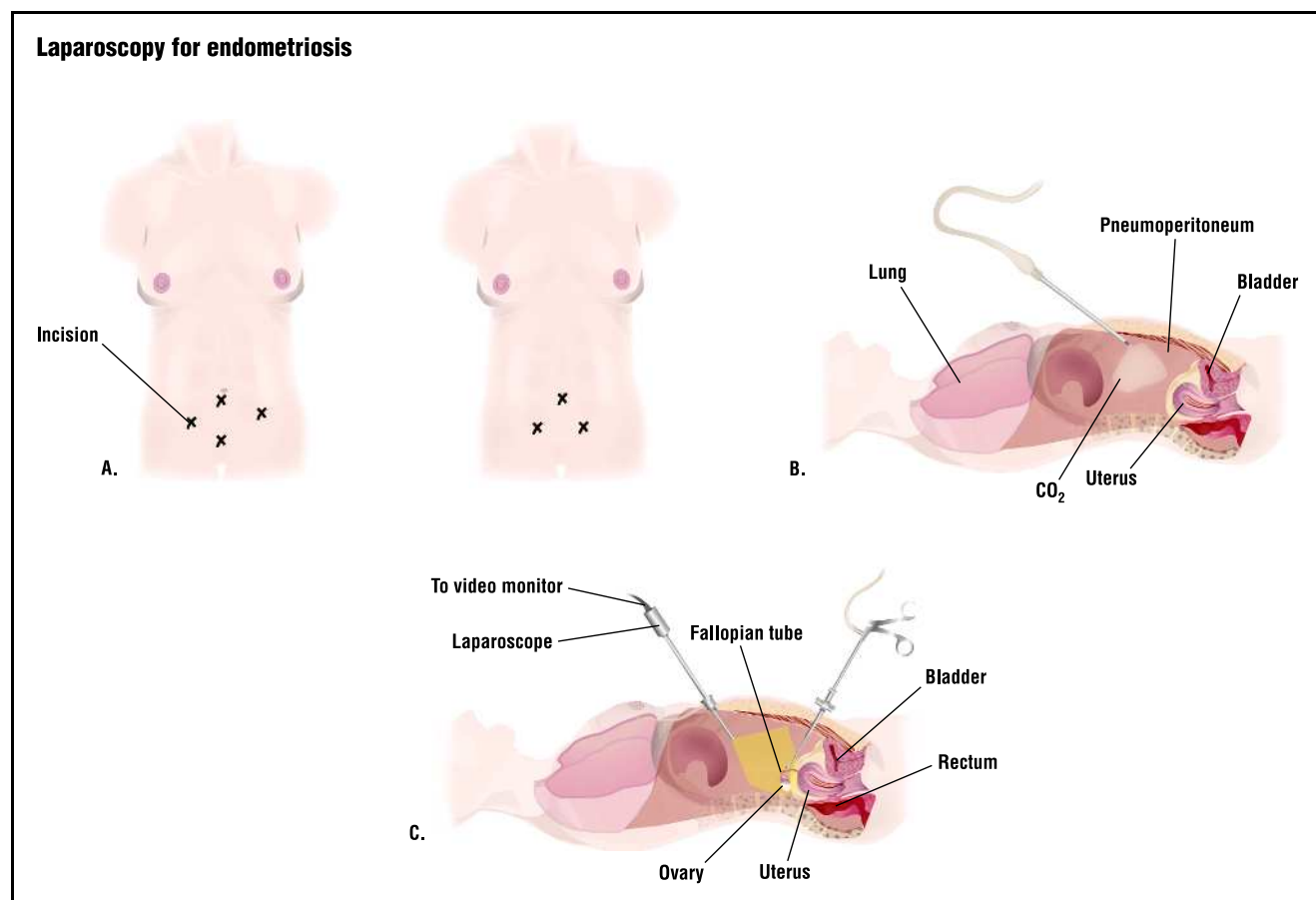
**Laparoscopy** is a surgical procedure in which a laparoscope, a telescope-like instrument, is inserted into the abdomen through a small incision and used to diagnose or treat various diseases. Specifically, laparoscopy may be used to diagnose and treat endometriosis, a condition in which the tissue that lines the uterus grows elsewhere in the body, usually in the abdominal cavity.

### Purpose

The endometrium is the inner lining of the uterus; it is where a fertilized egg will implant during the early days of pregnancy. The endometrium normally sheds during each menstrual cycle if the egg released during

ovulation has not been fertilized. Endometriosis is a condition that occurs when cells from the endometrium begin growing outside the uterus. The outlying endometrial cells respond to the hormones that control the menstrual cycle, bleeding each month the way the lining of the uterus does. This causes irritation of the surrounding tissue, leading to pain and scarring.

Endometrial growths are most commonly found on the pelvic organs, including the ovaries (the most common site), fallopian tubes, bladder, rectum, cervix, vagina, and the outer surface of the uterus. Growths are also sometimes found in other areas of the body, including the skin, lungs, brain, or surgical scars. There are numerous theories as to the cause of endometriosis; these include retrograde menstruation (movement of menstrual blood up through the fallopian tubes), movement of endometrial tissue through the blood or lymph system, or surgical transplantation (when endometriosis is found in surgical scars).



For this procedure, three or four incisions may be made in the woman's lower abdomen (A). Carbon dioxide is pumped into the abdomen to create a condition called pneumoperitoneum, which allows the surgeon to work easier in the abdomen (B). A laparoscope with video monitor is used to view the internal structures, while endometrial growths are removed with other tools (C). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Acupuncture**—The insertion of tiny needles into the skin at specific spots on the body for curative purposes.

**Fallopian tubes**—The structures that carry a mature egg from the ovaries to the uterus.

**Ovulation**—A process in which a mature female egg is released from one of the ovaries (egg-shaped structures located to each side of the uterus) every 28 days.

**Sub-fertility**—A decreased ability to become pregnant.

There are a number of reasons why laparoscopy is used to treat endometriosis. It is useful as both a diagnostic tool (to visualize structures in the abdominal cavity and examine them for endometrial growths) and as an operative tool (to excise or destroy endometrial growths). A patient's recovery time following laparoscopic surgery is shorter and less painful than following a traditional laparotomy (a larger surgical incision into the abdominal cavity). A disadvantage to laparoscopy is that some growths may be too large or extensive to remove with laparoscopic instruments, necessitating a laparotomy.

## Demographics

Endometriosis has been estimated to affect up to 10% of women. Approximately four out of every 1,000 women are hospitalized as a result of endometriosis each year. Women ages 25–35 are most affected, with 27 being the average age at diagnosis. The incidence of endometriosis is higher among white women and among women who have a family history of the disease.

## Description

The patient is given anesthesia before the procedure commences. The method of anesthesia depends on the type and duration of surgery, the patient's preference, and the recommendation of the physician. **General anesthesia** is most common for operative laparoscopy, while diagnostic laparoscopy is often performed under regional or **local anesthesia**. A catheter is inserted into the bladder to empty it of urine; this is done to minimize the risk of injury to the bladder.

A small incision is first made into the patient's abdomen in or near the belly button. A gas such as carbon dioxide is used to inflate the abdomen to allow the surgeon a better view of the surgical field. The laparoscope is a thin, lighted tube that is inserted into the abdominal cavity through the incision. Images taken by the laparoscope may be seen on a video monitor connected to the scope.

The surgeon will examine the pelvic organs for endometrial growths or adhesions (bands of scar tissue that may form after surgery or trauma). Other incisions may be made to insert additional instruments; this would allow the surgeon to better position the internal organs for viewing. To remove or destroy endometrial growths, a laser or electric current (electrocautery) may be used. Alternatively, implants may be cut away with a scalpel (surgical knife). After the procedure is completed, any incisions are closed with **stitches**.

## Diagnosis/Preparation

Some of the symptoms of endometriosis include pelvic pain (constant or during menstruation), infertility, painful intercourse, and painful urination and/or bowel movements during menstruation. Such symptoms, however, are also exhibited by a number of other diseases. A definitive diagnosis of endometriosis may only be made by laparoscopy or laparotomy.

Prior to surgery, the patient may be asked to refrain from eating or drinking after midnight on the day of surgery. An intravenous (IV) line will be placed for administration of fluids and/or medications.

## Aftercare

After the procedure is completed, the patient will usually spend several hours in the **recovery room** to ensure that she recovers from the anesthesia without complication. After leaving the hospital, she may experience soreness around the incision, shoulder pain from the gas used to inflate the abdomen, cramping, or constipation. Most symptoms resolve within one to three days.

## Risks

Risks that are associated with laparoscopy include complications due to anesthesia, infection, injury to organs or other structures, and bleeding. There is a risk that endometriosis will reoccur or that not all of the endometrial implants will be removed with surgery.



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Laparoscopy for endometriosis is performed by a surgeon or gynecologist who has been trained in laparoscopic techniques. A gynecologist is a medical doctor who has completed specialized training in the areas of women's general and reproductive health, pregnancy, labor and delivery, and prenatal testing. Laparoscopy is usually performed in a hospital on an outpatient basis.

### Normal results

After laparoscopy for endometriosis, a woman should recover quickly from the surgery and experience a significant improvement in symptoms. Some studies suggest that surgical treatment of endometriosis may improve a sub-fertile woman's chance of getting pregnant.

### Morbidity and mortality rates

The overall rate of risks associated with laparoscopy is approximately 1–2%, with serious complications occurring in only 0.2% of patients. The rate of reoccurrence of endometrial growths after laparoscopic surgery is approximately 19%. The mortality rate associated with laparoscopy is less than five per 100,000 cases.

### Alternatives

While laparoscopy remains the definitive approach to diagnosing endometriosis, some larger endometrial growths may be located by **ultrasound**, a procedure that uses high-frequency sound waves to visualize structures in the human body. Ultrasound is a non-invasive technique that may detect endometriomas (cysts filled with old blood) larger than 0.4 in (1 cm).

A physician may recommend noninvasive measures to treat endometriosis before resorting to surgical treatment. Over-the-counter or prescription pain medications may be recommended to relieve pain-related symptoms. Oral contraceptives or other hormone drugs may be prescribed to suppress ovulation and menstruation. Some women seek alternative medical therapies such as acupuncture, management of diet, or herbal treatments to reduce pain.

Severe endometriosis may need to be treated by more extensive surgery. Conservative surgery consists

## QUESTIONS TO ASK THE DOCTOR

- Why is laparoscopic surgery recommended for my particular case?
- Will operative laparoscopy be performed if endometriosis is diagnosed?
- What options do I have in terms of anesthesia and pain relief?
- What are the risks if I decide against surgical treatment?
- What alternatives to laparoscopy are available to me?

of excision of all endometrial implants in the abdominal cavity, with or without removal of bowel that is involved by the disease. Semi-conservative surgery involves removing some of the pelvic organs; examples are **hysterectomy** (removal of the uterus) and **oophorectomy** (removal of the ovaries). Radical surgery involves removing the uterus, cervix, ovaries, and fallopian tubes (called a total hysterectomy with bilateral salpingo-oophorectomy).

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- Endometriosis Association. 8585 North 76th Place, Milwaukee, WI 53223. (414) 355 2200. <http://www.endometriosisassn.org>.

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## Laparotomy, exploratory

### Definition

A laparotomy is a large incision made into the abdomen. Exploratory laparotomy is used to visualize and examine the structures inside of the abdominal cavity.

### Purpose

Exploratory laparotomy is a method of abdominal exploration, a diagnostic tool that allows physicians to examine the abdominal organs. The procedure may be recommended for a patient who has abdominal pain of unknown origin or who has sustained an injury to the abdomen. Injuries may occur as a result of blunt trauma (e.g., road traffic accident) or penetrating trauma (e.g., stab or gunshot wound). Because of the nature of the abdominal organs, there is a high risk of infection if organs rupture or are perforated. In addition, bleeding into the abdominal cavity is considered a medical emergency. Exploratory laparotomy is used to determine the source of pain or the extent of injury and perform repairs if needed.

Laparotomy may be performed to determine the cause of a patient's symptoms or to establish the extent of a disease. For example, endometriosis is a disorder in which cells from the inner lining of the uterus grow elsewhere in the body, most commonly on the pelvic and abdominal organs. Endometrial growths, however, are difficult to visualize using standard imaging techniques such as x ray, **ultrasound** technology, or computed tomography (CT) scanning. Exploratory laparotomy may be used to examine the abdominal and pelvic organs (such as the ovaries, fallopian tubes, bladder, and rectum) for evidence of endometriosis. Any growths found may then be removed.

Exploratory laparotomy plays an important role in the staging of certain cancers. Cancer staging is used to describe how far a cancer has spread. A laparotomy enables a surgeon to directly examine the abdominal organs for evidence of cancer and remove samples of tissue for further examination. When laparotomy is used for this use, it is called staging laparotomy or pathological staging.

Some other conditions that may be discovered or investigated during exploratory laparotomy include:

- cancer of the abdominal organs
- peritonitis (inflammation of the peritoneum, the lining of the abdominal cavity)
- appendicitis (inflammation of the appendix)
- pancreatitis (inflammation of the pancreas)
- abscesses (a localized area of infection)
- adhesions (bands of scar tissue that form after trauma or surgery)
- diverticulitis (inflammation of sac-like structures in the walls of the intestines)
- intestinal perforation
- ectopic pregnancy (pregnancy occurring outside of the uterus)
- foreign bodies (e.g., a bullet in a gunshot victim)
- internal bleeding

### Demographics

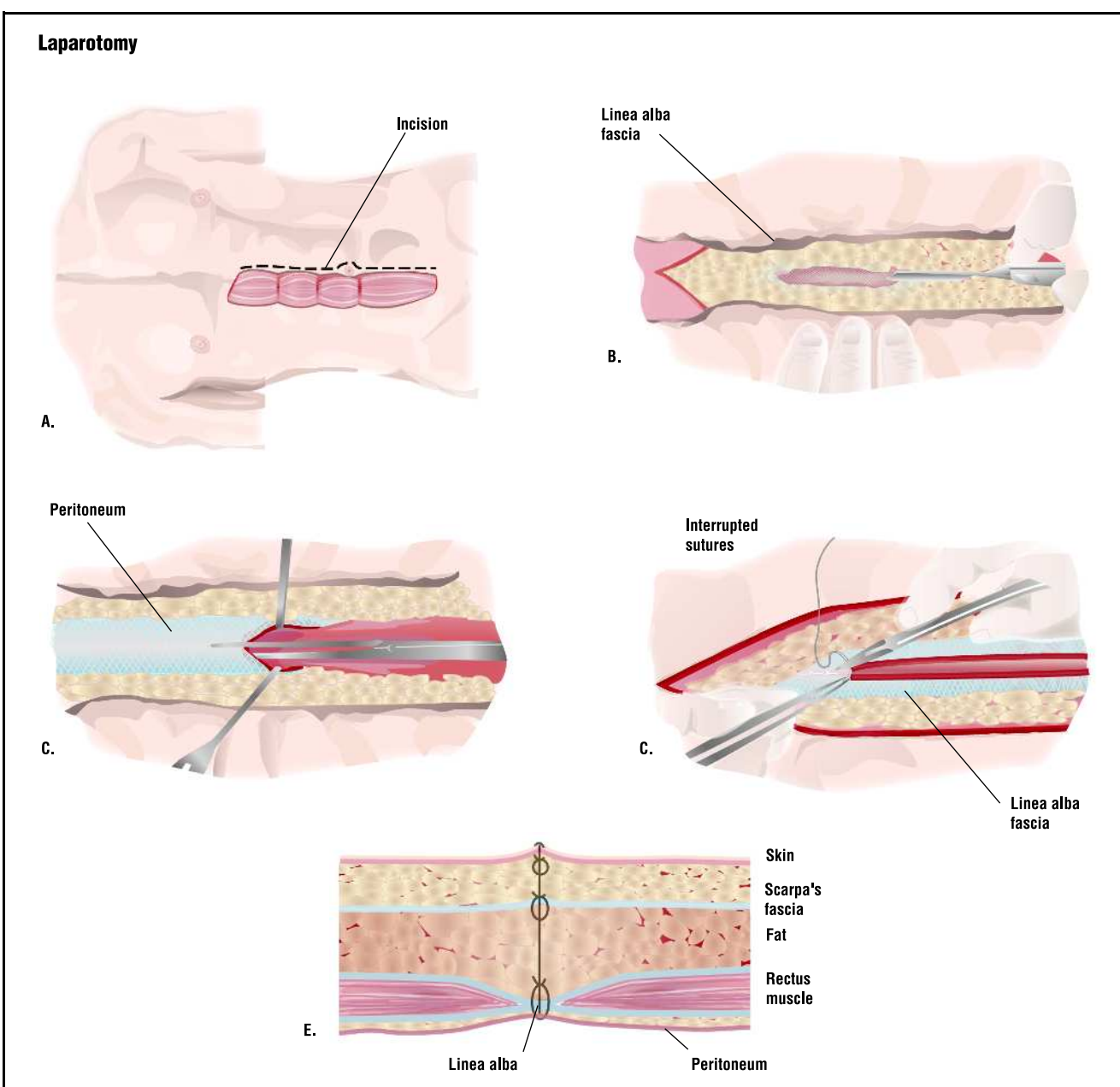
Because laparotomy may be performed under a number of circumstances to diagnose or treat numerous conditions, no data exists as to the overall incidence of the procedure.

### Description

The patient is usually placed under **general anesthesia** for the duration of surgery. The advantages to general anesthesia are that the patient remains unconscious during the procedure, no pain will be experienced nor will the patient have any memory of the procedure, and the patient's muscles remain completely relaxed, allowing safer surgery.

### Incision

Once an adequate level of anesthesia has been reached, the initial incision into the skin may be made. A scalpel is first used to cut into the superficial layers of the skin. The incision may be median (vertical down the patient's midline), paramedian (vertical elsewhere on the abdomen), transverse (horizontal), T-shaped, or curved, according to the needs of the surgery. The incision is then continued through the subcutaneous fat, the abdominal muscles, and finally, the peritoneum. Electrocautery is often used to cut through the subcutaneous tissue as it has the ability to stop bleeding as it cuts. Instruments called retractors may be used to hold the incision open once the abdominal cavity has been exposed.



During a laparotomy, and an incision is made into the patient's abdomen (A). Skin and connective tissue called fascia is divided (B). The lining of the abdominal cavity, the peritoneum, is cut, and any exploratory procedures are undertaken (C). To close the incision, the peritoneum, fascia, and skin are stitched (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

### *Abdominal exploration*

The surgeon may then explore the abdominal cavity for disease or trauma. The abdominal organs in question will be examined for evidence of infection, inflammation, perforation, abnormal growths, or other conditions. Any fluid surrounding the abdominal organs will be inspected; the presence of blood, bile, or other fluids may indicate specific diseases or injuries. In some cases, an abnormal smell encountered upon

entering the abdominal cavity may be evidence of infection or a perforated gastrointestinal organ.

If an abnormality is found, the surgeon has the option of treating the patient before closing the wound or initiating treatment after exploratory surgery. Alternatively, samples of various tissues and/or fluids may be removed for further analysis. For example, if cancer is suspected, biopsies may be obtained so that the tissues can be examined microscopically for

## KEY TERMS

**Intestinal perforation**—A hole in the intestinal wall.

**Subcutaneous**—Under the skin.

evidence of abnormal cells. If no abnormality is found, or if immediate treatment is not needed, the incision may be closed without performing any further surgical procedures.

During exploratory laparotomy for cancer, a pelvic washing may be performed; sterile fluid is instilled into the abdominal cavity and washed around the abdominal organs, then withdrawn and analyzed for the presence of abnormal cells. This may indicate that a cancer has begun to spread (metastasize).

### Closure

Upon completion of any exploration or procedures, the organs and related structures are returned to their normal anatomical position. The incision may then be sutured (stitched closed). The layers of the abdominal wall are sutured in reverse order, and the skin incision closed with sutures or **staples**.

### Diagnosis/Preparation

Various diagnostic tests may be performed to determine if exploratory laparotomy is necessary. Blood tests or imaging techniques such as x ray, computed tomography (CT) scan, and **magnetic resonance imaging** (MRI) are examples. The presence of intraperitoneal fluid (IF) may be an indication that exploratory laparotomy is necessary; one study indicated that IF was present in nearly three-quarters of patients with intra-abdominal injuries.

Directly preceding the surgical procedure, an intravenous (IV) line will be placed so that fluids and/or medications may be administered to the patient during and after surgery. A Foley catheter will be inserted into the bladder to drain urine. The patient will also meet with the anesthesiologist to go over details of the method of anesthesia to be used.

### Aftercare

The patient will remain in the postoperative **recovery room** for several hours where his or her recovery can be closely monitored. **Discharge from the hospital** may occur in as little as one to two days after the procedure, but may be later if additional procedures were performed or complications were encountered. The patient

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Depending on the reason for performing an exploratory laparotomy, the procedure may be performed by a general or specialized surgeon in a hospital operating room. In the case of trauma to the abdomen, laparotomy may be performed by an emergency room physician.

will be instructed to watch for symptoms that may indicate infection, such as fever, redness or swelling around the incision, drainage, and worsening pain.

### Risks

Risks inherent to the use of general anesthesia include nausea, vomiting, sore throat, fatigue, headache, and muscle soreness; more rarely, blood pressure problems, allergic reaction, heart attack, or stroke may occur. Additional risks include bleeding, infection, injury to the abdominal organs or structures, or formation of adhesions (bands of scar tissue between organs).

### Normal results

The results following exploratory laparotomy depend on the reasons why it was performed. The procedure may indicate that further treatment is necessary; for example, if cancer was detected, chemotherapy, radiation therapy, or more surgery may be recommended. In some cases, the abnormality is able to be treated during laparotomy, and no further treatment is necessary.

### Morbidity and mortality rates

The operative and postoperative complication rates associated with exploratory laparotomy vary according to the patient's condition and any additional procedures performed.

### Alternatives

**Laparoscopy** is a relatively recent alternative to laparotomy that has many advantages. Also called minimally invasive surgery, laparoscopy is a surgical procedure in which a laparoscope (a thin, lighted tube) and other instruments are inserted into the abdomen through small incisions. The internal operating field may then be visualized on a video monitor that is connected to the scope. In some patients, the technique may be used for abdominal exploration in place of a



## QUESTIONS TO ASK THE DOCTOR

- Why is exploratory laparotomy being recommended?
- What diagnostic tests will be performed to determine if exploratory laparotomy is necessary?
- Are any additional procedures anticipated?
- What type of incision will be used and where will it be located?

laparotomy. Laparoscopy is associated with faster recovery times, shorter hospital stays, and smaller surgical scars.

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Stephanie Dionne Sherk

Large bowel resection see **Bowel resection**

## Laryngectomy

### Definition

A laryngectomy is the partial or complete surgical removal of the voice box (larynx).

### Purpose

Because of its location, the voice box, or larynx, plays a critical role in breathing, swallowing, and

speaking. The larynx is located above the windpipe (trachea) and in front of the food pipe (esophagus). It contains two small bands of muscle called the vocal cords that close to prevent food from entering the lungs and vibrate to produce the voice. If cancer of the larynx develops, a laryngectomy is performed to remove tumors or cancerous tissue. In rare cases, the procedure may also be performed when the larynx is badly damaged by gunshot, automobile injuries, or other traumatic accidents.

### Demographics

The American Cancer Society estimates that, in 2007, about 11,300 people in the United States will be found to have laryngeal cancer; 8,960 cases will occur in men and 2,340 cases will occur in women. Tobacco smoking is by far the greatest risk factor for laryngeal cancer. Others include alcohol abuse, radiation exposure, asbestos exposure, and genetic factors.

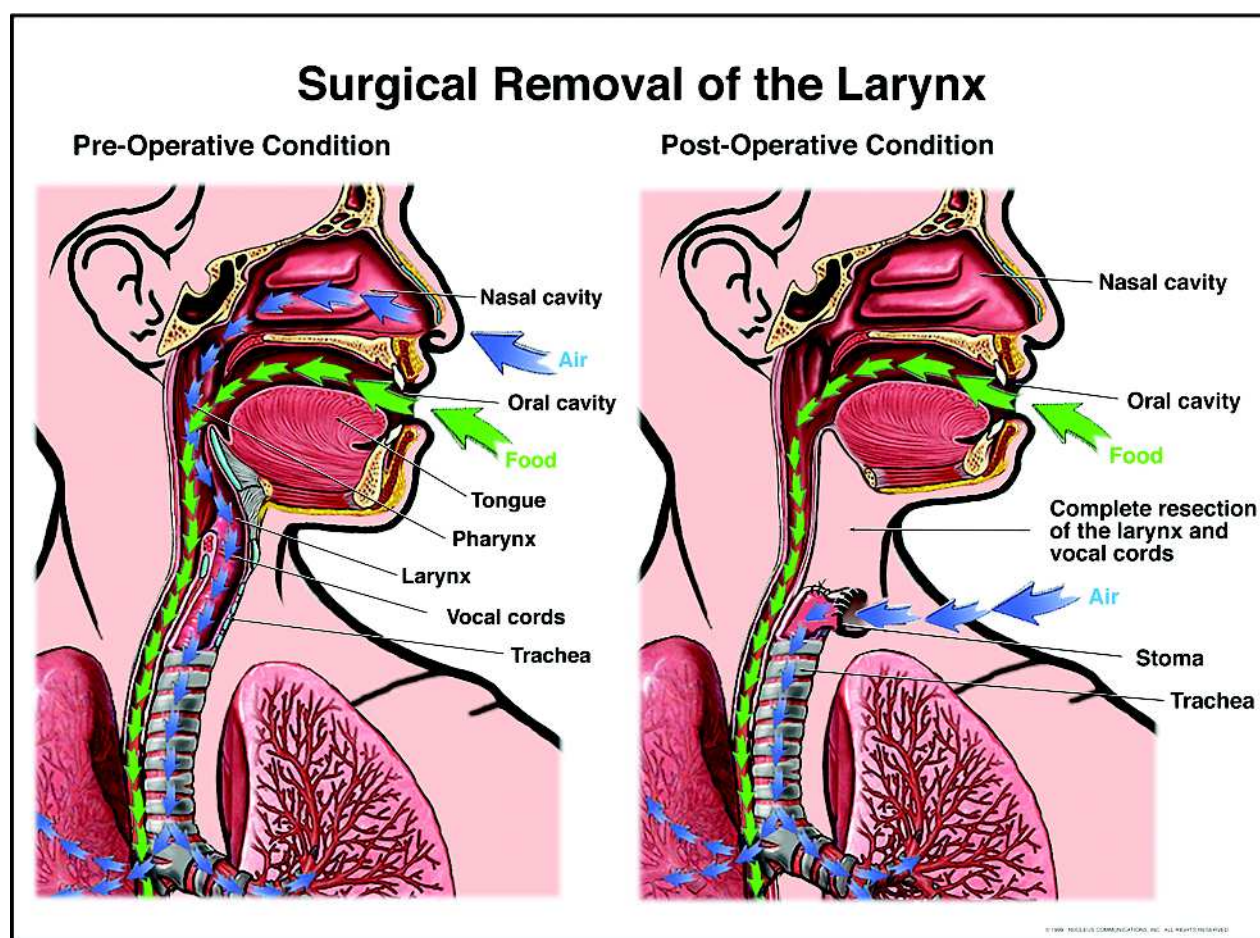
### Description

Laryngectomies may be total or partial. In a total laryngectomy, the entire larynx is removed. If the cancer has spread to other surrounding structures in the neck, such as the lymph nodes, they are removed at the same time. If the tumor is small, a partial laryngectomy is performed, by which only a part of the larynx, usually one vocal chord, is removed. Partial laryngectomies are also often performed in conjunction with other cancer treatments, such as radiation therapy or chemotherapy.

During a laryngectomy, the surgeon removes the larynx through an incision in the neck. The procedure also requires the surgeon to perform a **tracheotomy**, because air can no longer flow into the lungs. He makes an artificial opening called a stoma in the front of the neck. The upper portion of the trachea is brought to the stoma and secured, making a permanent alternate way for air to get to the lungs. The connection between the throat and the esophagus is not normally affected, so after healing, the person whose larynx has been removed (called a laryngectomee) can eat normally.

### Diagnosis/Preparation

A laryngectomy is performed after cancer of the larynx has been diagnosed by a series of tests that allow the otolaryngologist (a physician often called an ear, nose and throat, or ENT specialist) to examine the throat and take tissue samples (biopsies) to confirm and stage the cancer. People need to be in good general health to undergo a laryngectomy, and will have



The surgical removal of the larynx. (Nucleus Medical Art, Inc./Alamy)

standard pre-operative blood work and tests to make sure they are able to safely withstand the operation.

As with any surgical procedure, the patient is required to sign a consent form after the procedure is thoroughly explained. Blood and urine studies, along with **chest x ray** and EKG may be ordered as required. If a total laryngectomy is planned, the patient meets with a speech pathologist for discussion of post-operative expectations and support.

### Aftercare

A person undergoing a laryngectomy spends several days in intensive care (ICU) and receives intravenous (IV) fluids and medication. As with any major surgery, blood pressure, pulse, and respiration are monitored regularly. The patient is encouraged to turn, cough, and deep-breathe to help mobilize secretions in the lungs. One or more drains are usually inserted in the neck to remove any fluids that collect. These drains are removed after several days.

It takes two to three weeks for the tissues of the throat to heal. During this time, the laryngectomee cannot swallow food and must receive nutrition through a tube inserted through the nose and down the throat into the stomach. Normal speech is also no longer possible and patients are instructed in alternate means of vocal communication by a speech pathologist.

When air is drawn in normally through the nose, it is warmed and moistened before it reaches the lungs. When air is drawn in through the stoma, it does not have the opportunity to be warmed and humidified. In order to keep the stoma from drying out and becoming crusty, laryngectomees are encouraged to breathe artificially humidified air. The stoma is usually covered with a light cloth to keep it clean and to keep unwanted particles from accidentally entering the lungs. Care of the stoma is extremely important, since it is the person's only way to get air to the lungs. After a laryngectomy, a health-care professional will teach the laryngectomee and his or her caregivers how to care for the stoma.

## KEY TERMS

**Larynx**—Also known as the voice box, the larynx is composed of cartilage that contains the apparatus for voice production. This includes the vocal cords and the muscles and ligaments that move the cords.

**Lymph nodes**—Accumulations of tissue along a lymph channel, which produce cells called lymphocytes that fight infection.

**Tracheotomy**—A surgical procedure in which an artificial opening is made in the trachea (windpipe) to allow air into the lungs.

There are three main methods of vocalizing after a total laryngectomy. In esophageal speech, patients learn how to “swallow” air down into the esophagus and create sounds by releasing the air. Tracheoesophageal speech diverts air through a hole in the trachea made by the surgeon. The air then passes through an implanted artificial voice. The third method involves using a hand-held electronic device that translates vibrations into sounds. The choice of vocalization method depends on several factors including the age and health of the laryngectomee, and whether other parts of the mouth, such as the tongue, have also been removed (**glossectomy**).

## Risks

Laryngectomy is often successful in curing early-stage cancers. However, it requires major lifestyle changes and there is a risk of severe psychological stress from unsuccessful adaptations. Laryngectomees must learn new ways of speaking, they must be constantly concerned about the care of their stoma. Serious problems can occur if water or other foreign material enters the lungs through an unprotected stoma. Also, women who undergo partial laryngectomy or who learn some types of artificial speech will have a deep voice similar to that of a man. For some women this presents psychological challenges. As with any major operation, there is a risk of infection. Infection is of particular concern to laryngectomees who have chosen to have a voice prosthesis implanted, and is one of the major reasons for having to remove the device.

## Normal results

Ideally, removal of the larynx will remove all cancerous material. The person will recover from the operation, make lifestyle adjustments, and return to an active life.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A laryngectomy is usually performed by an otolaryngologist in a hospital operating room. In the case of trauma to the throat, the procedure may be performed by an emergency room physician.

## Morbidity and mortality rates

The American Cancer Society estimates that 3,660 people will die of laryngeal cancer in 2007. Of these, 2,900 will be men and 760 will be women.

## Alternatives

There are two alternative forms of treatment:

- Radiation therapy, a treatment that uses high-energy rays (such as x rays) to kill or shrink cancer cells.
- Chemotherapy, a treatment that uses drugs to kill cancer cells. Usually the drugs are given into a vein or by mouth. Once the drugs enter the bloodstream, they spread throughout the body to the cancer site.

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### ORGANIZATIONS

- American Academy of Otolaryngology–Head and Neck Surgery. One Prince Street, Alexandria, VA 22314. (703) 806 4444. <http://www.entnet.org>.
- American Cancer Society. National Headquarters. 1599 Clifton Road NE, Atlanta, GA 30329. (800) ACS 2345. <http://www.cancer.org>.
- Cancer Information Service. National Cancer Institute. Building 31, Room 10A19, 9000 Rockville Pike, Bethesda, MD 20892. (800)4 CANCER. <http://www.nci.nih.gov/cancerinfo/index.html>.



## QUESTIONS TO ASK THE DOCTOR

- Is laryngectomy my only viable treatment option?
- How will drinking and eating be affected?
- How will I talk without my larynx?
- How will my breathing be affected?
- What about my usual activities?
- Is there a support group in the area that can assist me after surgery?
- How long will it be until I can verbally communicate? What are my options?
- What is the risk of recurring cancer?

International Association of Laryngectomees (IAL). <http://www.larynxlink.com/>.

National Institute on Deafness and Other Communication Disorders. National Institutes of Health. 31 Center Drive, MSC 2320, Bethesda, MD 20892 2320. <http://www.nidcd.nih.gov>.

The Voice Center at Eastern Virginia Medical School. Norfolk, VA 23507. <http://www.voice-center.com>.

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"Laryngectomy: The Operation." The Voice Center. <http://www.voice-center.com/laryngectomy.html>.

Kathleen Dredge Wright  
Tish Davidson, A.M.  
Monique Laberge, Ph.D.  
Rosalyn Carson-DeWitt, MD

Larynx removal see **Laryngectomy**

Laser coagulation therapy see **Photocoagulation therapy**

## Laser in-situ keratomileusis (LASIK)

### Definition

Laser in-situ keratomileusis (LASIK) is a non-reversible refractive procedure performed by ophthalmologists to correct myopia, hyperopia, or astigmatism. The surgeon uses an excimer laser to cut or reshape the cornea so that light will focus properly on the retina.

### Purpose

LASIK is an **elective surgery** for patients who want to permanently correct myopia (nearsightedness), hyperopia (farsightedness), or astigmatism without eyeglasses, contact lenses, or refractive surgical procedures. The goal for most patients is to be free of any type of corrective lenses. Some patients may find wearing eyeglasses or contact lenses interferes with their careers or hobbies. Many professional athletes have chosen LASIK to improve their performance. However, patients with higher degrees of refractive error will still need some type of corrective lens.

LASIK is most commonly performed on myopes. For myopia, the surgeon flattens the cornea; for hyperopia, the surgeon steepens the cornea. Surgeons correct astigmatism by creating a normally shaped cornea with the excimer laser.

A new type of LASIK also can treat contrast sensitivity as well as refractive error. Custom LASIK incorporates new eye mapping technology into standard LASIK. The surgeon measures the eye from front to back creating a three dimensional corneal map. This much-more detailed map gives surgeons more specific information for the excimer laser and enables them to correct other abnormalities besides refractive error.

### Demographics

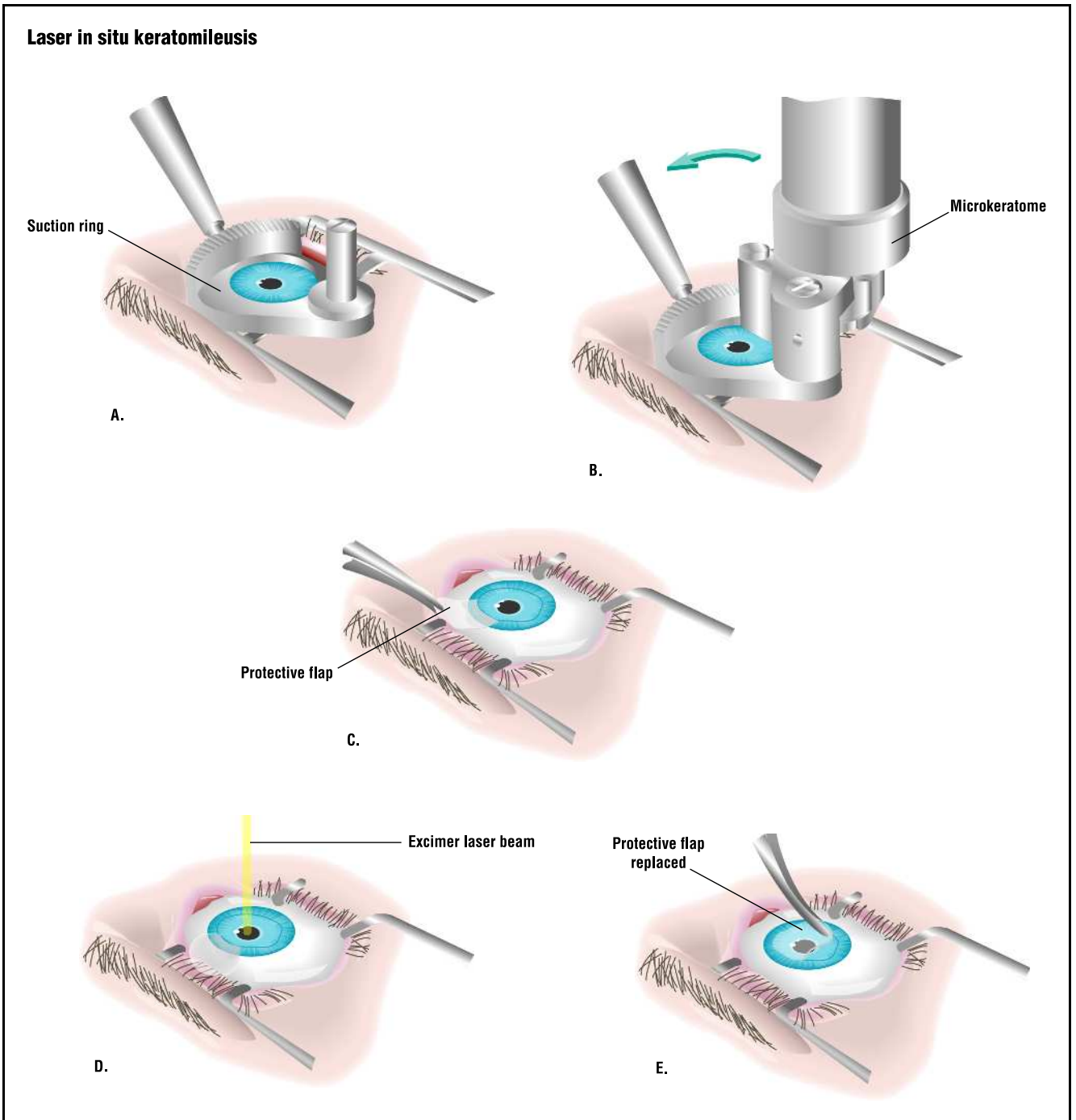
LASIK candidates have myopia, hyperopia, or astigmatism; are 18 or older; and have had stable vision for at least two years. The American Academy of Ophthalmology (AAO) estimated that 1.3 million refractive surgery procedures were performed in 2002. LASIK was estimated to account for 95% of those procedures.

The first LASIK patients in the late 1990s were in the upper class, or upper middle class, and in their early 30s to mid-40s. The market was limited for the elective procedure that at first could range as expensive as \$5,000 per eye. The number of younger patients receiving LASIK (in their early to mid-20s) was expected to rise in 2003 and beyond. The number of procedures also was expected to increase as prices continued to stabilize, and surgery centers and physicians offered payment plans.

### Description

LASIK is a relatively new procedure. In April 1985, German physician Theo Seiler was the first to use an excimer laser to attempt to correct astigmatism in blind eyes. Experiments with excimer lasers on blind eyes were also completed in the United States in the mid-1980s. The term LASIK was invented by Greek ophthalmologist Ioannis Pallikari, the first surgeon to





In LASIK surgery, the eye is held open with a speculum, and a suction ring is attached to the eyeball (A). A microkeratome is used to shave the protective flap off the top of the eye (B), which is then pulled back (C). A computer-controlled laser is used to reshape the cornea (D), and the protective flap is replaced (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

use the hinged flap technique. Dr. Stephen Brint, as part of a clinical trial in 1991, performed the first LASIK procedure in the United States.

As of 2003, there are two types of LASIK. The standard LASIK procedure and custom LASIK, which relatively few surgeons have the technology to perform.

## KEY TERMS

**Ablation**—During LASIK, the vaporization of eye tissue.

**Astigmatism**—Asymmetric vision defects due to irregularities in the cornea.

**Cornea**—The clear, curved tissue layer in front of the eye. It lies in front of the colored part of the eye (iris) and the black hole in the center of the iris (pupil).

**Corneal topography**—Mapping the cornea's surface with a specialized computer that illustrates corneal elevations.

**Dry eye**—Corneal dryness due to insufficient tear production.

**Enhancement**—A secondary refractive procedure performed in an attempt to achieve better visual acuity.

**Excimer laser**—An instrument that is used to vaporize tissue with a cold, coherent beam of light with a single wavelength in the ultraviolet range.

**Hyperopia**—The inability to see near objects as clearly as distant objects, and the need for accommodation to see objects clearly.

**Intraocular lens (IOL) implant**—A small, plastic device (IOL) that is usually implanted in the lens capsule of the eye to correct vision after the lens of the eye is removed. This is the implant used in cataract surgery.

**Macular degeneration**—A condition usually associated with age in which the area of the retina called the macula is impaired due to hardening of the arteries (arteriosclerosis). This condition interferes with vision.

**Microkeratome**—A precision surgical instrument that can slice an extremely thin layer of tissue from the surface of the cornea.

**Myopia**—A vision problem in which distant objects appear blurry. Myopia results when the cornea is too steep or the eye is too long and the light doesn't focus properly on the retina. People who are myopic or nearsighted can usually see near objects clearly, but not far objects.

**Nomogram**—A surgeon's adjustment of the excimer laser to fine-tune results.

**Presbyopia**—A condition affecting people over the age of 40 where the system of accommodation that allows focusing of near objects fails to work because of age-related hardening of the lens of the eye.

**Retina**—The sensory tissue in the back of the eye that is responsible for collecting visual images and sending them to the brain.

**Stroma** —The thickest part of the cornea between Bowman's membrane and Decemet's membrane.

### Standard LASIK

Standard LASIK takes from 10 to 20 minutes to perform and the results are immediate. It's standard practice in LASIK operating rooms to have a clock on the wall so patients immediately can note they are able to read a clock face or other items that previously were blurry.

Immediately before the procedure, the ophthalmologist may request corneal topography (a corneal map) to compare with previous maps to ensure the treatment plan is still correct. The surgeon may also measure the cornea's thickness if he didn't previously. After these tests, a technician or co-managing optometrist will perform a refraction to make sure the refractive correction the surgeon will program into the laser is correct.

Three sets of eye drops will be administered twice before surgery. The first drop anesthetizes the cornea, the second drop prevents infection and the third drop controls inflammation after LASIK. Patients may be given a sedative, such as Valium. This is administered to calm nervous patients or to help patients sleep after the procedure.

After the prep work is completed, the patient reclines on a laser bed and the surgeon is seated directly behind the patient. If the procedure is being done on both eyes on the same day, the surgeon will patch the second eye. An eyelid speculum is inserted in the eye to be treated first to hold the eyelids apart. The patient stares at the blinking light of a laser microscope and must fixate his or her gaze on that light. The patient must remain still throughout the procedure.

The surgeon checks the refractive numbers on the laser. Because each patient's cornea is shaped differently, the surgeon may have to adjust the level of correction. Laser companies provide an algorithm to determine the correction level, and the surgeon may alter the level because of a patient's special needs. The adjustments are called nomograms. After the adjustments, the surgeon checks the microkeratome blade for defects.

The surgeon then indents the cornea to mark the flap location. The surgeon places a suction ring in the center of the sclera. A technician will activate the microkeratome's suction. The patient's vision dims at

this point. The surgeon tests pressure by touching the cornea with a tonometer. Before using the microkeratome, sterile saline solution is squirted into the suction ring to lubricate the cornea. The microkeratome head is placed in the gear tracks of the suction ring, and the surgeon guides the microkeratome across the suction ring to create a flap. The microkeratome stops just short of traveling completely across the cornea. It leaves a hinge of tissue, commonly called a flap. After the flap is created, the surgeon removes the suction ring and slips a spatula under it and moves it to the side, exposing the stroma (inner cornea).

Once the stroma is exposed, the laser ablation begins, ranging from 30 to 60 seconds. The ablation flattens the cornea of myopic patients; steepens the cornea of hyperopic patients; and reshapes the cornea of astigmatic patients. After the ablation, the surgeon replaces the flap. More saline solution is squirted to remove any debris and enable the flap to move back into place without interruption. The surgeon ensures the flap is in place and removes any wrinkles. The surgeon places a shield over the eye to keep the flap in place. No **stitches** are used.

If bilateral LASIK is being performed, the patient must remain still while he is prepared for treatment on the remaining eye.

### *Custom LASIK*

About half of all LASIK procedures are deemed "custom" LASIK. The difference between standard LASIK and custom LASIK lies in the diagnosis and who can be treated. With custom LASIK, surgeons use a wavefront analyzer (aberrometer) that beams light through the eye and finds irregularities based on how the light travels through the eye. It creates a three-dimensional corneal map to create a customized pattern for each patient. For standard LASIK, each patient with the same refractive error is treated with the same setting on the excimer laser, barring a few adjustments. The new technology individualizes treatment not only for refractive errors, but also for visual disorders that previous corneal mapping technology could not detect. As of early 2003, there was only one FDA-approved laser capable of the customized ablations, but others were awaiting approval.

Besides the customized excimer laser, the surgical procedure is the same. Surgeons now can treat patients who have higher-order aberrations, such as contrast sensitivity. Therefore, custom LASIK can successfully treat glare, night vision and other contrast problems.

## **Diagnosis/Preparation**

Before LASIK, patients need to have a complete eye evaluation and comprehensive medical history taken. Soft contact lens wearers should stop wearing their lenses at least one week before the initial exam. Gas permeable lens wearers should not wear their lenses from three weeks to a month before the exam. Contact lens wear can alter the cornea's shape, which should be allowed to return to its natural shape before the initial exam.

### *The initial exam*

During the first exam, the surgeon's staff will take a comprehensive medical history to determine if there are underlying medical problems that will prevent a successful surgery. This screening process will determine patients who should not have the procedure including:

- pregnant women or women who are breastfeeding
- patients with very small or very large refractive errors
- patients with low contrast sensitivity
- patients with scarred corneas or macular disease
- people with autoimmune diseases
- diabetics
- glaucoma patients
- patients with persistent blepharitis

The physician will also ask about medication. Some prescription medicines have been known to cause post-surgical scarring or cause flecks under the corneal flap. It is important for the patient to disclose any prescriptions or over-the-counter medicines taken regularly. Allergies to prescription medicine must also be discussed.

A complete eye exam will be performed to determine refractive error, uncorrected visual acuity and best corrected visual acuity. A cycloplegic refraction using eye drops to dilate the pupils also will be performed. Other examination procedures include corneal mapping, a keratometer reading to determine the curvature of the central part of the cornea, a slit lamp exam to determine any damage to the cornea and evidence of glaucoma and cataracts. A fundus exam also will be performed to check for retinal holes and macular degeneration and macular disease. Other tests are done to rule out glaucoma.

While those tests check general eye health, others more closely relate to the outcome of LASIK surgery. A corneal pachymeter measures the cornea's thickness. This is important because surgeons remove tissue during surgery. A pupilometer measures the pupil when it is naturally dilated in a dark room without drops. Patients with large pupils have been known to have complications after LASIK, such as glare and halos.

### *Treatment options/Informed consent*

After the exam, the patient and physician discuss treatment options and expectations. Patients who expect to see perfectly after LASIK are usually not considered good candidates because they usually are dissatisfied with the results. Surgeons also discuss how patients will handle presbyopia, which occurs during the patient's 40s. LASIK does not correct for presbyopia, and patients will need reading glasses to accommodate for reading when presbyopia occurs. Sometimes patients 40 and older opt for monovision to treat presbyopia, where one eye is left untreated or one eye is only partially corrected. Monovision means one eye is for short-term vision and the other is for distance vision.

The doctor will advise the patient of any possible LASIK complications, explain the procedure and answer questions. After deciding on a treatment option, the patient is required to sign an **informed consent** form.

At this time, payment will also be discussed. Insurance usually does not cover LASIK, although some offer a limited benefit for the procedure. Some laser centers offer payment plans and some physicians have begun using credit companies to handle payments. LASIK can cost anywhere from \$999 to \$3,000 per eye. The cost varies greatly from surgeon to surgeon. Most of the fees are global, and cover all the pre-operative and postoperative exams as well as the procedure. Patients should be advised of what the fee covers, and if retreatments to the original surgery are included in that price.

### *Presurgery preparations*

The patient is advised to discontinue contact lens wear immediately and refrain from using creams, lotions, make-up or perfume for at least two days before surgery. Patients may also be asked to scrub their eyelashes for a period of time to remove any debris. Patients also must find transportation to and from the surgery, and also to and from the first postoperative visit. Medication and distorted vision make it unsafe for the patients to drive after LASIK.

### **Aftercare**

After LASIK, patients may experience burning, itching or a foreign body sensation. They should be advised not to touch the eye as that could damage the flap. Many physicians recommend sleeping after the surgery. Patients may also experience glare, starbursts, or halos that should improve after the first few days. Patients are advised to seek help immediately if they feel severe eye pain, or if symptoms worsen.

The first follow-up visit is 24–48 hours after surgery. The physician will remove the eye shield, check the patient's vision, and may prescribe more antibiotic drops or artificial tears. Patients must refrain from strenuous activity, such as contact sports, for at least a month. The use of creams, lotions, and make-up must also be avoided for at least two weeks. Hot tubs and swimming pools should be avoided for at least two months. Patients are advised that refraining from these activities and products will help stem infection and aid healing of the cornea.

Patients will have regularly scheduled visits post-LASIK for at least six months. Vision gradually improves the first few months after surgery. In some cases, if the vision does not meet expectations and the surgeon believes it can be further corrected, he will perform an enhancement. Enhancements are usually done for undercorrection. Overcorrected patients usually need eyeglasses or contact lenses.

### **Risks**

Surgeons separate LASIK complications into two categories.

#### *Intraoperative risks*

- Cornea perforation. This complication has almost disappeared because of advances in microkeratome design.
- Flap complications. Newer microkeratomes also have reduced the likelihood of “free caps,” where the cap becomes unhinged. An experienced surgeon replaces the cap after ablation. In some cases, the procedure must be aborted while the eye heals.
- Laser hot spots. Higher energy surrounding the laser beam can cause irregular astigmatism. Proper laser testing before the procedure eliminates this risk.
- Central islands. This refers to a raised area in the central part of the treated zone that receives insufficient laser treatment. Any raised area can decrease the laser's effectiveness. The island either shrinks by itself or can be remedied with retreatment.
- Decentered ablation. This occurs when the laser beam is aimed incorrectly. This can result in permanent halos and ghost images.

#### *Postoperative complications*

- Undercorrection or overcorrection. Undercorrection can usually be treated with an enhancement, but overcorrection will require the use of eyeglasses or contact lenses.



- Debilitating symptoms. These can be permanent or transient, and include glare, halos, double vision and poor nighttime vision. Some patients may also lose contrast sensitivity.
- Dry eye. This also can be permanent or transient. Most patients experience some dry eye immediately after surgery. Some patients continue to experience dry eye and are treated with artificial tears or punctal plugs.
- Displaced flap. Occurs after the eye is hit or rubbed. If immediate attention is given by the surgeon, who must lift the flap and clean under it, no long-term effects occur.
- Nonspecific diffuse intralamellar keratitis. Commonly known as Sands of the Sahara, this complication can range from corneal haze to eye clouding that resembles swirling sand. It is treated with topical steroids, although severe cases may require eye irrigation.
- Epithelial ingrowth. The cells of the lower cornea migrate under the corneal cap. The surgeon must lift the cap and remove the cells. If untreated, vision is impaired.
- Striae. These are wrinkles in the flap that can reduce visual acuity. The surgeon must lift the corneal flap and smooth the wrinkles.
- Photophobia. Extreme sensitivity to light can last a few days or a week after surgery.
- Infection. This rarely occurs after LASIK. It is treated with antibiotics.

### Normal results

After LASIK, most patients are able to see well enough to pass a driver's license exam without glasses or contact lenses. Some patients will still need corrective lenses, but the lenses won't need to be as powerful.

Because LASIK is a relatively new procedure, there is limited information on long-term regression. If patients are being treated for myopia, they should be aware they will have to rely on spectacles with the onset of presbyopia.

### Morbidity and mortality rates

Information about mortality rates following LASIK is limited because the procedure is elective. Complications that can lead to more serious conditions, such as infection, are treated with **topical antibiotics** after LASIK. The most serious possible complication from LASIK is blindness from an untreated complication. As of 2000, there had been no reports of blindness-induced LASIK. One incidence

of legal blindness was reported after a severely myopic patient had retinal hemorrhages. However, it was inconclusive whether or not LASIK was the causative agent.

## Alternatives

### *Nonsurgical alternatives*

Nonsurgical alternatives to LASIK are contact lenses and eyeglasses, which can also correct refractive errors. Continuous-wear contact lenses, which a patient can sleep in for as long as 30 days, can provide the same effect as LASIK if the patient wants good vision upon waking. Orthokeratology involves a rigid gas permeable contact lens the patient wears for a predetermined amount of time to reshape the cornea. After removing the lens, it takes weeks for the cornea to return to its normal shape. At that time, the patient repeats the process.

Corneal rings and implants are another alternative for myopes. These require surgery without lasers and involve a corrective lens surgically implanted in the eye. One of the biggest benefits to these procedures is that they are reversible. However, they may not provide the crisp vision of a successful LASIK. There also are several different types of intraocular lenses being tested to treat myopia and hyperopia.

### *Surgical alternatives*

There also are surgical alternatives to LASIK. They include:

- Conductive keratoplasty. This uses radio frequency waves to shrink corneal collagen. It is used to treat mild to moderate hyperopia.
- Photorefractive keratectomy (PRK). PRK also uses an excimer laser and is similar to LASIK. However, in PRK, the surface of the cornea is removed by the laser. PRK patients have a longer recovery time and may need steroidal eye drops for months after surgery. Its success rate is similar to that of LASIK.
- Radial keratotomy (RK). RK was the first widely used surgical correction for mild to moderate myopia. The surgeon alters the shape of the cornea without a laser. This is one of the oldest refractive procedures, and has proved successful on lower and moderate corrections.
- Astigmatic keratotomy (AK). AK is a variation of RK used to treat mild to moderate astigmatism. AK has proved successful if the errors are mild to moderate.
- Laser thermal keratoplasty (LTK). LTK was approved as to treat hyperopia in 2000. An LTK patient's vision

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

An ophthalmologist performs LASIK, but because it is a relatively new technology, the surgeon may not have received training as part of his residency. It is more likely the surgeon has completed continuing medical education courses or may have had training provided by the laser companies. He may also have received training as part of membership in an organization such as the American Society of Refractive Surgeons.

Before and aftercare probably will be provided by a co-managing optometrist. The optometrist usually performs the pre- and postoperative exams, and also discusses the patient's suitability for LASIK and any potential problems.

Ophthalmic technicians may perform preliminary testing, including corneal topography and corneal measuring. Laser technicians are required to have special training provided by the laser manufacturer.

Surgeons may perform LASIK in a hospital where they rely on the hospital staff for support. Because lasers are expensive, some surgeons pool their resources and purchase a laser that they share at a freestanding surgery center. LASIK is also provided by surgeons at surgery centers owned by refractive surgery companies. These businesses hire support staff, optometrists and surgeons to perform LASIK.

is overcorrected for one to three months, and the effect of improved near vision may diminish over time as distance vision improves. Some regression has been noted.

### Resources

#### BOOKS

Yanoff, M et al. *Ophthalmology*. 2nd ed. St. Louis: Mosby, 2004.

#### ORGANIZATIONS

American Academy of Ophthalmology. PO Box 7424, San Francisco, CA 94120 7424 (415) 561 8500. <http://www.aao.org>

American Society of Cataract and Refractive Surgery. 4000 Legato Road, Suite 850, Fairfax, VA 22033 4055. (703) 591 2220. <ascrs@ascrs.org>. <http://www.ascrs.org>.

## QUESTIONS TO ASK THE DOCTOR

- How many LASIK procedures have you performed and how long have you been performing them?
- Who will handle the aftercare, the ophthalmologist or co-managing optometrist?
- What is the experience of the laser support team?
- How many of your patients achieve 20/20 or better?
- What percentage of your patients have serious complications? Minor complications?
- Who will treat complications, if any, after the procedure?
- If the patient needs an enhancement, is that an extra expense, or is it covered in the original fee?

### OTHER

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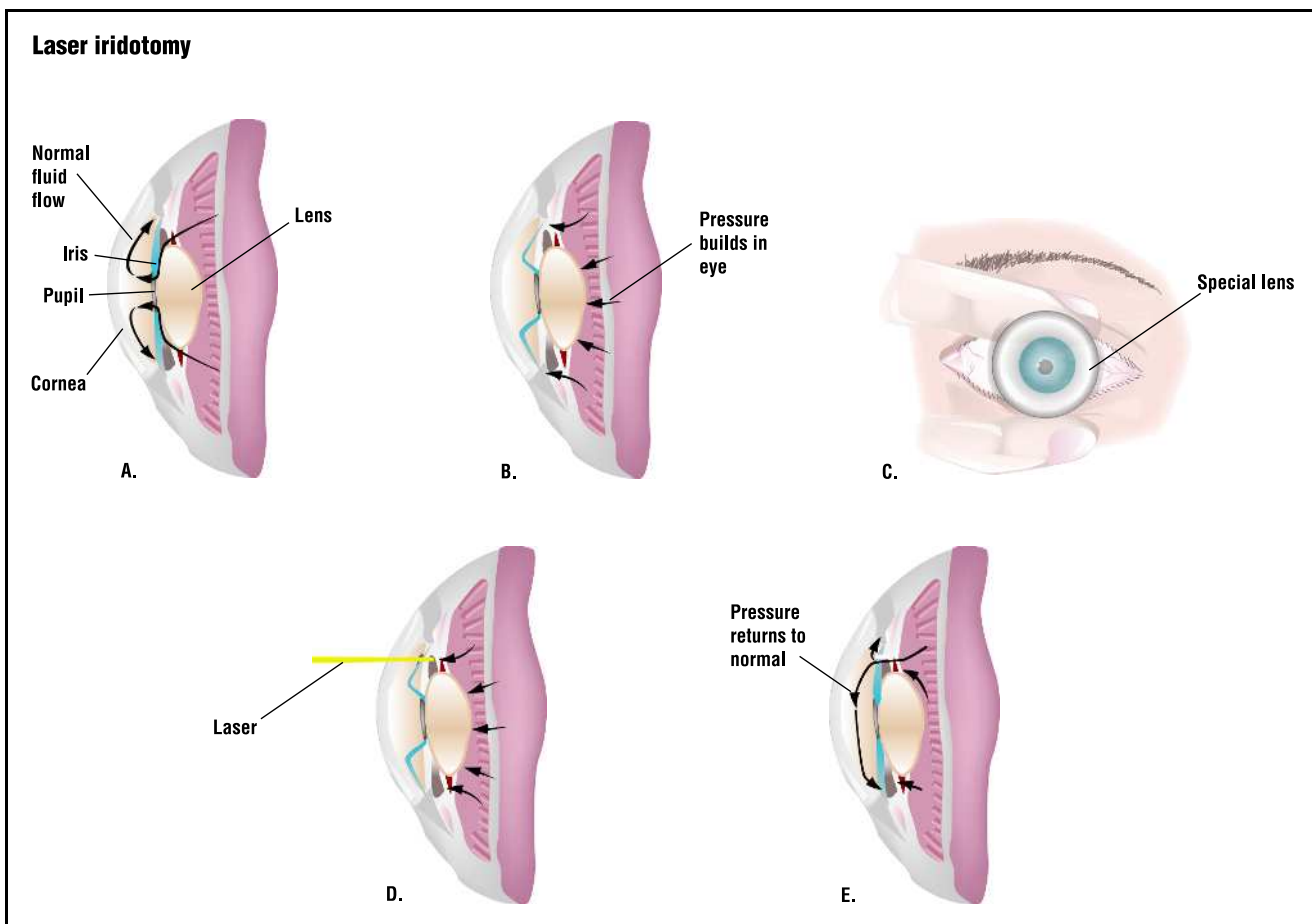
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Mary Bekker

## Laser iridotomy

### Definition

Laser iridotomy is a surgical procedure that is performed on the eye to treat angle closure glaucoma, a condition of increased pressure in the front chamber



Normally intraocular fluid flows freely between the anterior and posterior sections of the eye (A). As pressure builds in the eye, this circulation is cut off (B). In a laser iridotomy, a special lens is placed on the eye (C). A laser is used to create a hole in part of the iris (D), allowing fluid to flow more normally and intraocular pressure to return to normal (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

(anterior chamber) that is caused by sudden (acute) or slowly progressive (chronic) blockage of the normal circulation of fluid within the eye. The block occurs at the angle of the anterior chamber that is formed by the junction of the cornea with the iris. All one needs to do to see this angle is to look at a person's eye from the side. Angle closure of the eye occurs when the trabecular meshwork, the drainage site for ocular fluid, is blocked by the iris. Laser iridotomy was first used to treat angle closures in 1956. During this procedure, a hole is made in the iris of the eye, changing its configuration. When this occurs, the iris moves away from the trabecular meshwork, and proper drainage of the intraocular fluid is enabled.

The angle of the eye refers to a channel in which the trabecular meshwork is located. To maintain the integrity of the eye, fluid must always be present in the anterior (front) and posterior (back) chambers of the eye. The fluid, known as aqueous fluid, is made in

the ciliary processes, which are located behind the iris. Released continuously into the posterior chamber of the eye, aqueous fluid circulates throughout the eye. Eventually the fluid returns to the general circulation of the body, first passing through a space between the iris and the lens, then flowing into the anterior chamber of the eye and down the angle, where the trabecular meshwork is located. Finally, the fluid leaves the eye. An angle closure occurs when drainage of the aqueous fluid through the trabecular meshwork is blocked and the intraocular pressure builds up as a result.

For most types of angle closure, or narrow angle glaucoma, laser iridotomy is the procedure of choice. Changes in intraocular pressure (IOP) can alter the name of the condition when the IOP in the eye becomes elevated above 22 mm/Hg as a result of an angle closure. Then, angle closure becomes angle closure glaucoma. Lowering of the IOP is important

because extreme elevations in IOP can damage the retina and the optic nerve permanently. The lasers used to perform this surgery are either the Nd:Yag laser or, if a patient has a bleeding disorder, the argon laser. The majority of patients with glaucoma do not have angle closure glaucoma, but rather have an open angle glaucoma, a type of glaucoma in which the angle of the eye is open.

An angle closure occurs when ocular anomalies (abnormalities) temporarily or permanently block the trabecular meshwork, restricting drainage of the ocular fluid. The anatomical anomalies that make an individual susceptible to an angle closure are, for example, an iris that is bent forward in the anterior chamber (front) of the eye, a small anterior chamber of the eye, and a narrow entrance to the angle of the eye. Some conditions that cause an angle closure are a pupillary block, a plateau iris, phacolytic glaucoma, and malignant glaucoma. The end result of all of these situations is an elevation of the IOP due to a build-up of aqueous fluid in the back part of the eye. The IOP rises quickly when an acute angle attack occurs and within an hour the pressure can be dangerously elevated. The sclera or white of the affected eye becomes red or injected. The patient will usually experience decreased vision and ocular pain with an acute angle closure. In severe cases of acute angle glaucoma, the patient may experience nausea and vomiting. Individuals with neurovascular glaucoma caused by uncontrolled diabetes or hypertension may have similar symptoms, but treatment for this type of glaucoma is very different.

Within a normal eye, the iris is in partial contact with the lens of the eye behind it. Individuals with narrow angles are at greater risk of angle closure by pupillary block because their anterior chamber is shallow; thus, the iris is closer to the lens and more likely to adhere completely to the lens, creating a pupillary block. Patients who experience a pupillary block may have had occasionally temporary blocks prior to a complete angle closure. Pupillary block can be started by prolonged exposure to dim light. Therefore, it not uncommon for an acute angle closure to occur as an individual with a narrow angle emerges from a dark environment such as a theater into bright light. It can also be brought on by neurotransmitter release during emotional stress or by medications taken for other medical conditions. Pupil dilation may be a side effect of one or more of those medications. However, pupillary block is the most common cause of angle closure, and laser iridotomy effectively treats this condition.

The irises of individuals with plateau iris is bunched up in the anterior chamber, and it is malpositioned

## KEY TERMS

**Angle**—A channel in the anterior part of the eye in which the trabecular meshwork is located.

**Angle closure**—A blockage of the angle of the eye, causing an increase in pressure in the eye and possible glaucoma.

**Aphakic**—Having no lens in the eye.

**Cataract**—Condition that causes the lens to become opaque.

**Glaucoma**—A group of diseases of the eye, often caused by increased pressure (IOP), which can cause blindness if not treated.

**Gonioscopy**—Examination of the anterior chamber of the eye using a special instrument called a gonioscope.

**Hyperosmotic agents**—Causing abnormally rapid osmosis.

**Iridectomy**—Removal of a portion of the iris.

**Iridoplasty**—Surgery to alter the iris.

**Iris**—The colored part of the eye that is located in the anterior chamber.

**Malignant glaucoma**—Glaucoma that gets worse even after iridectomy.

**Mannitol**—A type of diuretic.

**Laser iridotomy**—A procedure, using either the Nd:Yag laser or the argon laser, to penetrate the iris, such that a hole, through which the fluid in the eye can drain, is formed.

**Osmosis**—Passage of a solvent through a membrane from an area of greater concentration to an area of lesser concentration.

**Phacolytic glaucoma**—Type of glaucoma causing dissolution of the lens.

**Photocoagulation**—Condensation of material by laser.

**Pilocarpine**—Drug used to treat glaucoma.

**Trabecular meshwork**—Area of fibrous tissue that forms a canal between the iris and cornea, through which aqueous humor flows.

**Uveitis**—Inflammation of the iris and ciliary bodies.

along the trabecular meshwork. Plateau iris develops into glaucoma when the iris bunches up further; this occurs on dilation of the iris, which temporarily closes off the angle of the eye. Laser iridotomy is often performed as a preventive measure in these patients, but is



not a guarantee against future angle closure. This is because changes within the eye, such as narrowing of the angle and increase in lens size can lead to iris plateau syndrome, where the iris closes the angle of the eye even if a laser iridotomy has already been performed. Peripheral laser iridoplasty and other surgical techniques can be performed if the angle still closes after iridotomy.

Other causes of narrow angle glaucoma are not as common. Phacolytic glaucoma results when a cataract becomes hypermature and the proteins of the lens with the cataract leak out to block the angle and the trabecular meshwork. Laser iridotomy is not effective for this type of angle closure. Malignant glaucoma exists secondary to prior ocular surgery, and is the result of the movement of anatomical structures within the eye such that the meshwork is blocked. Patients who have no intraocular lens (aphakic) are at increased risk for angle closure, as well.

Laser iridotomy is also performed prophylactically (preventively) on asymptomatic individuals with narrow angles and those with pigment dispersion. Individuals with a narrow angle are at higher risk of an acute angle closure, especially upon dilation of the eye. Pigment dispersion is a condition in which the iris pigment is shed and is dispersed throughout the anterior part of the eye. If the dispersion occurs because of bowing of the iris (the case in 60% of patients with pigment dispersion) a laser iridotomy will decrease the bowing or concavity of the iris and subsequent pigment dispersion. This decreases the risk of these individuals to develop pigmentary glaucoma, a condition in which the dispersed pigment may clog the trabecular meshwork. Laser iridotomy is also done on the fellow eye of a patient who has had an angle closure of one eye, as the probability of an angle closure in the second eye is 50%.

There are other indications for laser iridotomy. It is performed on patients with nanophthalmos, or small eyes. Laser iridotomy may be also be indicated for patients with malignant glaucoma to help identify the etiology of elevated IOP. Because laser iridotomy changes the configuration of the iris, it is sometimes used to open the angle of the eye prior to performing a laser argon laser trabeculoplasty, if the angle is narrow. Laser trabeculoplasty is another laser procedure used to treat pigmentary and pseudoexfoliation glaucoma.

Laser iridotomy cannot be performed if the cornea is edematous or opacified, nor if the angle is completely closed. If an inflammation (such as uveitis

or neovascular glaucoma) has caused the angle to close, laser iridotomy cannot be performed.

## Purpose

The purpose of a laser iridotomy is to allow an equalization of pressure between the anterior (front) and posterior (back) chambers of the eye by making a hole in the superior peripheral iris. Once the laser iridotomy is completed, the intraocular fluid flows freely from the posterior to the anterior part of the eye, where it is drained via the trabecular meshwork. The result of this surgery is a decrease in IOP.

When laser iridotomy is performed on patients with chronic angle closure, or on patients with narrow angles with no history of angle closure, the chances of future pupillary blocks are decreased.

## Demographics

Acute angle glaucoma occurs in one in 1,000 individuals. Angle-closure glaucoma generally expresses itself in populations born with a narrow angle. Individuals of Asian and Eskimo ancestry appear to be at greater risk of developing it. Family history, as well as age, are risk factors. Older women are more often affected than are others. Laser iridotomy is performed on the same groups of individuals as those likely to experience angle closures due to pupillary block or plateau iris. They are performed more often on females (whose eyes are smaller than those of males), and more often performed on the smaller eyes of far-sighted people than on those of the nearsighted because angle closures occur more frequently in those who are far-sighted. Most laser iridotomies are performed on those over age 40 with a family history of plateau iris or narrow angles. However, preventative plateau iris laser iridotomies are performed on patients in their 30s. Individuals who are aphakic (have no intraocular lens) are at greater risk of angle closure and undergo laser iridotomy more frequently than phakic patients. Phakic patients are those who either have an intact lens or who are pseudophakic (have had a lens implant after the removal of a cataract removal).

## Description

After the cornea swelling has subsided and the IOP has been lowered, which is usually 48 hours after an acute angle closure, laser iridotomy can be performed. Pilocarpine is applied topically to the eye to constrict the pupil prior to surgery. When the pupil is constricted, the iris is thinner and it is easier for the surgeon to form a penetrating hole. If the eye is still edematous (swollen)—often the situation when the

IOP is extremely high—glycerin is applied to the eye to enable the surgeon to visualize the iris. Apraclonidine, an IOP-lowering drop, is applied one hour before surgery. Immediately prior to surgery, an anesthetic is applied to the eye.

Next, an iridotomy contact lens, to which methylcellulose is added for patient comfort, is placed on the upper part of the front of the eye. This lens increases magnification and helps the surgeon to project the laser beam accurately. The patient is asked to look downwards as the surgeon applies laser pulses to the iris, until a hole is formed. Once the hole has penetrated the iris, iris material bursts through the opening, followed by aqueous fluid. At this point, the surgeon can also see the anterior part of the lens capsule through the opening. The hole, or iridotomy, is formed on the upper section of the iris at an 11:00 or 1:00 position, so that the hole is covered by the eyelid. In an aphakic eye, the hole may be made on the inferior iris. After performing the laser iridotomy, the surgeon may place a gonioscopy lens on the eye if the angle has been opened. There is no pain associated with this surgery, although heat may be felt at the site of the lasering.

If a patient has a tendency to bleed, the argon laser will be used to pre-treat the patient prior to completing the procedure with an Nd:Yag laser, or the argon laser alone may be used. The argon laser is capable of photocoagulation, and thus minimizes any bleeding that occurs as the iris is penetrated. Formation of a hole is more difficult with the argon laser because it operates with a decreased power density and the tissue response to the argon laser has greater variability. The argon laser can be used with more patients who have medium-brown irises, however, since the energy of this laser is readily absorbed by irises of this color.

### Diagnosis/Preparation

To determine if laser iridotomy is indicated, the surgeon must first determine if and how the angle is occluded. The eye is anesthetized and the aonioscopic lens, which enables the surgeon to see the interior of the eye, is placed on the front of the eye. This is done at the slit lamp biomicroscope in a dark room. In cases of prophylactic surgery, an image of the eye is taken with a **ultrasound** biomicroscope in both dim and bright light; this shows the doctor how the patient's iris moves with dilation and constriction, and how this movement can close an angle if the patient has ocular features that predispose the eye to an angle closure.

When an angle is completely occluded (blocked), the elevated IOP usually causes corneal edema (swelling). Because this swelling can obscure the surgeon's

view of the iris, prior to performing a laser iridotomy, the IOP must be lowered. One technique to lower the IOP is corneal indentation, in which the gentle pressure is applied several times to the cornea with a lens or hook to open the angle. This pressure on the cornea causes a shift in the internal structures of the eye, enhances aqueous drainage, and lowers the IOP.

The doctor can attempt to lower the IOP medically, as well. One drug that lowers the pressure is acetazolamide, which is given either orally or by intravenous (IV) to decrease aqueous production in the eye. This may be administered up to four times a day, until the adhesion is broken. Another method of lowering the IOP, if acetazolamide is not effective, is the use of hyperosmotic agents, which through osmosis causes drainage of the aqueous fluid from the eye into the rest of the body. Hyperosmotic agents are given orally; an example of such an agent is glycerine. Given by IV, mannitol can be used. As the fluid drains from the eye, the vitreous—the jellylike substance behind the lens in the posterior chamber—shrinks. As it shrinks, the lens in the eye pulls away from the vitreous, creating an opening to the anterior chamber such that aqueous fluid can flow to the anterior chamber. The success of this procedure is increased, due to gravity, if the patient is laying supine (on the back).

Once the IOP has begun to decrease, the pressure is further decreased using topical glaucoma medications, such as pilocarpine, or beta blockers. Any inflammation that occurs because of the iridotomy must be controlled with steroid eye drops.

If glaucomatous-like visual field is present prior to surgical intervention, the prognosis for the patient is not as good as if the visual field were completely intact. Thus, a visual field test may be done prior to surgery.

### Aftercare

Immediately after the procedure, another drop of aproclonidine is applied to the eye. The IOP is checked every hour for a several hours postsurgery. If the IOP increases dramatically, then the increased IOP is treated until lowered. Because of inflammation is inherent in this procedure, **corticosteroids** are applied to the eye every five minutes for 30 minutes, then hourly for six hours. This therapy is then continued four times a day for a week. Thereafter, the patient is seen by the surgeon at one week postsurgery and again at two to six weeks postsurgery. If there are complications, the patient is seen more frequently.

After the pressure has been stabilized, a visual field test to determine the extent of damage to the optic nerve may be performed again.

## Risks

The greatest risk of laser iridotomy is an increase in intraocular pressure. Usually, the IOP spike is transient and of concern to the surgeon only during the first 24 hours after surgery. However, if there is damage to the trabecular meshwork during **laser surgery**, the intraocular pressure may not be lowered enough and extended medical intervention or filtration surgery is required. Patients who undergo preventative laser iridotomy do not experience as great an elevation in IOP.

The second greatest risk of this procedure is anterior uveitis, or inflammation within the eye. Usually the inflammation subsides within several days, but can persist for up to 30 days. Thus, the follow-up care for laser iridotomy includes the application of topical corticosteroids. A posterior synechia, in which the iris may again adhere to the lens, may occur if intraocular inflammation is not properly managed.

Other risks of this procedure include the following: swelling of, abrasions to, or opacification of the cornea; damage to the corneal endothelium (the part of the cornea that pumps oxygen and nutrients into the iris); bleeding of the iris during surgery, which is controlled during surgery by using the iridotomy lens to increase pressure on the eye; and macular edema, which can be avoided by careful aim of the laser during surgery to avoid the macula. The macula is the part of the eye where the highest concentration of photoreceptors is found. Perforations of the retina are rare. Distortion of the pupil and rupture of the lens capsule are other possible complications. Opacification of the anterior part of the lens is common, but this does not increase the risk of cataract formation when compared with the general population.

When the iridotomy hole is large, or if the eyelid does not completely cover the opening, some patients report such side effects as glare and double vision. The argon laser produces larger holes. Patients may also complain of an intermittent horizontal line in their vision. This may occur when the eyelid is raised just enough such that a small section of the inferior part of the hole is exposed, and disappears when the eyelid is lowered. Blurred vision may occur as well, but usually disappears 30 minutes after surgery.

## Normal results

In successful laser iridotomy, the IOP differential between the anterior and posterior chambers is relieved and IOP is decreased, and the pupil is able to constrict normally. These are the results of the flatter configuration of the iris after laser iridotomy. If an

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A laser iridotomy is performed in an office setting by an ophthalmologist, a doctor or osteopathic doctor with residency training in the treatment of eye diseases. The doctor who performs a laser iridotomy may have advanced fellowship training in the treatment of glaucoma, after completing his or her three-year residency.

angle closure is treated promptly, the patient will have minimal or no loss of vision. This procedure is successful in up to 44% of patients treated.

## Morbidity and mortality rates

For up to 64% of patients, one to three years after laser iridotomy, the IOP will rise above 21 mmHg, and long-term medical treatment is required. One-third of argon laser iridotomies will close within six to 12 weeks after surgery and will require a repeat laser iridotomy. Approximately 9% of Nd:Yag laser iridotomies must be redone for this reason. Closure of the iridotomy site is more likely if a uveitis presented after surgery. Up to 45% of patients will have anterior lens opacities after laser iridotomy, but these opacifications do not put the patient at an increased risk of cataracts.

## Alternatives

An alternative to laser iridotomy is surgical **iridectomy**, a procedure in which part of the iris is removed surgically. This was the procedure of choice prior to the development of laser iridotomy. The risks for iridectomy are greater than for the laser iridotomy, because it involves an incision through the sclera, the white tunic covering of the eye that surrounds the cornea. The most common complication of an iridectomy is cataract formation, occurring in more than 50% of patients who have had a surgical iridectomy. Since an incision in the eye is required for surgical iridectomy, other procedures, such as filtration surgery—if needed in the future—will be more difficult to perform. Studies comparing the visual outcomes and IOP control of laser iridotomy with surgical iridectomy show equivalent results.

In the case of acute angle closures that occur because of reasons other than, or in addition to pupillary block, argon laser peripheral iridoplasty is performed.

## QUESTIONS TO ASK THE DOCTOR

Will this procedure successfully lower the pressure in my eye indefinitely, or will I need further surgery or medication?

What is the probability that my other eye will also need surgery?

What will my vision be like after surgery?

Which laser will you use for my surgery?

How many laser iridotomies have you performed?

During this procedure, several long burns of low power are placed in the periphery of the iris. The iris contracts and pulls away from the angle, opening it up and relieving the IOP.

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- Canadian Ophthalmological Society (COS). 610 1525 Carling Avenue, Ottawa ON K1Z 8R9 Canada. <http://www.eyesite.ca>.
- National Eye Institute. 2020 Vision Place, Bethesda, MD 20892 3655. (301) 496 5248. <http://nei.nih.gov>.
- Prevent Blindness America. 500 East Remington Road, Schaumburg, IL 60173. (800) 331 2020. <http://www.preventblindness.org>.
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## Laser posterior capsulotomy

### Definition

Laser posterior capsulotomy, or YAG laser capsulotomy, is a noninvasive procedure performed on the eye to remove the opacification (cloudiness) that develops on the posterior capsule of the lens of the eye after extraction of a cataract. This differs from the anterior capsulotomy that the surgeon makes during cataract extraction to remove a cataract and implant an intraocular lens (IOL). Laser posterior capsulotomy is



performed with Nd:YAG laser, which uses a wavelength to disrupt the opacification on the posterior lens capsule. The energy emitted from the laser forms a hole in the lens capsule, removing a central area of the opacification. This posterior capsule opacification (PCO) is also referred to as a secondary cataract.

PCO formation is an attempt by the eye to make a new lens from remaining lens material. One form of PCO is a fibrosis that forms inside the capsule by lens epithelial (outer lining) cells that migrate from the anterior capsule to the posterior capsule when the anterior lens capsule is opened to remove the primary cataract and insert the IOL. Opacification is also formed by residual lens cortex cells. The epithelial cells can transform into myofibroblasts and proliferate; myofibroblasts are precursors to muscle cells and capable of contraction. The deposit of collagen on these cells leaves the posterior lens capsule with a white, fibrous appearance. This type of opacification can appear within days of cataract surgery. The greatest capsule opacification is found around the edges of the IOL, where the anterior and posterior lens capsules adhere and form a seam, called Soemmering's ring.

Elschnig's pearls are a proliferation of cells on the outside of the capsule. This type of PCO can be several layers thick and develops months to years after cataract surgery. Elschnig's pearls can also appear along the margins of a previously performed laser capsulotomy.

A secondary cataract will also form from wrinkling of the lens capsule, either secondary to contraction of the myofibroblasts on the capsule or because of stretching of the capsule by haptics, or hooks, used to hold the IOL in place.

Posterior capsule opacification is the most common complication of cataract removal or extraction. It does not occur when an anterior chamber lens is implanted, because in this procedure the capsule is usually extracted along with the cataract, and a lens is attached to the iris in the front part of the eye, called the anterior chamber. This technique for cataract removal is not often performed.

### Purpose

The purpose of a laser capsulotomy is to remove a PCO. This procedure dramatically improves visual acuity and contrast sensitivity and decreases glare. The visual acuity before capsulotomy can be as poor as 20/400, but barring any other visual or ophthalmologic conditions, the patient will see as well after a laser posterior capsulotomy as after removal of the original

## KEY TERMS

**Anterior chamber**—The part of the eye located behind the cornea and in front of the iris and lens; it is filled with aqueous fluid.

**Cataract**—An opacification of the lens in the eye. There are three types of cataracts: subcapsular, which forms inside the capsule in which the lens is located; nuclear, which is a natural yellowing of the lens nucleus; cortical, which refers to spoke-type opacities within the cortex layer of the lens.

**Lens capsule**—The “bag” is a membrane that holds the lens in place and holds a posterior lens implant when a cataract is removed.

**Macula**—This is the part of the retina in which the highest concentration of photoreceptors are found.

**Posterior capsule opacification (PCO)**—This refers to the opacities that form on the back of the lens capsule after cataract removal or extraction. It is synonymous with a secondary cataract.

**Posterior chamber**—This is the part of the eye located behind the lens of the eye and includes the retina, where the photoreceptors are located.

**Vitreous**—This is the jelly-like substance that fills the space between the lens capsule and the retina.

cataract. Laser capsulotomies are usually performed once a patient's vision is 20/30.

## Demographics

Approximately 20% of patients who undergo cataract extraction with placement of an intraocular lens into the posterior lens capsule will eventually undergo a laser capsulotomy, although a PCO may appear in up to 50% of patients who have undergone cataract surgery. The average time after cataract extraction for this procedure to be performed is two years, but it may be performed as early as three months after cataract removal, or as late as five years afterward.

Patients who fall into groups with an increased incidence of a secondary cataract formation have an increased rate of YAG capsulotomy. Patients who are younger when undergoing cataract removal are more likely to develop a PCO than are geriatric patients. This is particularly true of pediatric patients who are experiencing ocular growth. The incidence of PCO is higher in women than in men. Fifty percent of patients who experience papillary, or iris capture, of the IOL,

which occurs if the IOL moves through the pupil (a hole in the iris) from its position in the posterior chamber of the eye to the anterior chamber, will form a PCO and benefit from laser capsulotomy.

The degree and incidence of capsule opacification also varies with the type of implant used in the initial cataract operation. Larger implants are associated with decreased opacification, and round-edged silicone implants are associated with a greater incidence of opacification than are acrylic implants, which have a square-edged design. These two types of IOLs are called foldable implants because they unfold after being placed in the eye, allowing for a smaller incision on the front of the eye during cataract surgery. Also, the incidence of PCO is less with a silicone IOL than with a rigid IOL. The greater the amount of remaining lens material after extraction, especially in the area of Soemmering's ring, the greater the probability of PCO formation and laser capsulotomy. Also, diabetic patients are more likely to require a YAG capsulotomy than are non-diabetic patients. This is especially true for YAG capsulotomies performed on diabetics 18 months or later after cataract removal. The extent of diabetic retinopathy does not correlate with incidence of PCO or laser capsulotomy. Finally, insufficient dilation of the pupil during cataract surgery and inexperience of the surgeon doing cataract removal contribute to an increased risk of secondary cataract formation.

## Description

Laser capsulotomy is usually performed in an ophthalmologist's office as an outpatient procedure. Before beginning the capsulotomy, the patient is given an **informed consent** for the procedure. An hour before the laser capsulotomy, a drop of a pressure-lowering drug such as timoptic or apraclonidine is administered. A weak dilating drop to enlarge the pupil is applied to the eye. The eye may be anesthetized locally if the doctor uses a special contact lens for the procedure.

The patient then puts the head in the chinrest of a slit lamp microscope, to which a laser is attached. The doctor then may place a special lens on the front of the eye. It is important that the patient remain still as the doctor focuses on the posterior capsule. A head strap to help keep the patient's head in place may be used. While focusing on the posterior capsule, the doctor, with repeated bursts from the Nd:Yag laser in a circular manner, disrupts the PCO. An opening forms on the posterior part of the lens capsule as part of the PCO falls off of the posterior capsule and into the vitreous. Another drop of apraclonidine, or other pressure-lowering eyedrop, is applied to the eye as a

preventative measure for increased pressure in the eye, which is experienced by most patients after the procedure. This is a brief procedure lasting only a few minutes and is not associated with pain.

## Diagnosis/Preparation

Prior to performing a posterior capsulotomy, the doctor will perform a thorough ophthalmic examination and review any systemic medical problems. The ophthalmologic includes evaluation of visual acuity, slit-lamp biomicroscope examination of the eye to assess the extent and type of opacification and rule out inflammation or swelling in the front of the eye, measurement of intraocular pressure, and a thorough evaluation of the fundus or back of the eye to check for retinal detachments and macular problems, which would limit the extent to which the YAG capsulotomy could improve vision. A potential acuity meter (PAM) may be used to ascertain best expected visual acuity after YAG capsulotomy, and brightness acuity testing will determine the extent of glare experienced by the patient. Contrast sensitivity testing is employed by some doctors.

This procedure cannot be performed in the presence of certain preexisting ophthalmologic conditions. For example, irregularities of the cornea would interfere with the ability of the doctor to see the posterior capsule. Also, a laser capsulotomy could not be performed if there is ongoing inflammation in the eye, or if swelling of the macula (a part of the retina) is present. A laser capsulotomy would be contraindicated with glass IOLs. If macular edema is suspected, which can occur in up to 30% of patients who have undergone cataract surgery, a test called a fluorescein **angiography** may also be performed.

## Aftercare

After a laser capsulotomy, the patient will remain in the office for one to four hours so that the pressure in the eye can be evaluated. The patient can then resume normal everyday activities. After surgery, pressure-lowering eyedrops may be used for a week if the intraocular pressure is raised significantly. Cycloplegic agents to keep the pupil dilated and to prevent spasm of the muscles in the iris, and steroids to reduce inflammation may also be prescribed for up to a week. Follow-up visits are scheduled at one day, one week, one month, three months, and six months after capsulotomy.

## Risks

One risk of laser capsulotomy is damage to the intraocular implant. Factors that determine the extent

of damage to the IOL include the inherent resistance of a particular IOL to damage by the laser, the amount of energy used in the procedure, the position of the IOL within the lens capsule, and the focusing accuracy of the surgeon. The thicker the opacification of the lens capsule, the greater the amount of energy needed to remove it. The accuracy of the surgeon is improved when there is less opacification on the lens capsule.

In addition, during laser capsulotomy, the IOL can be displaced into the eye's vitreous. This happens more often in eyes with a rigid implant, rather than with acrylic or silicone IOLs, and also if a larger implant is used. If the posterior capsule ruptures during extraction of the primary cataract, risk of lens displacement is also increased. Displacement risk is also increased if the area over which the laser capsulotomy is done is large. The most serious complication of a capsulotomy is IOL damage so extensive that extraction would be required. This is a rare complication.

Another risk of this surgery is the re-formation of Elschnig's pearls over the opening created by the capsulotomy. This occurs in up to 80% of patients within two years of laser capsulotomy. Most of time, these PCOs will resolve over time without treatment, but 20% of patients will require a second laser capsulotomy. This secondary opacification by Elschnig pearls represents a spatial progression of the opacification that caused the initial secondary cataract.

Other risks to take into account when considering a posterior capsulotomy are macular edema, macular holes, corneal edema, inflammation of the iris, retinal detachment, and increased pressure in the eye, as well as glaucoma. These risks escalate with increased laser energy and with increased size of the capsulotomy area. Retinal detachments are usually treated with removal of the vitreous behind the lens capsule. Macular edema is treated by application of topical anti-inflammatory drops or intraocular steroid injections. Steroids control iritis (inflammation of the iris), either topically or intraocularly. Macular holes are also treated by removal of the vitreous (the substance that fills the main area of the eyeball), followed by one to three weeks of facedown positioning. Elevated intraocular pressure and glaucoma are treated with anti-glaucoma drops or glaucoma surgery, if necessary.

Finally, increased glare at night may result when the size of the capsulotomy is smaller than the diameter of the pupil during dark conditions.

### Normal results

Within one to two days after surgery, maximum visual acuity will be attained by almost 99% of patients.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The procedure is usually performed in the office of an ophthalmologist or an osteopathic physician. The training of an ophthalmologist includes a year of internship and at least three years of residency training in the treatment of eye diseases and in eye surgery after graduation from medical school. In states where doctors of optometry are permitted by law to use lasers, and if trained in laser surgery, an optometrist may do the laser capsulotomy. A co-managing optometrist may perform some of the preoperative testing and postoperative follow-up.

Once the opacification is removed, most patients will not need a change in spectacle prescription. However, patients who have undergone implantation of a rigid IOL may experience an increase in hyperopia, or farsightedness, after a capsulotomy. For a few weeks after surgery, the presence of visual floaters, which are pieces of the excised capsule, is normal. But, the presence of floaters months after this timeframe, especially if accompanied by flashes of light, may signal a retinal tear or detachment and require immediate attention. Also, if vision suddenly or gradually worsens after an initial improvement, further follow-up to determine the cause of a decrease in visual function is imperative.

### Morbidity and mortality rates

The probability of a retinal detachment after capsulotomy is 1.6–1.9%. This represents a two-fold increase of retinal detachment over the rate for all patients undergoing cataract surgery, regardless if a posterior capsulotomy was done or not. Macular edema occurs in up to 2.5% of patients who undergo a laser capsulotomy and is more likely to occur when the capsulotomy is performed soon after cataract extraction, or in younger individuals. Rarely does glaucoma develop after laser capsulotomy, although as many as two-thirds of patients will experience transient increased intraocular pressure.

### Alternatives

The alternative to laser capsulotomy is surgical capsulotomy of the PCO and the adjacent anterior vitreous. There is an increased risk of retinal detachment when this invasive intraocular surgery is employed. The other alternative is to leave the PCO in place. This leaves the patient with permanent decreased visual acuity.

## QUESTIONS TO ASK THE DOCTOR

- What are the alternatives to laser capsulotomy?
- Am I a good candidate for this procedure?
- What will my vision be like after the procedure?
- How many of these procedures have you performed?

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## Laser skin resurfacing

### Definition

Laser skin resurfacing involves the application of laser light to the skin in order to remove fine wrinkles and tighten the skin surface. It is most often used on the skin of the face.



## Purpose

The purpose of laser skin resurfacing is to use the heat generated by extremely focused light to remove the upper to middle layers of the skin. This procedure eliminates superficial signs of aging and softens the appearance of other lesions such as scars. Upon healing, the surface of the skin has a younger appearance. Microscopic analysis of skin after laser resurfacing shows that the healed surface more closely resembles younger, healthier skin in many aspects.

## Demographics

According to the American Society for Aesthetic **Plastic Surgery**, there were more than 72,000 laser skin resurfacing procedures performed in the United States in 2002. Almost all persons of sufficient age have one or more symptoms of aging or damaged skin that can be treated by this procedure, including fine lines in the skin, known as rhytides; discoloration of the skin; acne scarring; and surgical or other types of scars.

## Description

A central component of the laser skin resurfacing technique is the laser device. Laser is an acronym for light amplification by stimulated emission of radiation. This device produces an intense beam of light of a specific, known wavelength. Laser light is produced by high-energy stimulation of different substances such as crystals, liquid dyes, and gases. For skin resurfacing, two types of lasers produce light that is well absorbed by the upper to middle layers of the skin: light produced from carbon dioxide gas (CO<sub>2</sub>) and light produced from a crystal made of erbium, yttrium, aluminum, and garnet (Er:YAG). Combination lasers are also commercially available.

There are as yet no standard parameters for laser use in all skin resurfacing procedures. Settings are determined on a case-by-case basis by the laser surgeon who relies on his or her own experience.

Before the procedure begins, medication is often given to relax the patient and reduce pain. For small areas, local topical (surface-applied) anesthetics are often used to numb the area to be treated. Alternatively, for large areas, nerve block-type anesthesia is used. Some laser surgeons use **conscious sedation** (twilight anesthesia) alone or in combination with other techniques.

During the procedure, the patient lies on his or her back on the surgical table, eyes covered to protect them from the laser light. Laser passes are performed over the area being treated, utilizing computer control

## KEY TERMS

**Acetic acid**—Vinegar; very dilute washes of the treated areas with a vinegar solution are suggested by some surgeons after laser skin resurfacing.

**Carbon dioxide**—Abbreviated CO<sub>2</sub>; a gas that produces light that is well absorbed by the skin, so is commonly used for skin resurfacing treatments.

**Erbium:YAG**—A crystal made of erbium, yttrium, aluminum, and garnet that produces light that is well absorbed by the skin, so it is used for skin resurfacing treatments.

**Hydrogel**—A gel that contains water, used as a dressing after laser skin resurfacing.

**Milia**—Small bumps on the skin that occur when sweat glands are clogged.

**Rhytides**—Very fine wrinkles, often of the face.

**Topical**—Applied to the skin surface.

of the laser for precise results. In general, more passes are needed with Er:YAG lasers than carbon dioxide laser treatment.

Because areas of the body other than the face have relatively low numbers of the cells central to the healing process, laser skin resurfacing is not generally used anywhere but on the face, as elsewhere the healing process may be so slow as to result in scarring.

## Diagnosis/Preparation

An initial consideration is to determine which laser would be best for any particular skin resurfacing procedure. Carbon dioxide lasers have been in use longer and have been shown to produce very good results. However, the healing times tend to be long and redness can persist for several months. In contrast, because the light produced by the Er:YAG laser is more efficiently absorbed by the skin, less light energy and shorter pass times can be used, which significantly shortens the healing time. Unfortunately, the results obtained with this laser have not been as consistently good as with a carbon dioxide laser. Patients should therefore discuss the two laser types and the condition of their skin with their doctor to determine which would be better for their particular situation.

Although controversial, some studies have reported abnormal scarring in patients previously treated with 13 cis-retinoic acid (Accutane), so many surgeons will

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The procedure is performed by an experienced laser surgeon or a dermatological surgeon with special training in the use of the laser. It is performed in a special suite adapted for laser use, often located at the surgeon's offices.

require a six-month break from the medication before performing laser skin resurfacing.

Laser skin resurfacing does increase the chance of recurrent or initial herpes simplex virus infection (cold sores) during the healing process. Even with no patient history of the problem, it is important that anti-viral medicine is administered before, the morning of, and following laser skin resurfacing.

### Aftercare

After the procedure, any treated areas are dressed for healing. Surgeons are divided on whether the wound should remain open or closed (covered) during the healing process. For example, surgeons that adopt a closed procedure can use a dressing that is primarily hydrogel held on a mesh support to cover the wound. This kind of dressing is changed daily while the epithelium (outer layer of skin) is restored. Open **wound care** involves frequent soaks in salt water or dilute acetic acid, followed by application of ointment. Whatever wound treatment is used, it is important to keep the healing skin hydrated.

Full restoration of the epithelial layer occurs in seven to 10 days after treatment with a carbon dioxide laser and three to five days after treatment with a Er:YAG laser, although redness can persist for many weeks afterward.

### Risks

Risks of this procedure include skin redness that persists beyond the initial healing period, swelling, burning sensations, or itching. These risks tend to be short term and lessen over time. More long-term problems can include scarring, increased or decreased pigmentation of the skin, and infection during healing. Finally, the formation of milia, bumps that form due to obstruction of the sweat glands, can occur, although this can be treated after healing with retinoic acid.

## QUESTIONS TO ASK THE DOCTOR

- What characteristics of my skin abnormality suggest using laser skin resurfacing to treat it?
- Which laser would be best to treat my skin condition?
- Would dermabrasion or chemical treatments be a better option?
- What is the expected cosmetic outcome for the laser resurfacing treatment in my case?

### Normal results

Normal results of this procedure include reduction in the fine lines found in aging skin, improving skin texture, making skin coloration more consistent, and softening the appearance of scars. In a recent study, more than 93% of patients subjectively rated their results from the procedure either very good or excellent.

### Morbidity and mortality rates

The morbidity and mortality rates for this cosmetic procedure are close to zero.

### Alternatives

Surgical techniques such as facelifts or **blepharoplasty** (eyelid surgery) are often recommended when facial aging is beyond the restorative powers of a laser treatment and the most common alternative technique. Patients should also consider other skin resurfacing techniques such as **dermabrasion** or chemical peels, as these are more effective than laser resurfacing for certain skin conditions and certain skin types.

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## Laser surgery

### Definition

The term "laser" means light amplification by stimulated emission of radiation. Laser surgery uses a laser light source to remove tissues that are diseased or unwanted, to treat blood vessels that are bleeding, or to terminate tumors or lesions. Laser beams are strong beams of light produced by electrically stimulating a particular material, in the case of laser surgery, most often carbon dioxide, argon, or neodymium.

The special light beam is focused to treat tissues by heating the cells until they burst. There are a number of different laser types. Each has a different use and color. Three types of laser that are commonly used are: the carbon dioxide (CO<sub>2</sub>) laser; the YAG laser (yttrium aluminum garnet); and the argon laser.

### Purpose

Laser surgery is used to:

- cut or destroy tissue that is abnormal or diseased without harming healthy, normal tissue
- shrink or destroy tumors and lesions
- close off nerve endings to reduce postoperative pain
- cauterize (seal) blood vessels to reduce blood loss
- seal lymph vessels to minimize swelling and decrease spread of tumor cells
- remove moles, warts, and tattoos
- decrease the appearance of skin wrinkles

### Precautions

Anyone who is thinking about having laser surgery should ask the surgeon to:

- explain why laser surgery is likely to be of greater benefit than traditional surgery
- describe the surgeon's experience in performing the laser procedure the patient is considering

Because some lasers can temporarily or permanently discolor the skin of blacks, Asians, and Hispanics, a dark-skinned patient should make sure that the surgeon has successfully performed laser procedures on people of color. Potential problems include infection, pain, scarring, and changes in skin color.

Some types of laser surgery should not be performed on pregnant women or on patients with severe cardiopulmonary disease or other serious health problems.

Additionally, because some laser surgical procedures are performed under **general anesthesia**, its risks should be fully discussed with the anesthesiologist. The patient should fully disclose all over-the-counter and prescription medications that are being taken, as well as the foods and beverages that are generally consumed; some can interact with agents used in anesthesia.

### Description

Lasers are used to perform many surgical procedures. Lasers of various wavelengths are used remove tissue, cut, coagulate, and vaporize. Often times, lasers can take the place of conventional surgical tools—scalpels, cryosurgery probes, electrosurgical units, or microwave devices—to carry out standard procedures such as **mastectomy** (breast surgery). By using lasers, surgeons can accomplish more complex tasks and reduce blood loss, decrease postoperative patient discomfort, decrease the chances of infection to the wound, reduce the spread of some cancers, minimize the extent of surgery (in some cases), and achieve better outcomes in wound healing. Also, because lasers are more precise, the laser can penetrate tissue by adjusting the intensity of the light.

Lasers are also extremely useful in both open and laparoscopic procedures. Breast surgery, hernia repair, **bowel resection**, **hemorrhoidectomy**, gallbladder removal, and solid organ surgery are among the common types of laser surgery.

The first working laser was introduced in 1960. Initially used to treat diseases and disorders of the eye, the device was first used to treat diseases and disorders of the eye, whose transparent tissues gave ophthalmic surgeons a clear view of how the narrow, concentrated beam was being directed. Dermatologic surgeons also helped to pioneer laser surgery, and developed and improved upon many early techniques and more refined surgical procedures.

### Types of lasers

The three types of lasers most often used in medical treatment are the:

## KEY TERMS

**Argon**—A colorless, odorless gas.

**Astigmatism**—A condition in which one or both eyes cannot filter light properly and images appear blurred and indistinct.

**Canker sore**—A blister-like sore on the inside of the mouth that can be painful but is not serious.

**Carbon dioxide**—A heavy, colorless gas that dissolves in water.

**Cardiopulmonary disease**—Illness of the heart and lungs.

**Cardiopulmonary resuscitation (CPR)**—An emergency procedure used to restore circulation and prevent brain death to a person who has collapsed, is unconscious, is not breathing, and has no pulse.

**Cauterize**—To use heat or chemicals to stop bleeding, prevent the spread of infection, or destroy tissue.

**Cornea**—The outer, transparent lens that covers the pupil of the eye and admits light.

**Endometriosis**—An often painful gynecologic condition in which endometrial tissue migrates from the inside of the uterus to other organs inside and beyond the abdominal cavity.

**Glaucoma**—A disease of the eye in which increased pressure within the eyeball can cause gradual loss of vision.

**Invasive surgery**—A form of surgery that involves making an incision in the patient's body and inserting instruments or other medical devices into it.

**Laparoscopic procedures**—Surgical procedures during which surgeons rely on a laparoscope—a pencil-thin instrument that has its own lighting system and miniature video camera. To perform surgeries, only small incisions are needed to insert the instruments and the miniature camera.

**Nearsightedness**—A condition in which one or both eyes cannot focus normally, causing objects at a distance to appear blurred and indistinct. Also called myopia.

**Ovarian cyst**—A benign or malignant growth on an ovary. An ovarian cyst can disappear without treatment or become extremely painful and have to be surgically removed.

**Pilonidal cyst**—A special kind of abscess that occurs in the cleft between the buttocks. Forms frequently in adolescence after long trips that involve sitting.

**Vaporize**—To dissolve solid material or convert it into smoke or gas.

**Varicose veins**—Swollen, twisted veins, usually occurring in the legs, that occur more often in women than in men.

- Carbon dioxide (CO<sub>2</sub>) laser. Primarily a surgical tool, this device converts light energy to heat strong enough to minimize bleeding, while cutting through or vaporizes tissue.
- Neodymium:yttrium-aluminum-garnet (Nd:YAG) laser. Capable of penetrating tissue more deeply than other lasers, the Nd:YAG laser enables blood to clot quickly, allowing surgeons to see and can enable surgeons to see and touch body parts that could otherwise be reached only through open (invasive) surgery.
- Argon laser. This laser provides the limited penetration needed for eye surgery and superficial skin disorders. In a special procedure known as photodynamic therapy (PDT), this laser uses light-sensitive dyes to shrink or dissolve tumors.

### *Laser applications*

Sometimes described as “scalpels of light,” lasers are used alone or with conventional **surgical instruments** in a array of procedures that:

- improve appearance
- relieve pain
- restore function
- save lives

Laser surgery is often standard operating procedure for specialists in:

- cardiology (branch of medicine which deals with the heart and its diseases)
- dentistry (branch of medicine which deals with the anatomy and development and diseases of the teeth)
- dermatology (science which treats the skin, its structure, functions, and its diseases)
- gastroenterology (science which treats disorders of the stomach and intestines)
- gynecology (science which treats of the structure and diseases of women)
- neurosurgery (surgery of the nervous system)
- oncology (cancer treatment)
- ophthalmology (treatment of disorders of the eye)



- orthopedics (treatment of disorders of bones, joints, muscles, ligaments, and tendons)
- otolaryngology (treatment of disorders of the ears, nose, and throat)
- pulmonology (treatment of disorders of the respiratory system)
- urology (treatment of disorders of the urinary tract and of the male reproductive system)

Routine uses of lasers, include eliminating birthmarks, skin discoloration, and skin changes due to aging, and removing benign, precancerous, or cancerous tissues or tumors. Lasers are used to stop a patient's snoring, remove tonsils, remove or transplant hair, and relieve pain and restore function in patients who are too weak to undergo major surgery. Lasers are also used to treat:

- angina (chest pain)
- cancerous or noncancerous tumors that cannot be removed or destroyed
- cold and canker sores, gum disease, and tooth sensitivity or decay
- ectopic pregnancy (development of a fertilized egg outside the uterus)
- endometriosis
- fibroid tumors
- gallstones
- glaucoma, mild-to-moderate nearsightedness and astigmatism, and other conditions that impair sight
- migraine headaches
- noncancerous enlargement of the prostate gland
- nosebleeds
- ovarian cysts
- ulcers
- varicose veins
- warts
- numerous other conditions, diseases, and disorders

#### *Advantages of laser surgery*

Often referred to as “bloodless surgery,” laser procedures usually involve less bleeding than conventional surgery. The heat generated by the laser keeps the surgical site free of germs and reduces the risk of infection. Because a smaller incision is required, laser procedures often take less time (and cost less money) than traditional surgery. Sealing off blood vessels and nerves reduces bleeding, swelling, scarring, pain, and the length of the recovery period.

#### *Disadvantages of laser surgery*

Although many laser surgeries can be performed in a doctor's office, rather than in a hospital, the person guiding the laser must be at least as thoroughly trained and highly skilled as someone performing the same procedure in a hospital setting. The American Society for Laser Medicine and Surgery urges that:

- All operative areas be equipped with oxygen and other drugs and equipment required for cardiopulmonary resuscitation (CPR).
- Nonphysicians performing laser procedures be properly trained, licensed, and insured.
- A qualified and experienced supervising physician be able to respond to and manage unanticipated events or other emergencies within five minutes of the time they occur.
- Emergency transportation to a hospital or other acute care facility (ACF) be available whenever laser surgery is performed in a non-hospital setting.

#### **Diagnosis/Preparation**

Because laser surgery is used to treat so many diverse conditions, the patient should ask the physician for detailed instructions about how to prepare for a specific procedure. Diet, activities, and medications may not have to be limited prior to surgery, but some procedures require a **physical examination**, a medical history, and conversation with the patient that:

- enables the doctor to evaluate the patient's general health and current medical status
- provides the doctor with information about how the patient has responded to other illnesses, hospital stays, and diagnostic or therapeutic procedures
- clarifies what the patient expects the outcome of the procedure to be

#### **Aftercare**

Most laser surgeries can be performed on an outpatient basis, and patients are usually permitted to leave the hospital or medical office when their **vital signs** have stabilized. A patient who has been sedated should not be discharged until recovery from the anesthesia is complete, unless a responsible adult is available to accompany the patient home.

The doctor may prescribe analgesic (pain-relieving) medication, and should provide easy-to-understand, written instructions on how to take the medication. The doctor should also be able to give the patient a good estimate of how the patient's recovery should progress, the recovery time, and what to do in case

complications or emergency arise. The amount of time it takes for the patient to recover from surgery depends on the surgery and on the individual. Recovery time for laser surgery is, for the most part, faster than for traditional surgery.

### Risks

Like traditional surgery, laser surgery can be complicated by:

- hemorrhage
- infection
- perforation (piercing) of an organ or tissue

Laser surgery can also involve risks that are not associated with traditional surgical procedures. Being careless or not practicing safe surgical techniques can severely burn the patient's lungs. Patients must wear protective eye shields while undergoing laser surgery on any part of the face near the eyes or eyelids, and the United States Food and Drug Administration has said that both doctors and patients must use special wavelength-specific, protective eyewear whenever a CO<sub>2</sub> laser is used.

There are other kinds of dangers that laser surgery can impose of which the patient should be aware. Laser beams have the capacity to do a great deal of damage when coupled with high enough energy and absorption. They can ignite clothing, paper, and hair. Further, the risk of fire from lasers increases in the presence of oxygen. Hair should be protected and clothing should be tied back, or removed, within the treatment areas. It is important to guard against electric shock, as lasers require the use of high voltage. Critically, installation must ensure proper wiring.

Laser beams can burn or destroy healthy tissue, cause injuries that are painful and sometimes permanent, and actually compound problems they are supposed to solve. Errors or inaccuracies in laser surgery can worsen a patient's vision, for example, and lasers can scar and even change the skin color of some patients.

All of the above risks, precautions, and potential complications should be discussed by the doctor with the patient.

### Normal results

The nature and severity of the problem, the skill of the surgeon performing the procedure, and the patient's general health and realistic expectations are among the factors that influence the outcome of laser surgery. Successful procedures can enable patients to

feel better, look younger, and enjoy longer, fuller, more active lives.

A patient who is considering any kind of laser surgery should ask the doctor to provide detailed information about what the outcome of the surgery is expected to be, what the recovery process will involve, and how long it will probably be before a normal appearance is regained and the patient can resume normal activities.

A person who is considering any type of laser surgery should ask the doctor to provide specific and detailed information about what could go wrong during the procedure and what the negative impact on the patient's health or appearance might be.

Lighter or darker skin may appear, for example, when a laser is used to remove sun damage or age spots from an olive- or dark-skinned individual. This abnormal pigmentation may or may not disappear over time.

Scarring or rupturing of the cornea is uncommon, but laser surgery on one or both eyes can:

- increase sensitivity to light or glare
- reduce night vision
- permanently cloud vision, or cause sharpness of vision to decline throughout the day

Signs of infection following laser surgery include:

- burning
- crusting of the skin
- itching
- pain
- scarring
- severe redness
- swelling

### Resources

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- American Society for Laser Medicine and Surgery. 2404 Stewart Square, Wausau, WI 54401. (715) 845 9283. <http://www.aslms.org>.
- Cancer Information Service. 9000 Rockville Pike, Building 31, Suite 10A18, Bethesda, MD 20892. 1 800 4 CANCER. <<http://wwwicic.nci.nih.gov>>.
- Mayo Clinic. Division of Colon and Rectal Surgery. 200 First Street. SW, Rochester, MN 55905. (507) 284 2511. <http://www.mayoclinic.org/colorectalsurgery/rst/laparoscopicsurgery.html>.
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LASIK see **Laser in-situ keratomileusis (LASIK)**

Lateral release see **Knee arthroscopic surgery**

## Laxatives

### Definition

Laxatives are medicines that promote bowel movements.

### Purpose

Laxatives are used to treat constipation—the passage of small amounts of hard, dry stools, usually fewer than three times a week. Before recommending the use of laxatives, a physician should perform differential diagnosis. Prolonged constipation may be evidence of a significant problem, such as localized peritonitis or **diverticulitis**. Complaints of constipation may be associated with obsessive-compulsive disorder. Use of laxatives should be avoided in these cases. Patients should be aware that patterns of defecation are highly variable, and may vary from two to three times daily to two to three times weekly.

Laxatives may also be used prophylactically for patients such as those recovering from a myocardial infarction (heart attack) or those who have had recent surgery and should not strain during defecation.

### Description

Laxatives may be grouped by mechanism of action.

Saline cathartics include dibasic sodium phosphate (Phospo-Soda), magnesium citrate, magnesium hydroxide (milk of magnesia), magnesium sulfate (Epsom salts), sodium biphosphate, and others. They act by attracting and holding water in the intestinal tissues, and may produce a watery stool. Magnesium sulfate is the most potent of the laxatives in this group.

Stimulant and irritant laxatives increase the peristaltic movement of the intestine. Product examples include cascara and bisacodyl (Dulcolax). Castor oil works in a similar fashion.

Bulk-producing laxatives increase the volume of the stool, and will both soften the stool and stimulate intestinal motility. Psyllium (Metamucil, Konsil) and methylcellulose (Citrucel) are examples of this type. The overall effect is similar to that of eating high-fiber foods, and this class of laxative is most suitable for regular use.

Docusate (Colace) is the only representative example of the stool softener class. It holds water within the fecal mass, providing a larger, softer stool. Docusate has no effect on acute constipation, since it must be present before the fecal mass forms to have any effect, but may be useful for prevention of constipation in patients with recurrent problems, or those who are about to take a constipating drug such as narcotic **analgesics**.

Mineral oil is an emollient laxative. It acts by retarding intestinal absorption of fecal water, thereby softening the stool.

The hyperosmotic laxatives are glycerin and lactulose (Chronulac, Duphalac), both of which act by holding water within the intestine. Lactulose may also increase peristaltic action of the intestine.

### Precautions

Short-term use of laxatives is generally safe except in cases of appendicitis, fecal impaction, or intestinal obstruction. Lactulose is composed of two sugar molecules, galactose and fructose, and should not be administered to patients who require a low-galactose diet.

## KEY TERMS

**Carbohydrates**—Compounds such as cellulose, sugar, and starch that contain only carbon, hydrogen, and oxygen, and are a major part of the diets of people and other animals.

**Cathartic colon**—A poorly functioning colon, resulting from the chronic abuse of stimulant cathartics.

**Colon**—The large intestine.

**Diverticulitis**—Inflammation of the part of the intestine known as the diverticulum.

**Fiber**—Carbohydrate material in food that cannot be digested.

**Hyperosmotic**—Hypertonic, containing a higher concentration of salts or other dissolved materials than normal tissues.

**Osteomalacia**—A disease of adults, characterized by softening of the bone; similar to rickets, which is seen in children.

**Pregnancy category**—A system of classifying drugs according to their established risks for use during pregnancy: category A: controlled human studies have demonstrated no fetal risk; category B: animal studies indicate no fetal risk, and there are no adequate and well-controlled studies in pregnant women; category C: no adequate human or animal studies, or adverse fetal effects in animal studies, but no available human data; category D: evidence of fetal risk, but benefits outweigh risks; category X: evidence of fetal risk, which outweigh any benefits.

**Steatorrhea**—An excess of fat in the stool.

**Stool**—The solid waste that is left after food is digested. Stool forms in the intestines and passes out of the body through the anus.

Chronic use of laxatives may result in fluid and electrolyte imbalances, steatorrhea, osteomalacia, diarrhea, cathartic colon, and liver disease. Excessive intake of mineral oil may cause impaired absorption of oil soluble vitamins, particularly A and D. Excessive use of magnesium salts may cause hypermagnesemia.

Lactulose and magnesium sulfate are pregnancy category B. Casanthranol, cascara sagrada, danthron, docusate sodium, docusate calcium, docusate potassium, mineral oil, and senna are category C. Casanthranol, cascara sagrada, and danthron are excreted in breast milk, resulting in a potential increased incidence of diarrhea in the nursing infant.

## Interactions

Mineral oil and docusate should not be used in combination. Docusate is an emulsifying agent that will increase the absorption of mineral oil.

Bisacodyl tablets are enteric coated, and so should not be used in combination with antacids. The antacids will cause premature rupture of the enteric coating.

## Recommended dosage

The patient should consult specialized drug references, or ask a physician or pharmacist about a specific medication.

## Resources

### PERIODICALS

“Constipation, Laxatives and Dietary Fiber.” *HealthTips* (April 1993): 9.

“Overuse Hazardous: Laxatives Rarely Needed.” *FDA Consumer* (April 1991): 33.

### ORGANIZATIONS

National Digestive Diseases Information Clearinghouse. 2 Information Way, Bethesda, MD 20892 3570. <niddic@erie.com>. <http://www.niddk.nih.gov/Brochures/NDDIC.htm>.

### OTHER

“Effectiveness of Laxatives in Adults.” Centre for Reviews and Dissemination, University of York. [cited June 2003] <http://www.york.ac.uk/inst/crd/ehc71.htm>.

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Samuel D. Uretsky, PharmD

## LDL cholesterol test

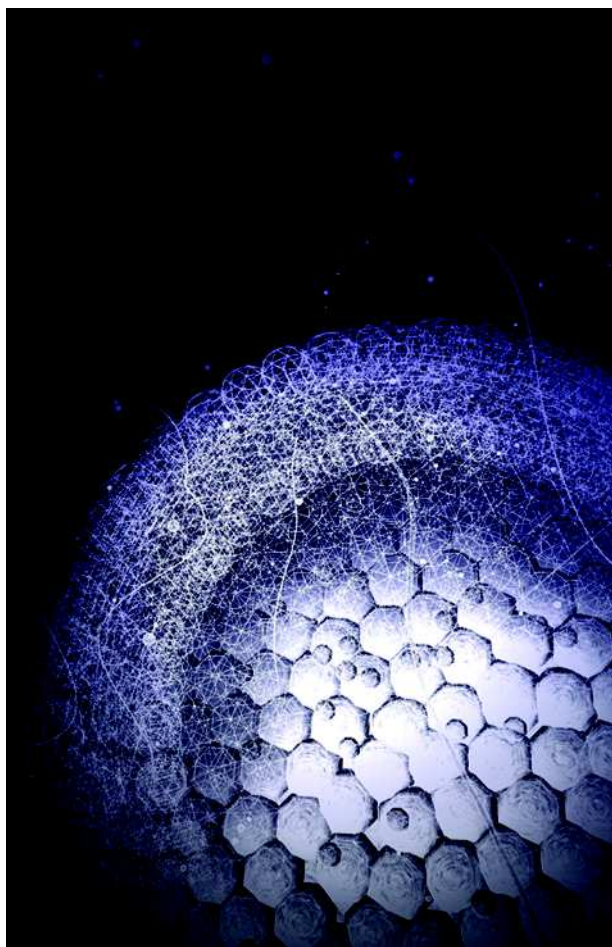
### Definition

An LDL test measures the low density lipoprotein fraction of a person's total cholesterol.

### Purpose

The purpose of an LDL test is to evaluate an individual's risk of cardiovascular (heart) disease.





Microscopic view of lipoproteins. (MedicalRF.com / Alamy)

### Description

The LDL test is a component of a **lipid profile**. A lipid profile includes four blood tests: total cholesterol, HDL cholesterol, LDL cholesterol and triglycerides.

LDL stands for low density lipoproteins. It is also known as the so-called bad cholesterol. It slowly accumulates on the inner walls of arteries. This buildup is known as plaque. Over time, it creates a condition known as atherosclerosis.

Dietary fats, including cholesterol, are absorbed from the small intestines. They are converted into triglycerides, which are then packaged into lipoproteins. All of these products are transported into the liver by chylomicrons. After a fast (not eating) lasting at least 12 hours, chylomicrons are absent from the bloodstream. This is the reason why persons that are having an LDL test must fast overnight.

A healthy LDL level is 129 mg/dL or less (in the optimal or near optimal ranges).

### WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

- LDL cholesterol tests are typically ordered by a family doctor, internist or geriatrician.
- A blood sample is usually obtained by a nurse, phlebotomist or medical technologist.
- The blood sample is tested or processed by a medical technologist.
- Results are usually reviewed, returned to the person being tested and interpreted by the physician initially ordering the LDL test.

- Optimal: Less than 100 mg/dL
- Near optimal: 100–129 mg/dL
- Borderline high: 130–159 mg/dL
- High: 160–189 mg/dL
- Very high: 190 mg/dL and higher

Pharmaceutical interventions are based, in part, on LDL test values.

An optimal range is defined as less than 70mg/dL for persons with a history of heart disease or those at very high risk for atherosclerotic disease.

Ranges for laboratory values may vary slightly among different laboratories.

### Recommended dosage

LDL cholesterol testing is a component of a lipid profile. A lipid profile can be ordered at any time. Routine lipid profiles that are used to monitor the effectiveness of drugs intended to reduce serum cholesterol are usually performed every three months.

### Precautions

A fast (not eating) for a minimum of 12 hours before drawing blood contributes to a more accurate measurement of lipids in the blood. No other precautions are needed.

At the time of drawing blood, the only precaution needed is to clean the venipuncture site with alcohol.

### Side effects

The most common side effects of an LDL test are minor bleeding (hematoma) or bruising at the site of venipuncture.

## QUESTIONS TO ASK YOUR DOCTOR

- Why are LDL cholesterol tests needed?
- What do the results indicate for my health?
- What treatment options do I have?

### Interactions

There are no interactions for an LDL test.

### Resources

#### BOOKS

- Fischbach, F. T. and M. B. Dunning. *A Manual of Laboratory and Diagnostic Tests*. 8th ed. Philadelphia: Lippincott Williams & Wilkins, 2008.
- McGhee, M. *A Guide to Laboratory Investigations*. 5th ed. Oxford, UK: Radcliffe Publishing Ltd, 2008.
- Price, C. P. *Evidence Based Laboratory Medicine: Principles, Practice, and Outcomes*. 2nd ed. Washington, DC: AACC Press, 2007.
- Scott, M.G., A. M. Gronowski, and C. S. Eby. *Tietz's Applied Laboratory Medicine*. 2nd ed. New York: Wiley Liss, 2007.
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- Leigh Hunt, N., and M. Rudolf. "A review of local practice regarding investigations in children attending obesity clinics and a comparison of the results with other studies." *Child Care Health and Delivery* 34, no. 1 (2008): 55-58.
- Shephard, M. D., B. C. Mazzachi, and A. K. Shephard. "Comparative performance of two point of care analyzers for lipid testing." *Clinical Laboratory* 53, no. 9 (2007): 561-566.
- Wright, J. T., S. Harris Haywood, S. Pressel, et al. "Clinical outcomes by race in hypertensive patients with and without the metabolic syndrome: Antihypertensive and Lipid Lowering Treatment to Prevent Heart Attack Trial." *Archives of Internal Medicine* 168, no. 2 (2008): 207-217.

#### ORGANIZATIONS

- American Association for Clinical Chemistry. <http://www.aacc.org/AACC/>.
- American Society for Clinical Laboratory Science. <http://www.ascls.org/>.
- American Society of Clinical Pathologists. <http://www.ascp.org/>.

## KEY TERMS

**Hematoma**—A collection of blood that has entered a closed space.

**Phlebotomist**—Health care professional trained to obtain samples of blood.

College of American Pathologists. <http://www.cap.org/apps/cap.portal>.

#### OTHER

- American Clinical Laboratory Association. "Information about clinical chemistry." 2008 [cited February 24, 2008]. <http://www.clinical labs.org/>.
- Clinical Laboratory Management Association. "Information about clinical chemistry." 2008 [cited February 22, 2008]. <http://www.clma.org/>.
- Lab Tests On Line. "Information about lab tests." 2008 [cited February 24, 2008]. <http://www.labtestsonline.org/>.
- National Accreditation Agency for Clinical Laboratory Sciences. "Information about laboratory tests." 2008 [cited February 25, 2008]. <http://www.naacls.org/>.

L. Fleming Fallon, Jr, MD, DrPH

## Leg lengthening or shortening

### Definition

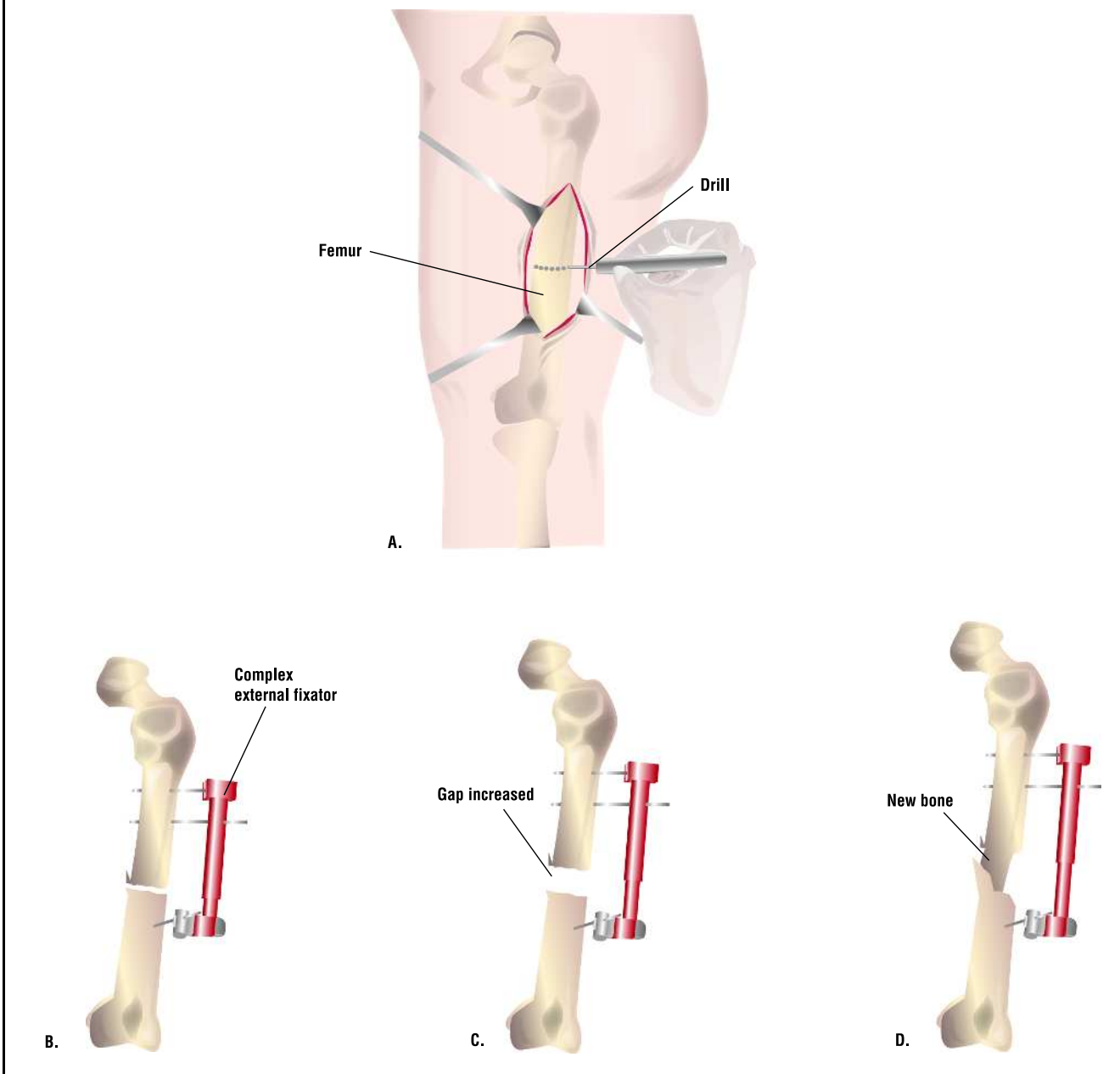
Leg lengthening or shortening involves a variety of surgical procedures used to correct legs of unequal lengths, a condition referred to as limb length discrepancy (LLD). LLD occurs because a leg bone grows more slowly on one leg than on the other leg. Surgical treatment is indicated for discrepancies exceeding 1 in (2.5 cm).

### Purpose

Leg lengthening or shortening surgery, also known as bone lengthening, bone shortening, correction of unequal bone length, femoral lengthening, or femoral shortening, has the goal of correcting LLD and associated deformities while preserving function of muscles and joints. It is performed to:

- Lengthen an abnormally short leg (bone lengthening or femoral lengthening). Leg lengthening is usually recommended for children whose bones are skeletally immature, meaning that they are still growing. The surgery can add up to 6 in (15.2 cm) in length.

## Leg lengthening



To lengthen a leg surgically, an incision is made in the leg to access the femur (A). A surgical drill is used to weaken the femur so the surgeon can break it. During the operation, screws are drilled into the bone on both sides of the break, and an external fixator is applied (B). The gap between the two pieces of bone is increased gradually (C), so new bone growth results in a longer leg (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

The leg lengthening and deformity correction process is based on the principle of distraction osteogenesis, meaning that a bone that has been cut during surgery can be gradually distracted (pulled apart), stimulating

new bone formation (osteogenesis) at the site of the lengthening. The procedure basically involves breaking a bone of the leg and attaching pins through the leg into the bone. The pins pull the bones apart by

## KEY TERMS

**Arthrodesis**—The surgical immobilization of a joint, also called joint fusion.

**Cerebral palsy**—Group of disorders characterized by loss of movement or loss of other nerve functions. These disorders are caused by injuries to the brain that occur during fetal development or near the time of birth.

**Diaphysis**—The shaft of a long bone.

**Epiphysiodesis**—An surgical procedure that partially or totally destroys an epiphysis and may incorporate a bone graft to produce fusion of the epiphysis or premature cessation of its growth; usually performed to equalize leg length.

**Epiphysis**—A part of a long bone where bone growth occurs from.

**Fibula**—The long bone in the lower leg that is next to the tibia. It supports approximately one-sixth of the body weight and produces the outer prominence of the ankle.

**Femur**—The thighbone. The large bone in the thigh that connects with the pelvis above and the knee below.

**Fixator**—A device providing rigid immobilization through external skeletal fixation by means of rods

(attached to pins which are placed in or through the bone).

**Ilizarov method**—A bone fixation technique using an external fixator for lengthening limbs, correcting deformities, and assisting the healing of fractures and infections. The method was designed by the Russian orthopedic surgeon Gavriil Abramovich Ilizarov (1921-1992).

**Medullary cavity**—The marrow cavity in the shaft of a long bone.

**Non-union**—Bone fracture or defect induced by disease, trauma, or surgery that fails to heal within a reasonable time span.

**Osteotomy**—The surgical cutting of a bone.

**Polio myelitis**—Disorder caused by a viral infection (poliovirus) that can affect the whole body, including muscles and nerves.

**Septic arthritis**—A pus-forming bacterial infection of a joint.

**Tibia**—The large bone between the knee and foot that supports five-sixths of the body weight.

about 0.4 in (1 mm) each day and the bone grows new bone to try to mend the gap. It takes about a month to grow an inch (2.5 cm).

- Shorten an abnormally long leg (bone shortening or femoral shortening). Shortening a longer leg is usually indicated for patients who have achieved skeletal maturity, meaning that their bones are no longer growing. This surgery can produce a very precise degree of correction.
- Limit the growth of a normal leg to allow a short leg to grow to a matching length (epiphysiodesis). During childhood and adolescence, the long bones—femur (thighbone) or tibia and fibula (lower leg bones)—each consist of a shaft (diaphysis) and end parts (epiphyses). The epiphyses are separated from the shaft by a layer of cartilage called the epiphyseal or growth plate. As the limbs grow during childhood and adolescence, the epiphyseal plates absorb calcium and develop into bone. By adulthood, the plates have been replaced by bone. Epiphysiodesis is an operation performed on the epiphyseal plate in one of the patient's legs that slows down the growth of a specific bone.

Leg lengthening or shortening surgery is usually recommended for severe unequal leg lengths resulting from:

- poliomyelitis, cerebral palsy, or septic arthritis
- small, weak (atrophied) muscles
- short, tight (spastic) muscles
- hip diseases, such as Legg-Perthes disease
- previous injuries or bone fractures that may have stimulated excessive bone growth
- scoliosis (abnormal spine curvature)
- birth defects of bones, joints, muscles, tendons, or ligaments

Guidelines for treatment are tailored to patient needs and are usually as follows:

- LLD < 0.79 in (2 cm): orthotics (lift in shoe)
- LLD = 0.79-3.2 in (2-6 cm): epiphysiodesis or shortening procedure
- LLD > 3.2 in (6 cm): lengthening procedure
- LLD > 5.9-7.9 in (15-20 cm): lengthening procedure, staged or combined with epiphysiodesis (Amputation if performed if the procedure fails.)

## Demographics

According to the Maryland Center for Limb Lengthening and Reconstruction, the rate of increase



of the leg length difference is progressive in the United States with one-fourth of the LLD present at birth, one-third by age one year, and one-half by age three in girls and age four in boys.

LLD is common in the general population, with 23% of the population having a discrepancy of 0.4 in (1 cm) or more. One person out of 1,000 requires a corrective device such as a shoe lift.

## Description

### *Leg lengthening*

Leg lengthening is performed under **general anesthesia**, so that the patient is deep asleep and can't feel pain. Of the several surgical techniques developed, the Ilizarov method, or variation thereof, is the one most often used. An osteotomy is performed, meaning that the bone to be lengthened is cut, usually the lower leg bone (tibia) or upper leg bone (femur). Metal pins or screws are inserted through the skin and into the bone. Pins are placed above and below the cut in the bone and the skin incision is stitched closed. An external fixator is attached to the pins in the bone. The fixator is used after surgery to gradually pull the cut bone apart, creating a gap between the ends of the cut bone in which new bone growth can occur. The fixator functions much like a bone scaffold and will be used very gradually, so that the bone lengthens in extremely small steps. The original Ilizarov external fixator consists of stainless steel rings connected by threaded rods. Each ring is attached to the underlying bone segment by two or more wires, placed under tension to increase stability, yet maintain axial motion. Titanium pins are also used for supporting the bone segments. Several fixators are available and the choice depends on the desired goal and on specific patient requirements.

Other surgical techniques, such as the Wagner method, or acute lengthening, are used much less commonly. The Wagner technique features more rapid lengthening followed by **bone grafting** and plating. The advantage of the Ilizarov technique is that it does not require an additional procedure for grafting and plating. However, there are reports indicative of higher pain scores associated with the Ilizarov method and conflicting reports concerning the level of complications associated with each technique.

### *Leg shortening*

Leg shortening surgery is also performed under general anesthesia. Generally, femoral shortening is preferred to tibial shortening, as larger resections are possible. Femoral shortening can be performed by open or closed methods at various femur locations. The bone to be shortened is cut, and a section is

removed. The ends of the cut bone are joined together, and a metal plate with screws or an intermedullary rod down the center of the bone is placed across the bone incision to hold it in place during healing.

### *Epiphysiodesis*

Epiphysiodesis is also performed under general anesthesia. The surgeon makes an incision over the epiphyseal plate at the end of the bone in the longer leg. He then proceeds to destroy the epiphyseal plate by scraping or drilling it to restrict further growth.

## Diagnosis/Preparation

LLD is a common problem that is frequently discovered during the growing years. A medical history specific to the problem of limb length discrepancy is taken by the treating physician to provide information as to the cause of discrepancy, previous treatment, and neuromuscular status of the limb. The patient is first evaluated standing on both legs to assess pelvic obliquity, relative height of the knees, presence of angular deformity, foot size, and heel pad thickness. Overall discrepancy is assessed by having the patient stand with the shorter leg on graduated blocks until the pelvis is level. Examination is then performed with the patient prone, hips extended and knees flexed to 90 degrees. In this position, the respective lengths of the femur and tibia segments of the two legs can be compared, and the relative contribution of the difference within each segment to the overall LLD can be roughly assessed.

Imaging studies, such as x rays, are the diagnostic tool of choice to fully evaluate the patient. A leg series of x rays shows the overall picture of the affected leg. The extent of LLD and required alignment can be measured with precision, and bone abnormalities involving specific parts of the leg can also be seen. The x rays are usually repeated at six to 12 month intervals to establish the growth pattern of the limbs. When several determinations of limb length have been compiled, the remaining growth and the ultimate discrepancy between the legs can be calculated, and a treatment plan selected based on predicting future growth and discrepancy, which is in turn dependent on an accurate record of past and present growth. Treatment is rarely started solely on the basis of a single determination of the existing discrepancy in a skeletally immature child. **CT scans** are not performed routinely but may be helpful in confirming the diagnosis or more accurately measure the amount of discrepancy.

For LLD patients with a nonfunctional foot, most physicians recommend **amputation**. In patients

with a functional foot, the surgical procedure recommendations generally fall into one of the following three groups:

- The first group involves patients with a leg discrepancy less than 10%. There is little disagreement that these patients can benefit from lengthening procedures.
- The second group involves patients with a leg discrepancy exceeding 30%. Amputation is usually recommended for these patients.
- The third group involves patients a discrepancy ranging between 10 and 30%. Lengthening more than 4 in (10 cm) in a leg with associated knee, ankle, and foot abnormalities is very complex. At skeletal maturity, an average lower-extremity length is often 31.5–39.4 in (80–110 cm) and a 10% discrepancy represents 3.1–4.3 in (8–11 cm).

In the case of leg lengthening, the patient is also seen and evaluated for the design of the external fixator before surgery.

One week before surgery, patients are usually scheduled for a blood and urine test. They are asked to have nothing at all to eat or drink after midnight on the night before surgery.

### Aftercare

After the operation, nursing staff teach patients how to clean and care for the skin around the pins that attach the external fixator to the limb (pinsite care). Patients are also shown how to recognize and treat early signs of infection and not to neglect pinsite care, which takes about 30 minutes every day until the apparatus is removed. It is very important in preventing infection from developing.

After an epiphysiodesis procedure, hospitalization is required for about a week. Occasionally, a cast is placed on the operated leg for three to four weeks. Healing usually requires from eight to 12 weeks, at which time full activities can be resumed.

In the case of leg shortening surgery, two to three weeks of hospitalization is common. Occasionally, a cast is placed on the leg for three to four weeks. Muscle weakness is common, and muscle-strengthening therapy is started as soon as tolerated after surgery. Crutches are required for six to eight weeks. Some patients may require from six to 12 months to regain normal knee control and function. The intramedullary rod is usually removed after a year.

In the case of leg lengthening surgery, hospitalization may require a week or longer. Intensive physical therapy is required to maintain a normal range of leg motion. Frequent visits to the treating physician are also required to adjust the external fixator and

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Leg lengthening/shortening surgery is performed in a hospital, by a treatment team usually consisting of an experienced orthopedic surgeon and residents specialized in extremity lengthening and deformity correction, physiotherapists, nurses, and other qualified orthopedic staff. Orthopedics is a medical specialty that focuses on the diagnosis, care and treatment of patients with disorders of the bones, joints, muscles, ligaments, tendons, nerves and skin. Orthopedic surgery is a specialty of immense variety, and includes LLD repair.

attentive care of the pins holding the device is essential to prevent infection. Healing time depends on the extent of lengthening. A rule of thumb is that each 0.4 in (1 cm) of lengthening requires some 36 days of healing. A large variety of external fixators are now available for use. Today's fixators are very durable, and are generally capable of holding full weight. Most patients can continue many normal activities during the three to six months the device is worn.

Metal pins, screws, **staples**, rods, or plates are used in leg lengthening/shortening surgery to stabilize bone during healing. Most orthopedic surgeons prefer to plan to remove any large metal implants after several months to a year. Removal of implanted metal devices requires another surgical procedure under general anesthesia.

During the recovery period, physical therapy plays a very important role in keeping the patient's joints flexible and in maintaining muscle strength. Patients are advised to eat a nutritious diet and to take calcium supplements. To speed up the bone healing process, gradual weight-bearing is encouraged. Patients are usually provided with an external system that stimulates bone growth at the site, either an **ultrasound** device or one that creates a painless electromagnetic field.

### Risks

All the risks associated with surgery and the administration of anesthesia exist, including adverse reactions to medications, bleeding and breathing problems.

Specific risks associated with LLD surgery include:

- osteomyelitis (bone infection)
- nerve injury that can cause loss of feeling in the operated leg

## QUESTIONS TO ASK THE DOCTOR

- Is surgery the best solution?
- How long does bone lengthening take?
- What is an external fixator?
- What are the major risks of the procedure?
- What kind of pain is to be expected after surgery and for how long?
- What are the risks associated with the surgery?
- How long will it take to resume normal walking?
- When will I be fitted with the external fixator?

- injury to blood vessels
- poor bone healing (non-union)
- avascular necrosis (AVN) of the femoral head as a result of vascular damage during surgery
- chondrolysis (destruction of cartilage) following insertion of rods and pins
- hardware failure, failure of epiphysiodesis, failure of slip progression
- unequal limb lengths if one leg fails to heal properly (The physician may need to reverse the direction of the external fixator device to strengthen it, causing a slight discrepancy between the two legs.)
- joint stiffness (contractures) may occur during lengthening, especially significant lengthenings
- pin loosening in the anchor sites

Another serious specific risk associated with leg lengthening/shortening surgery is infection of the pins or wires going through the bone and/or resting on the skin that may result in further bone or skin infections (osteomyelitis, cellulitis, staph infections).

### Normal results

Epiphysiodesis usually has good outcomes when performed at the correct time in the growth period, though it may result in an undesirable short stature. Bone shortening may achieve better correction than epiphysiodesis, but requires a much longer convalescence. Bone lengthening is completely successful only 40% of the time and has a much higher rate of complications. Recovery time from leg lengthening surgery varies among patients, with the consolidation phase sometimes lasting a long period, especially in adults. Generally speaking, children heal in half the time as it takes an adult patient. For example, when the desired goal is 1.5 in (3.8 cm) of new bone growth,

a child will wear the fixation device for three months, while an adult will need to wear it for six months.

### Alternatives

A LLD of 0.8 in (2 cm) or less is usually not a functional problem and non-surgical treatment options are preferred. The simplest forms do not involve surgery:

- **Orthotics.** Often leg length can be equalized with a sole or heel lift attached to or inserted inside the shoe. This measure can effectively level a difference of 0.4–2.0 in (1.0–5.0 cm) and correct about two thirds of the LLD. Up to 0.4 in (1 cm) can be inserted in a shoe. Beyond this, the lift gets heavy, awkward, and can cause problems such as ankle sprains and falls. The shoes look unsightly and patients complain of gait instability with such a large lift. A foot-in-foot prosthesis can be used for larger LLDs but they tend to be bulky and used as a temporary measure.
- **Physical therapy.** LLD results in the pelvis tilting sideways since one side of the body is higher than the other side. In turn, this causes a “kink” in the spine known as a scoliosis. Thus, leg length discrepancies can alter the mechanics of the pelvis so that the normal stabilizing and controlling action of specific muscles is altered. A common approach is to use exercises designed to modify the mechanics through specific strengthening of muscles that are weak and stretching of muscles that are restricting movement.

### Resources

#### BOOKS

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#### ORGANIZATIONS

- American Academy of Orthopaedic Surgeons. 6300 North River Road, Rosemont, Illinois 60018 4262. (847) 823 7186. <http://www.aaos.org>
- American College of Foot and Ankle Surgeons. 515 Busse Highway, Park Ridge, Illinois, 60068. (847) 292 2237. (800) 421 2237. <http://www.acfas.org/>.

#### OTHER

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Monique Laberge, Ph.D.

Leg veins x ray see **Phlebography**

## Length of hospital stay

### Definition

The length of time a patient is required to stay overnight in the hospital is determined by their medical condition.

### Description

The length of time a patient needs to stay in the hospital depends upon what type of care they require, how sick they are, and whether they need medications that cannot be administered at home. According to the United States Centers for Disease Control and Prevention (CDC), the average length of hospital stay statistically increases with age.

Conditions that May Require a Length of Hospital Stay

- Very High Fever
- Significantly Altered Vital Signs – Pulse, Blood Pressure, Breathing Rate, Temperature
- Severe Alterations in the Heartbeat
- Major Trauma - Injuries including Burns, Lacerations, and other Trauma
- Organ Failure
- Need for Intravenous (IV) Medications
- Psychotic Episodes
- Being Homicidal or Suicidal
- Recovery from Surgery
- Complications from Surgery
- Severe Allergic Reactions
- Severe Adverse Effects of Medications
- Drug-induced Delirium
- Severe Infections – Bacterial, Fungal, or Viral
- Inability to Breathe
- Inability to Urinate
- Chemical Toxicity from Poison
- Radiation Sickness
- Debilitating Diseases

### Length of Hospital Stay after Surgery

Whether or not a hospital stay is necessary after surgery depends on the type of surgical procedure and whether there are any medical complications. More invasive surgical procedures often require longer hospital stays than minimally invasive procedures. Patients may require a specific time period of hospital-based rest and recovery if their post-surgical medical condition is serious enough to warrant the supervision of a doctor. Post-surgical complications may require a length of hospital stay until they can be resolved, which may or may not include several overnight stays.

The presence of a fever after surgery may necessitate a length of time staying in the hospital. Fever may be a sign of surgically related systemic infection that could become life threatening. If the operative site is very swollen or showing other signs of local





(Bildagentur-online / Alamy)

infection, the patient may need to remain in the hospital. Operative sites that are still bleeding may also be cause to stay in the hospital. Generally speaking, a patient may be required to be able to think clearly, remain upright without fainting, drink fluids and consume light food without vomiting, breathe normally, urinate normally, be able to walk, and be free of severe pain before they are allowed to leave the hospital after a surgical procedure.

After a surgical procedure requiring **general anesthesia**, a patient is required to be awake and able to think clearly before they are discharged from the hospital. While many patients may experience some feelings of mental confusion after having general anesthesia, staying overnight is only necessary if the mental state has deteriorated beyond normal responses to anesthesia, such as seen with postoperative delirium. Delirium is a severe state of mental confusion, disorientation, agitation, and general incoherence. Delirium may also include hallucinations. Postoperative delirium is a temporary state of delirium that may be caused by multiple factors relating to the surgical procedure. A postoperative temporary state of delirium may occur if the patient experiences a lack of oxygen, hypotension, or sepsis as a result of the surgical procedure. With proper treatment, post-operative delirium usually only requires a hospital stay of about 72 hours.

If a patient is unable to keep down fluids or food, the length of hospital stay necessary after surgery is increased. The patient will need fluids through an IV route to remain hydrated until they may hydrate themselves by drinking fluids. Similarly, a patient who cannot keep down food after surgery may require a feeding tube for nourishment. Many patients may experience vomiting merely as an after effect of general anesthesia. In this case, problems with vomiting usually resolve themselves within hours and the length of hospital stay after surgery may be very short.

If there are complications with the patient's ability to breathe after a surgical procedure, a hospital stay will be necessary until the issue is resolved. In this case, a breathing tube and respirator is medically necessary and the length of stay is determined by whatever condition is causing the breathing problem. The ability to urinate after surgery can be affected by certain types of anesthesia used during the procedure. Anesthesia-based urinary retention may require a hospital stay that ranges from hours to several days before it is resolved. Additionally, some types of surgery may cause serious problems with the kidneys that first show up as urinary retention. Patients must be able to urinate before being allowed to go home.

Because patients must be generally well and on the road to recovery after surgical procedures, length of hospital stay is affected by a patient's ability to walk. Surgery is often associated with postoperative pain and some fatigue that greatly limits activity level. An activity level that is too high can also cause internal bleeding at surgical sites, and so bed rest is often encouraged. However, most patients should be able to walk short distances, such as to the bathroom, or they may require a hospital stay.

Severe pain is also associated with increased length of hospital stay after surgery. Often, if the pain is very severe, an IV form of morphine is used in the hospital. Additionally, severe pain after surgery may be an indication that something is wrong, or a surgical complication has occurred. Until severe pain is resolved and there are no apparent surgical complications, patients may be required to stay in the hospital.

### *Length of Hospital Stay after Childbirth*

Childbirth can cause significant physical trauma to a woman's body. Even without medical complications, the act of birthing takes a significant physical toll that usually requires a length of hospital stay. Usually, a normal vaginal birth with no complications results in a hospital stay that ranges from one to four days. When childbirth causes tearing of the skin or muscle around the vagina and surrounding area, it may create the need for a longer hospital stay. The more severe the tearing, the more likely it will need a longer stay for treatment and healing. Very severe tearing involving the rectum or post-tear infections may require the longest hospital length of stay. Childbirth done by caesarean delivery is performed through a surgical incision in the abdominal wall as well as the wall of the uterus. This method of childbirth is associated with the greatest length of hospital stay, usually from four to nine days. Infection of the incision site increases length of stay.

## KEY TERMS

**Caesarean Delivery**—Childbirth performed through a surgical incision in the abdominal wall as well as the wall of the uterus, as opposed to normal vaginal delivery.

**Delirium**—An altered state of consciousness that includes confusion, disorientation, incoherence, agitation, and defective perception (such as hallucinations).

**Laceration**—A ragged wound.

**Malignant Neoplasm**—Any malignant cancerous growth or tumor caused by uncontrolled cell division and capable of spreading to other parts of the body than where it formed.

**Morphine**—A very strong painkiller often used post-surgically.

**Pneumonia**—An inflammatory lung disease that affects the ability of the respiratory system to function.

**Vital Signs**—The physiological aspects of body function basic to life. They are temperature, pulse, breathing rate, and blood pressure.

## Average Length of Hospital Stay

Research done by the CDC determined the average length of short-term hospital stay for various medical conditions in 2005. The categories studied were diverse, ranging from psychiatric disorders to heart disease and injuries. The length of hospital stay in the categories studied was longest for psychiatric disorders, which had an average of eight days. One of the shortest lengths of hospital stay was for childbirth, which averaged 2.6 days. In 2005, the following were some of the medical conditions that averaged between four and six days length of hospital stay: heart disease, bone fractures, diabetes, urinary tract infections, and pneumonia. Malignant neoplasms (cancer) had an average length of short-term hospital stay that ranged between seven and nine days. These specific categories of disease were chosen for the study because in 2005 they were responsible for millions of hospital discharges.

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Ligation for varicose veins see **Vein ligation and stripping**

## Limb salvage

### Definition

Limb salvage surgery is a type of surgery primarily performed to remove bone and soft-tissue cancers occurring in limbs in order to avoid **amputation**.

### Purpose

Limb salvage surgery is performed to remove cancer and avoid amputation, while preserving the patient's appearance and the greatest possible degree of function in the affected limb. The procedure is most commonly performed for bone tumors and bone sarcomas, but is also performed for soft tissue sarcomas affecting the extremities. This complex alternative to amputation is used to cure cancers that are slow to spread from the limb where they originate to other parts of the body, or that have not yet invaded soft tissue.

Twenty years ago, the standard of care for a patient with a cancer in a limb was to amputate the affected extremity. Limb salvage surgery was an exception to the rule. Today, it is the exception that a patient loses a limb as part of cancer treatment. This is due to improvements in surgical technique, both resection and reconstruction, imaging methods (computed tomography [CT scan] and **magnetic resonance imaging** [MRI]), and survival rates of patients treated with chemotherapy.

In recent years, limb salvage has been extended more and more to patients severely affected by chronic

## KEY TERMS

**Resection**—Remove of a part of an organ.

**Sarcoma**—A form of cancer that arises in the supportive tissues such as bone, cartilage, fat, or muscle.

degenerative bone and joint diseases, such as rheumatoid arthritis, those facing diabetic limb amputation, and those with acute and chronic limb wounds.

### Demographics

According to the National Cancer Institute, primary bone cancer is rare, with only 2,500 new cases diagnosed each year in the United States. More commonly, bones are the site of tumors that result from the spread of other primary cancers—that is, from cancers that spread other organs, such as the breasts, lungs, and prostate. Bone cancers occur more frequently in children and young adults.

### Description

Also called limb-sparing surgery, limb salvage involves removing the cancer and about an inch of healthy tissue surrounding it. In addition, if had been removed, the removed bone is replaced. The replacement can be made with synthetic metal rods or plates (prostheses), pieces of bone (grafts) taken from the patient's own body (autologous transplant), or pieces of bone removed from a donor body (cadaver) and frozen until needed for transplant (allograft). In time, transplanted bone grows into the patient's remaining bone. Chemotherapy, radiation, or a combination of both treatments may be used to shrink the tumor before surgery is performed.

Limb salvage is performed in three stages. Surgeons remove the cancer and a margin of healthy tissue, implant a prosthesis or bone graft (when necessary), and close the wound by transferring soft tissue and muscle from other parts of the patient's body to the surgical site. This treatment cures some cancers as successfully as amputation.

### *Surgical techniques*

**BONE TUMORS.** Surgeons remove the malignant lesion and a cuff of normal tissue (wide excision) to cure low-grade tumors of bone or its components. To cure high-grade tumors, they also remove muscle, bone, and other tissues affected by the tumor (radical resection).

**SOFT TISSUE SARCOMAS.** Surgeons use limb-sparing surgery to treat about 80% of soft tissue sarcomas affecting extremities. The surgery removes the tumor, lymph nodes, or tissues to which the cancer has spread, and at least 1 inch (2.5 cm) of healthy tissue on all sides of the tumor.

Radiation and/or chemotherapy may be administered before or after the operation. Radiation may also be administered during the operation by placing a special applicator against the surface from which the tumor has just been removed, and inserting tubes containing radioactive pellets at the site of the tumor. These tubes remain in place during the operation and are removed several days later.

To treat a soft tissue sarcoma that has spread to the patient's lung, the doctor may remove the original tumor, administer radiation or chemotherapy treatments to shrink the lung tumor, and surgically remove the lung tumor.

### Diagnosis/Preparation

Before deciding that limb salvage is appropriate for a particular patient, the treating doctor considers what type of cancer the patient has, the size and location of the tumor, how the illness has progressed, and the patient's age and general health.

After determining that limb salvage is appropriate for a particular patient, the doctor makes sure that the patient understands what the outcome of surgery is likely to be, that the implant may fail, and that additional surgery—even amputation—may be necessary.

Physical and occupational therapists help prepare the patient for surgery by introducing the muscle-strengthening, ambulation (walking), and range of motion (ROM) exercises the patient will begin performing right after the operation.

### Aftercare

During the five to 10 days the patient remains in the hospital following surgery, nurses monitor sensation and blood flow in the affected extremity and watch for signs that the patient may be developing pneumonia, pulmonary embolism, or deep-vein thrombosis.

The doctor prescribes broad-spectrum **antibiotics** for at least the first 48 hours after the operation and often prescribes medication (prophylactic anticoagulants) and antiembolism stockings to prevent blood clots. A drainage tube placed in the wound for the first 24–48 hours prevents blood (hematoma) and fluid (seroma) from accumulating at the surgical site. As postoperative pain becomes less intense, mild narcotics

or anti-inflammatory medications replace the epidural catheter or patient-controlled analgesic pump used to relieve pain immediately after the operation.

### *Exercise intervention*

Limb salvage requires extensive surgical incisions, and patients who have these operations need extensive rehabilitation. The amount of bone removed and the type of reconstruction performed dictate how soon and how much the patient can **exercise**, but most patients begin muscle-strengthening, continuous passive motion (CPM), and ROM exercises the day after the operation and continue them for the next 12 months.

A patient who has had upper-limb surgery can use the opposite side of the body to perform hand and shoulder exercises. Patients should not do active elbow or shoulder exercises for two to eight weeks after having surgery involving the bone between the shoulder and elbow (humerus). Rehabilitation following lower-extremity limb salvage focuses on strengthening the muscles that straighten the legs (quadriceps), maintaining muscle tone, and gradually increasing weight-bearing so that the patient is able to stand on the affected limb within three months of the operation. A patient who has had lower-extremity surgery may have to learn a new way of walking (gait retraining) or wear a lift in one shoe.

### *Goals of rehabilitation*

Physical and occupational therapy regimens are designed to help the patient move freely, function independently, and accept changes in body image. Even patients who look the same after surgery as they did previously may feel that the operation has altered their appearance.

Before a patient goes home from the hospital or rehabilitation center, the doctor decides whether the patient needs a walker, brace, cane, or other device, and should make sure that the patient can climb stairs. Also, the doctor should emphasize the life-long importance of preventing infection and give the patient written instructions about how to prevent and recognize infection, as well as what steps to take if infection does develop.

### **Risks**

The major risks associated with limb salvage are: superficial or deep infection at the site of the surgery; loosening, shifting, or breakage of implants; rapid loss of blood flow or sensation in the affected limb; and severe blood loss and anemia from the surgery.

## **WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?**

Limb salvage surgery is performed in a hospital setting by experienced orthopedic surgeons with demonstrated expertise in limb salvage.

Postoperative infection is a serious problem. Chemotherapy or radiation can weaken the immune system, and extensive bone damage can occur before the infection is identified. Tissue may die (necrosis) if the surgeon used a large piece of tissue (flap) to close the wound. This is most likely to occur if the surgical site was treated with radiation before the operation. Treatment for postoperative infection involves removing the graft or implant, inserting drains at the infected site, and giving the patient oral or intravenous (IV) antibiotic therapy for as long as 12 months. Doctors may have to amputate the affected limb.

### **Normal results**

A patient who has had limb salvage surgery will remain disease-free as long as a patient whose affected extremity has been amputated.

Salvaged limbs always function better than artificial ones. However, it takes a year for patients to learn to walk again following lower-extremity limb salvage, and patients who have undergone upper-extremity salvage must master new ways of using the affected arm or hand.

Successful surgery reduces the frequency and severity of patient falls and fractures that often result from disease-related changes in bone. Although successful surgery results in limbs that look and function very much like normal, healthy limbs, it is not unusual for patients to feel that their appearance has changed.

Some patients may also need additional surgery within five years of the first operation.

### **Morbidity and mortality rates**

Orthopedic oncologists recognize that an operation to remove a tumor that spares the limb is associated with an incidence of tumor recurrence higher than that following an amputation. However, because there is no significant difference in overall survival rates, the increased rate of recurrence in patients who undergo limb salvage surgery is considered acceptable.



## QUESTIONS TO ASK THE DOCTOR

- What are the possible complications involved in limb salvage surgery?
- How do I prepare for surgery?
- What type of anesthesia will be used?
- How is the surgery performed?
- How long will I be in the hospital?
- How much limb salvage surgery do you perform in a year?
- Why do you think limb salvage will be successful in my case?
- How will I look and feel after the operation?
- Will I be able to enjoy my favorite sports and other activities after the operation?

## Alternatives

If the cancer's location makes it impossible to remove the malignancy without damaging or removing vital organs, essential nerves, or key blood vessels, or if it is impossible to reconstruct a limb that will function satisfactorily, salvage surgery may not be an appropriate treatment and amputation of the limb becomes the only alternative treatment.

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## Lipid profile

### Definition

A lipid profile includes data or results from four blood tests: total cholesterol, HDL cholesterol, LDL cholesterol and triglycerides.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

- A lipid profile is typically ordered by a family doctor, internist, or geriatrician.
- A blood sample is usually obtained by a nurse, phlebotomist, or medical technologist.
- The blood sample is tested or processed by a medical technologist.
- Results are usually reviewed, returned to the person being tested and interpreted by the physician initially ordering the lipid profile.

### Purpose

The purpose of a lipid profile is to help evaluate an individual's risk of cardiovascular disease.

### Description

A lipid profile quantifies four different forms of lipids that are found in the blood: total cholesterol, HDL cholesterol, LDL cholesterol and triglycerides. Dietary fats, including cholesterol, are absorbed from the small intestines. They are converted into triglycerides, which are then packaged into lipoproteins. All of these products are transported into the liver by chylomicrons. After a fast (not eating) lasting at least 12 hours, chylomicrons are absent from the bloodstream. This is the reason why persons that are having a lipid profile must fast overnight.

Humans make 75 to 80% of the cholesterol that they need. The remainder comes from their diet. Because it is important, the body stores extra cholesterol. Total cholesterol is just that: a measure of cholesterol in the blood. It is a useful measure but it can be refined, usually into the other three components of a lipid profile.

HDL stands for high density lipoproteins. HDL cholesterol is a fraction of total cholesterol. It is also known as so-called good cholesterol because high levels of HDL cholesterol seem to provide protection against a heart attack. A majority of experts feel that HDL cholesterol returns cholesterol to the liver where it is eliminated from the body. On average, 25 to 33% of all cholesterol in the blood is the HDL variety.

LDL stands for low density lipoproteins. It is also known as the so-called bad cholesterol. It slowly accumulates on the inner walls of arteries. This buildup is

## QUESTIONS TO ASK YOUR DOCTOR

- Why is a lipid profile needed?
- What do the results indicate for my health?
- What treatment options do I have?

known as plaque. Over time, it creates a condition known as atherosclerosis.

Triglycerides are made (synthesized) in the body. Synthesis can be increased by being overweight, living a sedentary lifestyle (minimal to no physical activity), smoking, eating a diet that is high in carbohydrates (more than 60% of total calories) or consuming excess alcohol. People with high triglyceride levels often develop diabetes or heart disease.

Physicians calculate the ratio of HDL to LDL values to assess disease risk related to blood lipid levels.

- Very low risk: 3.3 to 3.4
- Low risk: 3.8 to 4.0
- Average risk: 4.5 to 5.0
- Moderate risk: 7.0 to 9.5
- High risk: above 11

Pharmaceutical interventions are based on the HDL to LDL ratio.

### Recommended dosage

Lipid profiles can be ordered at any time. Routine lipid profiles that are used to monitor the effectiveness of drugs intended to reduce serum cholesterol are usually performed every three months.

### Precautions

A fast (not eating) for a minimum of 12 hours before drawing blood contributes to a more accurate measurement of lipid in the blood. No other precautions are needed.

At the time of drawing blood, the only precaution needed is to clean the venipuncture site with alcohol.

### Side effects

The most common side effects of a lipid profile are minor bleeding (hematoma) or bruising at the site of venipuncture.

## KEY TERMS

**Hematoma**—A collection of blood that has entered a closed space.

**Phlebotomist**—Health care professional trained to obtain samples of blood.

## Interactions

There are no interactions for a lipid profile.

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## Lipid tests

### Definition

Lipid tests are routinely performed on plasma, which is the liquid part of blood without the blood cells. Lipids themselves are a group of organic compounds that are greasy and cannot be dissolved in water, although they can be dissolved in alcohol. Lipid tests include measurements of total cholesterol, triglycerides, high-density lipoprotein (HDL) cholesterol, and low-density lipoprotein (LDL) cholesterol. Lipid tests may also be performed on amniotic fluid, which is the fluid that surrounds the fetus during pregnancy. Prenatal lipid tests include tests for lecithin and other pulmonary (lung) surfactants that cover the air spaces in the lungs with a thin film.

### Purpose

#### Blood tests

The purpose of blood lipid testing is to determine whether abnormally high or low concentrations of a specific lipid are present. Low levels of cholesterol are associated with liver failure and inherited disorders of cholesterol production. Cholesterol is a primary component of the plaques that form in atherosclerosis and is therefore the major risk factor for the rapid progression of coronary artery disease (CAD). High blood cholesterol may be inherited or result from such other conditions as biliary obstruction, diabetes mellitus, hypothyroidism, and nephrotic syndrome. In addition, cholesterol levels may be increased in persons who eat foods that are rich in saturated fats and cholesterol, and who lead a sedentary lifestyle.

## KEY TERMS

**Amniocentesis**—A procedure for removing amniotic fluid from the womb using a fine needle.

**Atherosclerosis**—A disease of the coronary arteries in which cholesterol is deposited in plaques on the arterial walls. The plaque narrows or blocks blood flow to the heart. Atherosclerosis is sometimes called coronary artery disease, or CAD.

**High-density lipoprotein (HDL)**—A type of lipoprotein that protects against CAD by removing cholesterol deposits from arteries or preventing their formation.

**Hypercholesterolemia**—The presence of excessively high levels of cholesterol in the blood.

**Hypertriglyceridemia**—The presence of excessively high levels of TAG in the blood.

**Lecithin**—A phospholipid found in high concentrations in surfactant.

**Lipid**—Any organic compound that is greasy, insoluble in water, but soluble in alcohol. Fats, waxes, and oils are examples of lipids.

**Lipoprotein**—A complex molecule that consists of a protein membrane surrounding a core of lipids. Lipoproteins carry cholesterol and other lipids from the

digestive tract to the liver and other body tissues. There are five major types of lipoproteins.

**Low-density lipoprotein (LDL)**—A type of lipoprotein that consists of about 50% cholesterol and is associated with an increased risk of CAD.

**Plaque**—An abnormal deposit on the wall of an artery. Plaque is made of cholesterol, triglyceride, dead cells, lipoproteins and calcium.

**Sedentary**—Characterized by inactivity and lack of exercise. A sedentary lifestyle is a risk factor for high blood cholesterol levels.

**Surfactant**—A compound made of fats and proteins that is found in a thin film along the walls of the air sacs of the lungs. Surfactant keeps the surface pressure low so that the sacs can inflate easily and not collapse.

**Tocolytic drug**—A compound given to women to stop the progression of labor.

**Triglyceride (TAG)**—A chemical compound that forms about 95% of the fats and oils stored in animal and vegetable cells. TAG levels are sometimes measured as well as cholesterol levels when a patient is screened for heart disease.

Low levels of triglyceride are seen in persons with malnutrition or malabsorption. Increased levels are associated with diabetes mellitus, hypothyroidism, pancreatitis, glycogen storage diseases, and estrogens. Diets rich in either carbohydrates or fats may cause elevated triglyceride levels in some persons. Although triglycerides are not a component of the plaque associated with atherosclerosis, they increase the viscosity (thickness) of the blood and promote obesity, which can contribute to coronary disease. The majority of cholesterol and triglyceride testing is performed to screen persons at increased risk of coronary artery disease.

### *Amniotic fluid tests*

Lipid tests are performed on amniotic fluid to determine the maturity of the fetal lungs. These tests are performed prior to delivery to ensure that there is sufficient pulmonary surfactant to prevent collapse of the lungs when the baby exhales (breathes out).

### Description

Cholesterol screening can be performed with or without fasting, but it should include tests of total and

HDL cholesterol levels. The frequency of cholesterol testing depends on the patient's risk of developing CAD. Adults over 20 with total cholesterol levels below 200 mg/dL should be tested once every five years. People with higher levels should be tested for LDL cholesterol levels, and tested at least once per year thereafter if their LDL cholesterol is 130 mg/dL or higher. The National Cholesterol Education Program (NCEP) suggests further evaluation when the patient has any of the symptoms of CAD, or if she or he has two or more of the following risk factors for CAD:

- high blood pressure
- history of cigarette smoking
- diabetes
- low HDL levels
- family history of CAD
- age over 45 years (men) or 55 years (women)

Measurements of cholesterol and triglyceride levels are routinely performed in all patients.



### *Measurement of pulmonary surfactants*

Lecithin is the principal pulmonary surfactant secreted by the alveolar cells of the lung. Lecithin and the other surfactants prevent collapse of the air sacs when the baby exhales. During the first half of gestation, the levels of lecithin and another lipid known as sphingomyelin in the amniotic fluid are approximately equal. During the second half of pregnancy, however, lecithin production increases while the sphingomyelin level remains constant. Infants born prematurely may suffer from respiratory distress syndrome (RDS) because the levels of pulmonary surfactant in their lungs are insufficient to prevent collapse of the air sacs. Tests for RDS are called fetal lung maturity (FLM) tests. The reference method for determining fetal lung maturity is the ratio between lecithin and sphingomyelin in the amniotic fluid, or the L/S ratio.

### Precautions

Tests for triglycerides and LDL cholesterol must be performed following a 12-hour fast. Acute illness, high fever, starvation, or recent surgery lowers the blood cholesterol and triglyceride levels. If possible, patients should also stop taking any medications that may affect the accuracy of the test.

Amniotic fluid is collected by a process called **amniocentesis**. This procedure is usually performed after the 30th week of gestation to evaluate the maturity of the baby's lungs. A miscarriage (spontaneous abortion) may occur as a consequence of this procedure, although its overall incidence following amniocentesis is less than 1%. Possible complications of amniocentesis include premature labor and placental bleeding. The fluid that is withdrawn may be contaminated with blood or meconium (a dark-green material in the intestines of a fetus), which may interfere with some fetal lung maturity tests.

### Preparation

Patients who are scheduled for a **lipid profile** test should fast (except for water) for 12–14 hours before the blood sample is drawn. If the patient's LDL cholesterol is to be measured, he or she should also avoid alcohol for 24 hours before the test. When possible, patients should also stop taking any medications that may affect the accuracy of the test results. These drugs include **corticosteroids**; estrogen or androgens; oral contraceptives; some **diuretics**; antipsychotic medications, including haloperidol; some **antibiotics**; and niacin. Antilipemics are drugs that lower the concentration of fatty substances in the blood. When these

medications are taken by the patient, blood testing may be done frequently to evaluate liver function as well as lipid levels.

### Aftercare

Aftercare following blood lipid tests includes routine care of the skin around the needle puncture. Most patients have no aftereffects, but some may have a small bruise or swelling. A washcloth soaked in warm water usually relieves any discomfort. In addition, the patient can resume taking any prescription medications that were discontinued before the test.

Care after amniocentesis requires that the clinician monitor the patient for any signs of infection or possible injury to the fetus. Some things to look for are fever, vaginal bleeding, or vaginal discharge. The patient may feel sick and there may be some cramping. She should be advised to rest and avoid strenuous activity. If the mother appears to be going into labor, she should be given supportive care. She may be given medications known as tocolytic agents to prevent the premature birth of the baby.

### Risks

The primary risk to the patient from blood tests of lipid levels is a mild stinging or burning sensation during the venipuncture, with minor swelling or bruising afterward.

Although amniocentesis is much safer in the third trimester, and is less risky when it is performed with the guidance of **ultrasound** technology, does present a risk of miscarriage and fetal injury. The mother should be monitored for any signs of bleeding, infection, or impending labor.

### Normal results

The normal values for serum lipids depend on the patient's age, sex, and race. Normal values for people in Western countries are usually given as 140–220 mg/dL for total cholesterol in adults, although as many as 5% of the population have a total cholesterol higher than 300 mg/dL. Among Asians, the figures are about 20% lower. As a rule, both total and LDL cholesterol levels rise as people get older. Normal values for HDL cholesterol are also age- and sex-dependent. The range for males 20–29 years is approximately 30–63 mg/dL; for females of the same age group it is 33–83 mg/dL. Normal values for fasting triglycerides are also age- and sex-dependent. The reference range for adult males 20–29 years is 45–200 mg/dL; for females of the same age group it is 37–144 mg/dL. As with cholesterol, the normal range rises with age.

Since a person's diet and lifestyle affect normal values, which are determined by the interval between the 5th and 95th percentile of the group, it is more helpful to evaluate cholesterol and triglycerides from the perspective of desirable plasma levels. The desirable values defined by the Nation Cholesterol Education Program (NCEP) in 2001 are as follows:

- Total cholesterol: Less than 200 mg/dL; 200–239 mg/dL is considered borderline high; and greater than 240 mg/dL is high.
- HDL cholesterol: Less than 40mg/dL is low.
- LDL cholesterol: Less than 100 mg/dL is optimal; near-optimal is 100–129 mg/dL; borderline high is 130–159 mg/dL; high is 160–189 mg/dL; and very high is any value over 190 mg/dL.
- Total cholesterol: HDL ratio: Under 4.0 in males; 3.8 in females.

### *Fetal lung maturity tests*

Low levels of surfactant in amniotic fluid are denoted by an L/S ratio lower than 2.0 or a lecithin level lower than or equal to 0.10 mg/dL. Lung development can be delayed in premature births and in babies whose mothers have diabetes.

### *Patient education*

Nurses should explain the results of abnormal blood lipid tests to patients and advise them on lifestyle changes. Patient education is important in fetal lung maturity testing. The situation faced by the expectant parents may be very critical; the more information they are given, the better choices they can make.

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- National Cholesterol Education Program: National Heart, Lung, and Blood Institute (NHLBI), National Institutes of Health. PO Box 30105, Bethesda, MD, 20824 0105. (301) 251 1222. <http://www.nhlbi.nih.gov/about/ncep/>.

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## Liposuction

### Definition

Liposuction, also known as lipoplasty or suction-assisted lipectomy, is **cosmetic surgery** performed to remove unwanted deposits of fat from under the skin. The surgeon sculpts and re-contours a person's body by removing excess fat deposits that have been resistant to reduction by diet or **exercise**. Removal of fat cells is permanent.

### Purpose

Liposuction is intended to reduce and smooth the contours of the body and improve a person's appearance. Its goal is cosmetic improvement. Liposuction does not remove large quantities of fat and is not intended as a weight-reduction technique. The average amount of fat removed is about 1 quart (1 liter). Although liposuction is not intended to remove cellulite (lumpy fat), some doctors believe that it improves the appearance of areas that contain cellulite, including thighs, hips, buttocks, abdomen, and chin. A technique called liposhaving shows more promise at reducing cellulite. Liposhaving can be done under **local anesthesia** and is reported to be less traumatic to the skin than liposuction. Liposuction is most often performed by board-certified plastic surgeons.

### Demographics

Liposuction is the most commonly performed cosmetic procedure for men in the United States and the second most common cosmetic procedure (after breast augmentation) for women. In 2006, about 403,680

## KEY TERMS

**Cellulite**—Dimpled skin that is caused by uneven fat deposits beneath the surface.

**Epinephrine**—Epinephrine, also called adrenalin, occurs naturally in the body and causes blood vessels to constrict or narrow. As a drug, it is used to reduce bleeding.

**Hemoglobin**—The component of blood that carries oxygen to the tissues.

**Liposhaving**—Involves removing fat that lies closer to the surface of the skin by using a needle-like instrument that contains a sharp-edged shaving device.

liposuction procedures were performed in the United States. This is more than double the amount performed ten years earlier.

### Description

Most liposuction procedures are performed under local anesthesia. Local anesthesia produces loss of sensation without loss of consciousness. The tumescent, or wet, technique is used most often. In this technique, a large volume of very dilute anesthetic is injected under the person's skin, making the tissue swollen (tumescent) and firm. Epinephrine is added to the solution to reduce bleeding, which allows the removal of larger amounts of fat.

The physician first numbs the skin with an injection of local anesthetic. After the skin is desensitized, the doctor makes a series of tiny incisions no larger than 0.12–0.25 in (3–6 mm) in length. Flooding the area with more dilute anesthetic, fat is then extracted with suction through a long, blunt hollow tube called a cannula. The doctor repeatedly pushes the cannula through the fat layers in a radiating pattern creating tunnels, thus removing fat and re-contouring the area.

Some newer modifications to the procedure include the use of a cutting cannula called a liposhaver. Formerly some surgeons used **ultrasound** to help break up the fat deposits, but this technique has largely been abandoned because it created greater safety risks than the tumescent technique. Larger incisions may be closed with a suture or staple, while micro incisions are covered with **bandages** but do not need sutures. Incisions usually heal completely within two weeks and should leave few or no scars

The length of time required to perform the procedure varies with the amount of fat that is to be removed and the number of areas to be treated. Most operations take from 30 minutes up to two hours, but extensive procedures can take longer. Risk of complications increases the more extensive the procedure. The length of time required also varies with the manner in which the anesthetic is injected.

The cost of liposuction varies depending upon the fees commonly charged in the region of the country where it is performed, the extent of the area being treated, and the person performing the procedure. In the mid-2000s, an increasing trend was for Americans to go overseas to have cosmetic procedures performed in countries where they cost substantially less than in the United States. These procedures are cosmetic and are not covered by most insurance policies.

### Diagnosis/Preparation

Liposuction is most successful when performed on persons who have firm, elastic skin and concentrated pockets of fat in areas that are characterized by cellulite. To get good results after fat removal, the skin must contract to conform to the new contours without sagging. Older persons have less elastic skin and, consequently, may not be good candidates for this procedure. People with generalized fat distribution, rather than localized pockets, are not good candidates. Candidates should be in good general health and free of heart or lung disease. People who have poor circulation or who have had recent surgery at the intended site of fat reduction are not good candidates.

The doctor will conduct a **physical examination** and may order blood work to determine clotting time and hemoglobin level for transfusions, in case the need should arise. The person may be placed on **antibiotics** before surgery to ward off potential infection.

### Aftercare

Liposuction is normally an outpatient procedure. Patients should plan to have someone available to drive them home and stay with them for the next 12–24 hours. If the tumescent technique is used, the patient will feel little or no pain for 24 hours following the procedure but after that may have soreness and swelling for several weeks. After some liposuction surgery, the patient may need to wear a support garment continuously for 2–3 weeks. If ankles or calves were treated, support hose should be worn for up to 6 weeks. The support garments can be removed during bathing. A drainage tube placed under the skin in the

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Many liposuction surgeries are performed by plastic surgeons or by dermatologists. Any licensed physician may legally perform liposuction. Liposuction may be performed in a private professional office, an outpatient center, or in a hospital.

area of the procedure may be needed to prevent fluid build-up.

The incisions involved in this procedure are tiny, but the surgeon may close them with metal sutures or **staples**. These will be removed a few days surgery. Some micro-incisions are small enough that the doctor may not need to close them with sutures. Minor bleeding or seepage through the incision site(s) is common after this procedure. Wearing the elastic bandage or support garment helps reduce fluid loss.

The patient usually can return to normal activity within a week. Any postoperative bruising is expected to go away within 10–14 days. Postoperative swelling begins to go down after a week. It may take 3–6 months for the final contour to be reached depending on the extent of the surgery.

### Risks

Liposuction under local anesthesia using the tumescent technique is exceptionally safe so long as the patient is in good health. The main hazards associated with this surgery involve migration of a blood clot or fat globule to the heart, brain, or lungs. Such an event can cause a heart attack or stroke. Ultrasound assisted liposuction has largely been abandoned because of safety concerns such as burns and complications such as scarring.

Staying in bed increases the risk of clot formation, but too much activity can result in increased swelling of the surgical area. Such swelling is a result of excess fluid and blood accumulation, and generally comes from not wearing the compression garments. If necessary, this excess fluid can be drained with a needle in the doctor's office.

Infection is another complication, but this rarely occurs. If the physician is skilled and works in a sterile environment, infection should not be much of a concern.

The greatest risk of complications arises when too much fat is removed or too many parts of the body are

## QUESTIONS TO ASK THE DOCTOR

Candidates for liposuction surgery should consider asking the following questions:

- What will be the resulting appearance?
- Is the surgeon board certified in plastic and reconstructive surgery?
- How many liposuction procedures has the surgeon performed?
- What is the surgeon's complication rate?
- How much will the procedure cost and is any of it covered by insurance?

worked on at one time. If too much fat is removed, the skin may peel in that area. Smokers are at increased risk for shedding skin because their circulation is impaired. Removing too much fat may also cause the patient to go into shock.

### Normal results

The loss of fat cells is permanent, and the patient should have smoother, more pleasing body contours without excessive bulges. Nevertheless, if the patient overeats, the remaining fat cells will grow in size. Although the patient may gain weight, the body should retain the new proportions and the suctioned area should remain proportionally smaller.

Tiny scars at the site of incision are normal. The doctor usually makes the incisions in places where the scars are not likely to show.

In some instances, the skin may appear rippled, wavy, or baggy after surgery. Pigmentation spots may develop. The re-contoured area may be uneven. This unevenness can be corrected with a second procedure that is less extensive than the first.

### Morbidity and mortality rates

The morbidity rate from liposuction is less than 1%. Mortality is exceedingly rare.

### Alternatives

Some of the alternatives to liposuction include modifying diet to lose excess body fat, exercise, accepting one's body and appearance as it is, or using clothing or makeup to downplay or emphasize body or facial features.



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- American College of Surgeons. 633 North Saint Claire Street, Chicago, IL 60611. (312) 202 5000. <http://www.facs.org>.
- American Society for Aesthetic Plastic Surgery. 11081 Winners Circle, Los Alamitos, CA 90720.(888) 272 7711. <http://www.surgery.org>.
- American Society for Dermatologic Surgery. 5550 Meadowbrook Drive, Suite 120, Rolling Meadows, IL 60006 (847) 956 0900. <http://www.asds.net.org>.
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## Lithotripsy

### Definition

Lithotripsy is the use of high-energy shock waves to fragment and disintegrate kidney stones. The shock wave, created by using a high-voltage spark or an electromagnetic impulse outside of the body, is focused on the stone. The shock wave shatters the stone, allowing the fragments to pass through the urinary system. Since the shock wave is generated outside the body, the procedure is termed extracorporeal shock wave lithotripsy (ESWL). The name is derived from the roots of two Greek words, *litho*, meaning stone, and *trip*, meaning to break.



**A woman undergoing lithotripsy.** (Phanie / Photo Researchers, Inc.)

### Purpose

ESWL is used when a kidney stone is too large to pass on its own, or when a stone becomes stuck in a ureter (a tube that carries urine from the kidney to the bladder) and will not pass. Kidney stones are extremely painful and can cause serious medical complications if not removed.

### Demographics

For an unknown reason, the number of persons in the United States developing kidney stones has been increasing over the past 20 years. White people are more prone to develop kidney stones than are persons of color. Although stones occur more frequently in men, the number of women who develop them has been increasing over the past 10 years, causing the ratio to change. Kidney stones strike most people between the ages of 20 and 40. Once persons develop more than one stone, they are more likely to develop others. Lithotripsy is not required for treatment in all cases of kidney stones.

### Description

Lithotripsy uses the technique of focused shock waves to fragment a stone in the kidney or the ureter. The affected person is placed in contact with a water-filled cushion (older machines require that the individual is actually seated in a tub of water). A sophisticated machine called Lithotripter produces the focused shock waves. A high-voltage electrical discharge is passed through a spark gap under water. The shock waves thus produced are focused on the stone inside the person's body. The shock waves are created and focused on the stone with the help of a machine called a C-Arm Image Intensifier. The wave shatters and

## KEY TERMS

**Aneurysm**—A dilation of the wall of an artery that causes a weak area prone to rupture.

**Bladder**—Organ in which urine is stored prior to urination.

**Bleeding disorder**—A problem related to the clotting mechanism of the blood.

**Cardiologist**—A physician who specializes in problems of the heart.

**EKG**—A graphical tracing of the electrical activity of the heart.

**Extracorporeal shock wave lithotripsy (ESWL)**—The use of focused shock waves, generated outside the body, to fragment kidney stones.

**Gravel**—The debris that is formed from a fragmented kidney stone.

**Intravenous pyelogram (IVP)**—A type of x ray. After obtaining an x ray of the lower abdomen, a radio-opaque dye is injected into the veins. X rays are then obtained every 15 minutes for the next hour. The dye pinpoints the location of kidney stones. It is also used to determine the anatomy of the urinary system.

**Kidney stone**—A hard mass that forms in the urinary tract that can cause pain, bleeding, obstruction, and/or infection. Stones are primarily composed of calcium.

**Stent**—A plastic tube placed in the ureter prior to the ESWL procedure, which facilitates the passage of gravel and urine.

**Ultrasound**—A diagnostic imaging modality that uses sound waves to determine internal structures of the body.

**Ureter**—A tube that carries urine from the kidney to the bladder.

**Urethra**—A tube that carries urine from the bladder to the outside of the body.

**Urologist**—A physician who specializes in problems of the urinary system.

fragments the stone. The resulting debris, called gravel, can then pass through the remainder of the ureter, through the bladder, and through the urethra during urination. There is minimal chance of damage to skin or internal organs because biologic tissues are resilient, not brittle, and because the shock waves are not focused on them.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Lithotripsy is performed by a technician or other individual with specialized training under the supervision of a physician. The physician in charge usually has specialized training in urology. Lithotripsy is most often performed as an outpatient procedure in a facility affiliated with a hospital.

The shock wave is characterized by a very rapid pressure increase in the transmission medium and is quite different from **ultrasound**. The shock waves are transmitted through a person's skin and pass harmlessly through soft tissues. The shock wave passes through the kidney and strikes the stone. At the edge of the stone, energy is transferred into the stone, causing small cracks to form on the edge of the stone. The same effect occurs when the shock wave exits the stone. With successive shock waves, the cracks open up. As more cracks form, the size of the stone is reduced. Eventually, the stone is reduced to small particles, which are then flushed out of the kidneys or ureter naturally during urination.

## Diagnosis/Preparation

ESWL should not be considered for persons with severe skeletal deformities, people weighing more than 300 lb (136 kg), individuals with abdominal aortic aneurysms, or persons with uncontrollable bleeding disorders. Women who are pregnant should not be treated with ESWL. Individuals with cardiac **pace-makers** should be evaluated by a cardiologist familiar with ESWL. The cardiologist should be present during the ESWL procedure in the event the pacemaker needs to be overridden.

Prior to the lithotripsy procedure, a complete **physical examination** is performed, followed by tests to determine the number, location, and size of the stone or stones. A test called an intravenous pyelogram (IVP) is used to locate the stones, which involves injecting a dye into a vein in the arm. This dye, which shows up on x ray, travels through the bloodstream and is excreted by the kidneys. The dye then flows down the ureters and into the bladder. The dye surrounds the stones. In this manner, x rays are used to evaluate the stones and the anatomy of the urinary system. Blood tests are performed to determine if any potential bleeding problems exist. For women of childbearing age, a pregnancy

## QUESTIONS TO ASK THE DOCTOR

Individuals contemplating a lithotripsy procedure should consider asking the following questions:

- Is the doctor board certified in urology?
- How many lithotripsy procedures has the doctor performed?
- What is the doctor's complication rate?

test is done to make sure they are not pregnant. Older persons have an EKG test to make sure that no potential heart problems exist. Some individuals may have a stent placed prior to the lithotripsy procedure. A stent is a plastic tube placed in the ureter that allows the passage of gravel and urine after the ESWL procedure is completed.

The process of lithotripsy generally takes about one hour. During that time, up to 8,000 individual shock waves are administered. Depending on a person's pain tolerance, there may be some discomfort during the treatment. **Analgesics** may be administered to relieve this pain.

### Aftercare

Most persons pass blood in their urine after the ESWL procedure. This is normal and should clear after several days to a week. Lots of fluids should be taken to encourage the flushing of any gravel remaining in the urinary system. Treated persons should follow up with a urologist in about two weeks to make sure that everything is progressing as planned. If a stent has been inserted, it is normally removed at this time.

### Risks

Abdominal pain is fairly common after ESWL, but it is usually not a cause for worry. However, persistent or severe abdominal pain may imply an unexpected internal injury. Occasionally, stones may not be completely fragmented during the first ESWL treatment and further lithotripsy procedures may be required.

Some people are allergic to the dye material used during an IVP, so it cannot be used. For these people, focused sound waves, called ultrasound, can be used to identify where the stones are located.

### Normal results

In most cases, stones are reduced to gravel and passed within a few days. Individuals may return to work whenever they feel able.

### Morbidity and mortality rates

Colicky renal pain is very common when gravel is being passed. Other problems may include perirenal hematomas (blood clots near the kidneys) in 66% of the cases; nerve palsies; pancreatitis (inflammation of the pancreas); and obstruction by stone fragments. **Death** is extremely rare and usually due to an undiagnosed associated or underlying condition that is aggravated by the lithotripsy procedure.

### Alternatives

Before the advent of lithotripsy, surgery was used to remove kidney stones. This approach is uncommon today, but occasionally used when other conditions prevent the use of lithotripsy. Attempts are occasionally made to change the pH of urine so as to dissolve kidney stones. This treatment has limited success.

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#### ORGANIZATIONS

- American Foundation for Urologic Disease. 1128 North Charles Street, Baltimore, MD 21201. (800) 242-2383 or (410) 468-1800. E mail: admin@afud.org. www.afud.org.
- American Lithotripsy Society. 305 Second Avenue, Suite 200, Waltham, MA 02451.
- American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464-5000. http://www.ama-assn.org.

American Urological Association. 1120 North Charles Street, Baltimore, MD 21201 5559. (410) 727 1100. [http://www.auanet.org/index\\_hi.cfm](http://www.auanet.org/index_hi.cfm).

National Kidney Foundation. 30 East 33rd Street, New York, NY 10016. (800) 622 9010, (781) 895 9098. Fax: (781) 895 9088. E mail: [als@lithotripsy.org](mailto:als@lithotripsy.org). <http://www.kidney.org>.

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## Liver biopsy

### Definition

A liver biopsy is a medical procedure performed to obtain a small piece of liver tissue for diagnostic testing. The sample is examined under a microscope by a pathologist, a doctor who specializes in the effects of disease on body tissues; in this case, to detect abnormalities of the liver. Liver biopsies are sometimes called percutaneous liver biopsies, because the tissue sample is obtained by going through the patient's skin. This is a useful diagnostic procedure with very low risk and little discomfort to the patient.

### Purpose

A liver biopsy is usually done to evaluate the extent of damage that has occurred to the liver because of chronic and acute disease processes or toxic injury. Biopsies are often performed to identify abnormalities in liver tissues after other techniques have failed to yield clear results. In patients with chronic hepatitis C, liver biopsy may be used to assess the patient's prognosis and the likelihood of responding to antiviral treatment.

A liver biopsy may be ordered to diagnose or stage any of the following conditions or disorders:

- jaundice
- cirrhosis

- repeated abnormal results from liver function tests
- alcoholic liver disease
- unexplained swelling or enlargement of the liver (hepatomegaly)
- suspected drug-related liver damage such as acetaminophen poisoning
- hemochromatosis, a condition of excess iron in the liver
- intrahepatic cholestasis, the build up of bile in the liver
- hepatitis
- primary cancers of the liver such as hepatomas, cholangiocarcinomas, and angiosarcomas
- metastatic cancers of the liver (more than 20 times as common in the United States as primary cancers)
- post-liver transplant to measure graft rejection
- fever of unknown origin
- suspected tuberculosis, sarcoidosis, or amyloidosis
- genetic disorders such as Wilson's disease (a disorder in which copper accumulates in the liver, brain, kidneys, and corneas)

### Demographics

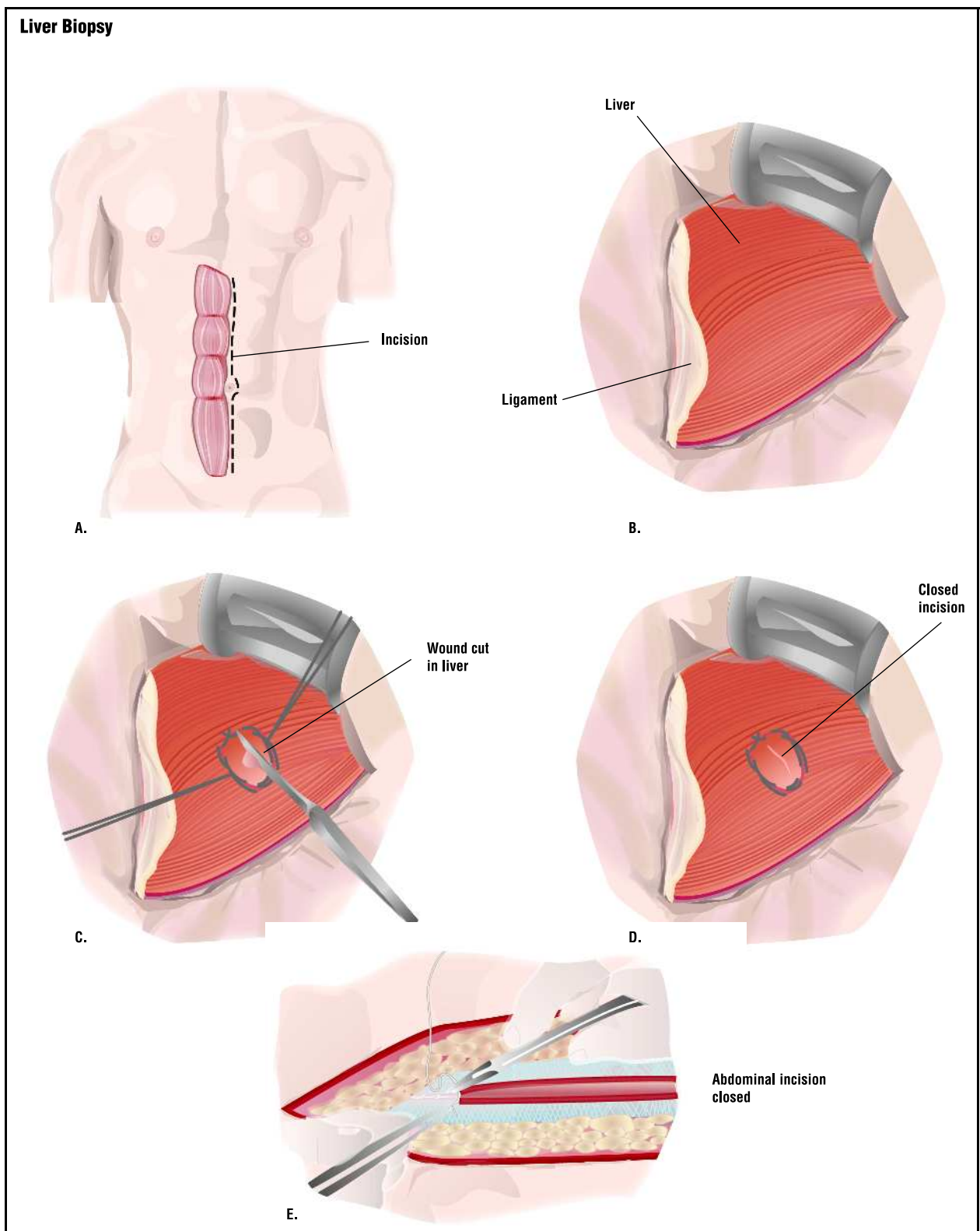
According to the American Liver Foundation, liver disease affects approximately 25 million (one in 10) Americans annually. Cirrhosis accounts for over 27,000 deaths each year. Liver disease is the third most common cause of **death** among individuals between the ages of 25 and 59, and the seventh most common cause of all disease-related deaths.

### Description

Percutaneous liver biopsy is sometimes called aspiration biopsy or fine-needle aspiration (FNA) because it is done with a hollow needle attached to a suction syringe. The special needles used to perform a liver biopsy are called Menghini or Jamshedi needles. The amount of specimen collected should be about 0.03–0.7 fl oz (1–2 cc). In many cases, the biopsy is done by a radiologist, doctor who specializes in x rays and imaging studies. The radiologist will use computed tomography (CT) scan or **ultrasound** to guide the needle to the target site for the biopsy. Some ultrasound-guided biopsies are performed using a biopsy gun that has a spring mechanism that contains a cutting sheath. This type of procedure gives a greater yield of tissue.

An hour or so before the biopsy, the patient will be given a sedative to aid in relaxation. The patient is then asked to lie on the back with the right elbow to





In a traditional liver biopsy, access to the liver is gained through an incision in the abdomen (A). A wedge-shaped section is cut into the liver and removed (C). The liver incision is (D). The abdominal incision is then repaired (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Aspiration**—The technique of removing a tissue sample for biopsy through a hollow needle attached to a suction syringe.

**Bile**—Liquid produced by the liver that is excreted into the intestine to aid in the digestion of fats.

**Biliary**—Relating to bile.

**Biopsy**—The surgical removal and microscopic examination of living tissue for diagnostic purposes.

**Cholestasis**—A blockage in the flow of bile.

**Cirrhosis**—A progressive disease of the liver characterized by the death of liver cells and their replacement with fibrous tissue.

**Formalin**—A clear solution of diluted formaldehyde that is used to preserve liver biopsy specimens until they can be examined in the laboratory.

**Hepatitis**—Inflammation of the liver, caused by infection or toxic injury.

**Jaundice**—Also termed icterus; an increase in blood bile pigments that are deposited in the skin, eyes, deeper tissue, and excretions. The skin and whites of the eye will appear yellow.

**Menghini needle/Jamshedi needle**—Special needles used to obtain a sample of liver tissue by aspiration.

**Metastatic cancer**—A cancer that has been transmitted through the body from a primary cancer site.

**Percutaneous biopsy**—A biopsy in which the needle is inserted and the sample removed through the skin.

**Prothrombin test**—A common test to measure the amount of time it takes for a patient's blood to clot; measurements are in seconds.

**Vital signs**—A person's essential body functions, usually defined as the pulse, body temperature, and breathing rate.

the side and the right hand under the head. The patient is instructed to lie as still as possible during the procedure. He or she is warned to expect a sensation resembling a pinch in the right shoulder when the needle passes a certain nerve (the phrenic nerve), but to remain motionless in spite of the momentary pain.

The doctor will then mark a spot on the skin of the abdomen where the needle will be inserted. The right side of the upper abdomen is thoroughly cleansed with an antiseptic solution, generally iodine. The patient is then given a local anesthetic at the biopsy site.

The doctor prepares the needle by drawing sterile saline solution into a syringe. The syringe is then attached to the biopsy needle, which is inserted into the patient's chest wall. The doctor then draws the plunger of the syringe back to create a vacuum. At this point, the patient is asked to take a deep breath and hold it. The needle is inserted into the liver and withdrawn quickly, usually within two seconds or less. The negative pressure in the syringe draws or pulls a sample of liver tissue into the biopsy needle. As soon as the needle is withdrawn, the patient can breathe normally. This step takes only a few seconds. Pressure is applied at the biopsy site to stop any bleeding and a bandage is placed over it. The liver tissue sample is placed in a cup with a 10% formalin solution and sent to the laboratory immediately. The entire procedure takes 10–15 minutes. Test results are usually available within a day.

Most patients experience minor discomfort during the procedure (up to 50% of patients), but not severe pain. According to a medical study of adult patients undergoing percutaneous liver biopsy, pain was most often described as mild to moderate (i.e., a rating of three on a scale of one to 10). Mild medications of a non-aspirin type can be given after the biopsy if the pain persists for several hours.

## Diagnosis/Preparation

Liver biopsies require some preparation by the patient. Since **aspirin** and ibuprofen (Advil, Motrin) are known to cause excessive bleeding by inhibiting platelets and lessening clotting function, the patient should avoid taking any of these medications for at least a week before the biopsy. The doctor should check the patient's records to see whether he or she is taking any other medications that may affect blood clotting. Both a platelet count (or **complete blood count**) and a **prothrombin time** (to assess how well the patient's blood clots) are performed prior to the biopsy. These tests determine whether there is an abnormally high risk of uncontrolled bleeding from the biopsy site, which may contraindicate the procedure. The patient should limit food or drink for a period of four to eight hours before the biopsy.

Patients should be told what to expect in the way of discomfort pre- and post-procedure. In addition, they should be advised about what medications they should not take before or after the biopsy. It is important for the clinician to reassure the patient concerning the safety of the procedure.

Before the procedure, the patient or family member must sign a consent form. The patient will be questioned about any history of allergy to the local

anesthetic, and then will be asked to empty the bladder so that he or she will be more comfortable during the procedure. **Vital signs**, including pulse rate, temperature, and breathing rate will be noted so that the doctor can tell during the procedure if the patient is having any physical problems.

When performing the liver biopsy and blood collection that precedes it, the physician and other health care providers will follow universal precautions to maintain sterility for the prevention of transmission of blood-borne pathogens.

Some patients should not have percutaneous liver biopsies. They include those with any of the following conditions:

- a platelet count below 50,000
- a prothrombin test time greater than three seconds over the reference interval, indicating a possible clotting abnormality
- a liver tumor with a large number of veins
- a large amount of abdominal fluid (ascites)
- infection anywhere in the lungs, the lining of the chest or abdominal wall, the biliary tract, or the liver
- benign tumors (angiomas) of the liver, which consist mostly of enlarged or newly formed blood vessels and may bleed heavily
- biliary obstruction (bile may leak from the biopsy site and cause an infection of the abdominal cavity)

### Aftercare

Liver biopsies are now performed as outpatient procedures in most hospitals. Patients are asked to lie on their right sides for one hour and then to rest quietly for three more hours. At regular intervals, a nurse checks the patient's vital signs. If there are no complications, the patient is discharged, but will be asked to stay in an area that is within an hour from the hospital in case delayed bleeding occurs.

Patients should arrange to have a friend or relative take them home after discharge. Bed rest for a day is recommended, followed by a week of avoiding heavy work or strenuous **exercise**. The patient can immediately resume eating a normal diet.

Some mild soreness in the area of the biopsy is expected after the anesthetic wears off. Irritation of the muscle that lies over the liver can also cause mild discomfort in the shoulder for some patients. **Acetaminophen** can be taken for minor soreness, but aspirin and ibuprofen products are best avoided. The patient should, however, call the doctor if there is severe pain in the abdomen, chest, or shoulder; difficulty breathing; or persistent bleeding. These signs

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The liver biopsy requires the skill of many clinicians, including the radiologist, hepatologist, and pathologist, to make the diagnosis. Nurses will assist the physician during the biopsy procedure and in caring for the patient after the procedure. Tissues are prepared for microscopic evaluation by a histologic technician in the pathology lab. The procedure is generally performed on an outpatient basis in a hospital.

may indicate that there has been leakage of bile into the abdominal cavity, or that air has been introduced into the cavity around the lungs.

### Risks

The complications associated with a liver biopsy are usually minor; most will occur in the first two hours following the procedure, and greater than 95% in the first 24 hours. The most significant risk is prolonged internal bleeding. Other complications from percutaneous liver biopsies include the leakage of bile or the introduction of air into the chest cavity (pneumothorax). There is also a small chance that an infection may occur. The risk that an internal organ such as the lung, gallbladder, or kidney might be punctured is decreased when using the ultrasound- or CT-guided procedure.

### Normal results

After the biopsy, the liver sample is sent to the pathology laboratory and examined. A normal (negative) result would find no evidence of pathology in the tissue sample. It should be noted that many diseases of the liver are focal and not diffuse; an abnormality may not be detected if the sample was taken from an unaffected site. If symptoms persist, the patient may need to undergo another biopsy.

The pathologist will perform a visual inspection of the sample to note any abnormalities in appearance. In cirrhosis, the sample will be fragmented and hard. Fatty liver, seen in heavy drinkers, will float in the formalin solution and will be yellow. Carcinomas are white. The pathologist will also look for deposition of bile pigments (green), indicating cholestasis (obstruction of bile flow). In preparation for microscopic examination, the tissue will be frozen and cut into

## QUESTIONS TO ASK THE DOCTOR

- Why is a biopsy indicated in my case?
- How many biopsies do you perform each year?  
What is your rate of complications?
- What will happen when I get the results?
- What alternatives are available to me?

thin sections, which will be mounted on glass slides and stained with various dyes to aid in identifying microscopic structures. Using the microscope, the pathologist will examine the tissue samples, and identify abnormal cells and any deposited substances such as iron or copper. In liver cancer, small dark malignant cells will be visible within the liver tissue. An infiltration of white blood cells may signal infection. The pathologist also checks for the number of bile ducts, and determines whether they are dilated. He or she also looks at the health of the small arteries and portal veins. Fibrosis will appear as scar tissue, and fatty changes are diagnosed by the presence of lipid droplets. Many different findings may be noted and a differential diagnosis (one out of many possibilities) can often be made. In difficult cases, other laboratory tests such as those assessing liver function enzymes will aid the clinician in determining the final diagnosis.

### Morbidity and mortality rates

Post-biopsy complications that require hospitalization occur in approximately 1–3% of cases. Moderate pain is reported by 20% of patients, and 3% report pain severe enough to warrant intravenous pain relief. The mortality rate is approximately one in 10,000. In about 0.4% of cases, a patient with liver cancer will develop a fatal hemorrhage from a percutaneous biopsy. These fatalities result because some liver tumors are supplied with a large number of blood vessels and thus may bleed excessively.

### Alternatives

Liver biopsy is an invasive and sometimes painful procedure that is also expensive (in 2002, direct costs associated with liver biopsy were \$1,500–2,000). In some instances, blood tests may provide enough information to health care providers to make an accurate diagnosis and therefore avoid a biopsy. Occasionally, a biopsy may be obtained using a laparoscope (an instrument inserted through the abdominal wall that allows the doctor to visualize the liver and obtain a

sample) or during surgery if the patient is undergoing an operation on the abdomen. Imaging techniques (such as ultrasound) may also be employed during a liver biopsy, in order to allow more accurate placement of the biopsy needle.

### Resources

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#### ORGANIZATIONS

- American Liver Foundation. 1425 Pompton Avenue, Cedar Grove, NJ 07009. (800) 465 4837. <http://www.liverfoundation.org>.

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## Liver function tests

### Definition

Liver function tests, or LFTs, include tests that are routinely measured in all clinical laboratories. LFTs include bilirubin, a compound formed by the breakdown of hemoglobin; ammonia, a breakdown product of protein that is normally converted into urea by the liver before being excreted by the kidneys; proteins that are made by the liver, including total protein, albumin, prothrombin, and fibrinogen; cholesterol and triglycerides, which are made and excreted via the liver; and the enzymes alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), gamma-glutamyl transferase (GGT), and lactate dehydrogenase (LDH). Other liver function tests include serological tests (to demonstrate antibodies); DNA tests for hepatitis and other viruses; and tests for antimitochondrial and smooth muscle antibodies, transthyretin (prealbumin), protein electrophoresis, bile acids, alpha-fetoprotein, and a constellation of other enzymes that help differentiate



## KEY TERMS

**Bile acid**—A detergent that is made in the liver and excreted into the intestine to aid in the absorption of fats.

**Biliary**—Relating to bile.

**Cirrhosis**—A liver disease where there is a loss of normal liver tissues, replaced by scar tissue. This is usually caused by chronic alcohol abuse, but also can be caused by blockage of the bile ducts.

**Detoxification**—A process of altering the chemical structure of a compound to make it less toxic.

**Hepatitis**—Inflammation of the liver.

**Hepatocyte**—Liver cell.

**Isoenzyme**—One of a group of enzymes that brings about the same reactions on the same chemicals, but are different in their physical properties.

**Jaundice**—Hyperbilirubinemia, or too much bilirubin in the blood. Bilirubin will be deposited in the skin and the mucosal membranes. The whites of the eyes and the skin appear yellow.

**Lipoprotein**—A chemical combination of a protein and a lipid (fats).

**Neonatal jaundice**—A disorder in newborns where the liver is too premature to conjugate bilirubin, which builds up in the blood.

necrotic (characterized by the **death** of tissue) versus obstructive liver disease.

### Purpose

Liver function tests done individually do not give the physician much information, but used in combination with a careful history, **physical examination**, and imaging studies, they contribute to making an accurate diagnosis of the specific liver disorder. Different tests will show abnormalities in response to liver inflammation; liver injury due to drugs, alcohol, toxins, or viruses; liver malfunction due to blockage of the flow of bile; and liver cancers.

### Precautions

Blood for LFTs is collected by sticking a needle into a vein. The nurse or phlebotomist (person trained to draw blood) performing the procedure must be careful to clean the skin before sticking in the needle.

**Bilirubin:** Drugs that may cause increased blood levels of total bilirubin include anabolic steroids,

**antibiotics**, antimalarials, ascorbic acid, Diabinese, codeine, **diuretics**, epinephrine, oral contraceptives, and vitamin A.

**Ammonia:** Muscular exertion can increase ammonia levels, while cigarette smoking produces significant increases within one hour of inhalation. Drugs that may cause increased levels include alcohol, **barbiturates**, narcotics, and diuretics. Drugs that may decrease levels include antibiotics, levodopa, lactobacillus, and potassium salts.

**ALT:** Drugs that may increase ALT levels include **acetaminophen**, ampicillin, codeine, dicumarol, indomethacin, methotrexate, oral contraceptives, **tetracyclines**, and verapamil. Previous intramuscular injections may cause elevated levels.

**GGT:** Drugs that may cause increased GGT levels include alcohol, phenytoin, and phenobarbital. Drugs that may cause decreased levels include oral contraceptives.

**LDH:** Strenuous activity may raise levels of LDH. Alcohol, anesthetics, **aspirin**, narcotics, procainamide, and fluoride may also raise levels. Ascorbic acid (vitamin C) can lower levels of LDH.

### Description

The liver is the largest and one of the most important organs in the body. As the body's "chemical factory," it regulates the levels of most of the biomolecules found in the blood, and acts with the kidneys to clear the blood of drugs and toxic substances. The liver metabolizes these products, alters their chemical structure, makes them water soluble, and excretes them in bile. Laboratory tests for total protein, albumin, ammonia, transthyretin, and cholesterol are markers for the synthetic (chemical-producing) function of the liver. Tests for cholesterol, bilirubin, ALP, and bile salts are measures of the secretory (excretory) function of the liver. The enzymes ALT, AST, GGT, LDH, and tests for viruses are markers for liver injury.

Some liver function tests are used to determine if the liver has been damaged or its function impaired. Elevations of these markers for liver injury or disease tell the physician that something is wrong with the liver. ALT and bilirubin are the two primary tests used largely for this purpose. Bilirubin is measured by two tests, called total and direct bilirubin. While total bilirubin is elevated in various liver diseases, it is also increased in certain (hemolytic) anemias caused by increased red blood cell turnover. Neonatal hyperbilirubinemia (jaundice) is a condition caused by an immature liver that cannot conjugate (process) the bilirubin. The level of total bilirubin in the blood becomes elevated and must be monitored closely in

order to prevent damage to the brain caused by unconjugated bilirubin, which has a high affinity for brain tissue. Bilirubin levels can be decreased by exposing the baby to UV light. Direct bilirubin is formed only by the liver, and therefore, it is specific for hepatic or biliary disease. Its concentration in the blood is very low (0–0.2 mg/dL) and therefore, even slight increases are significant. Highest levels of direct bilirubin are seen in obstructive liver diseases. However, direct bilirubin is not sensitive to all forms of liver disease and is not always elevated in the earliest stages of disease. Therefore, ALT is needed to exclude a diagnosis.

Although ALT is present in other tissues, its concentration in the liver is far greater than any other tissue. The enzyme is very sensitive to liver injury. Consequently, if ALT or direct bilirubin is increased, then some form of liver disease is likely. If both are normal, then liver disease is unlikely.

These two tests, along with others, are used to help make a diagnosis. The most useful tests for this purpose are the liver function enzymes and the ratio of direct to total bilirubin. These tests are used to differentiate diseases characterized primarily by hepatocellular damage (necrosis, or cell death) from those characterized by obstructive damage (cholestasis or blockage of bile flow). Liver cell damage may be caused by viral hepatitis, hepatitis induced by drugs or poisons (toxic hepatitis), alcoholic hepatitis, hypoxic necrosis (a consequence of congestive heart failure), chronic hepatitis, and cirrhosis of the liver. Obstructive liver diseases include intrahepatic (within the liver) obstructive disease or extrahepatic (outside the liver) obstruction. In both cases, the direct bilirubin is often greatly elevated because the liver can conjugate the bilirubin, but this direct bilirubin cannot be excreted via the bile. In such cases the ratio of direct to total bilirubin is greater than 0.4.

Aspartate aminotransferase (AST) is not as specific for liver disease as ALT is. However, differentiation of acute and chronic forms of liver disease is aided by examining the ratio of ALT to AST, called the DeRitis ratio. In acute hepatitis, Reye's syndrome, and infectious mononucleosis, the ALT predominates. However, in alcoholic liver disease, chronic hepatitis, and cirrhosis, the AST predominates.

Alkaline phosphatase (ALP) is increased in obstructive liver diseases, but it is not specific for the liver. Increases are commonly seen in bone diseases, late pregnancy, leukemia, and some other malignancies. The enzyme gamma-glutamyl transferase (GGT) is used to help differentiate the source of an elevated ALP. GGT is greatly increased in obstructive jaundice, alcoholic liver disease, and hepatic cancer. When

the increase in GGT is two or more times greater than the increase in ALP, the source of the ALP is considered to be from the liver. When the increase in GGT is five or more times the increase in ALP, this points to a diagnosis of alcoholic hepatitis. GGT, but not AST and ALT, is elevated in the first stages of liver inflammation due to alcohol consumption, and GGT is useful as a marker for excessive drinking. GGT has been shown to rise after acute persistent alcohol ingestion and then fall when alcohol is avoided.

Lactate dehydrogenase (LDH) is found in almost all cells in the body. LDH is increased in megaloblastic and hemolytic anemias, leukemias and lymphomas, myocardial infarction, infectious mononucleosis, muscle wasting diseases, and both necrotic and obstructive jaundice. LDH is markedly increased in most cases of liver cancer. An enzyme pattern showing a marked increase in LDH and to a lesser degree ALP with only slightly increased transaminases (AST and ALT) is seen in cancer of the liver.

Some liver function tests are not sensitive enough to be used for diagnostic purposes, but are elevated in severe or chronic liver diseases. These tests are used primarily to indicate the extent of damage to the liver. Tests falling into this category are ammonia, total protein, albumin, cholesterol, transthyretin, fibrinogen, and the **prothrombin time**.

Analysis of blood ammonia aids in the diagnosis of severe liver diseases and helps to monitor the course of these diseases. Together with the AST and the ALT, ammonia levels are used to confirm a diagnosis of Reye's syndrome, a rare disorder usually seen in children and associated with infection and aspirin intake. Reye's syndrome is characterized by brain and liver damage following an upper respiratory tract infection, chickenpox, or influenza. Ammonia levels are also helpful in the diagnosis and treatment of hepatic encephalopathy, a serious brain condition caused by the accumulated toxins that result from liver disease and liver failure. Ammonia levels in the blood are normally very low. Increasing ammonia signals end-stage liver disease and a high risk of hepatic coma.

Albumin is the protein found in the highest concentration in blood, making up over half of the protein mass. A persistently low albumin in liver disease is a sign of progressive liver failure. In the acute stages of liver disease, proteins such as transthyretin (prealbumin) may be measured to give an indication of the severity of the disease.

Cholesterol is synthesized by the liver. Its balance is maintained by the liver's ability to remove cholesterol from lipoproteins, and use it to produce bile acids and

salts that it excretes into the bile ducts. In obstructive jaundice caused by stones, biliary tract scarring, or cancer, the bile cannot be eliminated. Cholesterol and triglycerides may accumulate in the blood as low-density lipoprotein (LDL) cholesterol. In acute necrotic liver diseases, triglycerides may be elevated. In liver failure caused by necrosis, the liver's ability to synthesize cholesterol is reduced, and blood levels may be low.

The liver is responsible for production of the vitamin K clotting factors. In obstructive liver diseases a deficiency of vitamin K-derived clotting factors results from failure to absorb vitamin K. In obstructive jaundice, an intramuscular injection of vitamin K will be given. In severe necrotic disease, the liver cannot synthesize clotting factors from vitamin K.

The most prevalent liver disease is viral hepatitis. Tests for this condition include a variety of antigen and antibody markers and nucleic acid tests. In addition to hepatitis A-E, viral hepatitis may be caused by Epstein-Barr virus (EBV) and cytomegalovirus (CMV) infections of the liver. Tests for these viruses such as the infectious mononucleosis antibody test, anti-viral capsid antigen test (anti-VCA), and anti-CMV test are useful in diagnosing these infections.

Liver disease may be caused by autoimmune mechanisms in which autoantibodies destroy liver cells. Autoimmune necrosis is associated with systemic lupus erythematosus and chronic viral hepatitis, usually caused by hepatitis B and hepatitis C virus infections. These conditions give rise to anti-smooth muscle antibodies and anti-nuclear antibodies, and tests for these are useful markers for chronic hepatitis. Antibodies to mitochondrial antigens (antimitochondrial antibodies) are found in the blood of more than 90% of persons with primary biliary cirrhosis.

### Preparation

Patients are asked to fast and to inform clinicians of all drugs, even over-the-counter drugs, that they are taking. Many times liver function tests are done on an emergency basis. Thus fasting and obtaining a medical history may not be possible.

### Aftercare

Patients will have blood drawn into a vacuum tube and may experience some pain and burning at the site of injection. A gauze bandage may be placed over the site to prevent further bleeding. If the patient is suffering from severe liver disease, he or she may lack clotting factors. The nurse or caregiver should be careful to monitor bleeding in these patients after obtaining blood.

### Normal results

Reference ranges vary from laboratory to laboratory and also depend upon the method used. However, normal values are generally framed by the ranges shown below.

- ALT: 5–35 IU/L. (Values for the elderly may be slightly higher, and values also may be higher in men and in African-Americans.)
- AST: 0–35 IU/L.
- ALP: 30–120 IU/LALP is higher in children, older adults and pregnant females.
- GGT: males 2–30 U/L; females 1–24 U/L.
- LDH: 0–4 days old: 290–775 U/L; 4–10 days: 545–2000 U/L; 10 days–24 months: 180–430 U/L; 24 months–12 years: 110–295 U/L; 12–60 years: 100–190 U/L; 60 years: >110–210 U/L.
- Bilirubin: (Adult, elderly, and child) Total bilirubin: 0.1–1.0 mg/dL; indirect bilirubin: 0.2–0.8 mg/dL; direct bilirubin: 0.0–0.3 mg/dL. (Newborn) Total bilirubin: 1–12 mg/dL. Note: critical values for adult: greater than 1.2 mg/dL. Critical values for newborn (requiring immediate treatment): greater than 15 mg/dL.
- Ammonia: 10–70 micrograms per dL (heparinized plasma). Normal values for this test vary widely, depending upon the age of the patient and the type of specimen.
- Albumin: 3.2–5.4 g/L.

### Abnormal results

ALT: Values are significantly increased in cases of hepatitis, and moderately increased in cirrhosis, liver tumor, obstructive jaundice, and severe burns. Values are mildly increased in pancreatitis, heart attack, infectious mononucleosis, and shock. Most useful when compared with ALP levels.

AST: High levels may indicate liver cell damage, hepatitis, heart attack, heart failure, or gall stones.

ALP: Elevated levels occur in diseases that impair bile formation (cholestasis). ALP may also be elevated in many other liver disorders, as well as some lung cancers (bronchogenic carcinoma) and Hodgkin's lymphoma. However, elevated ALP levels may also occur in otherwise healthy people, especially among older people.

GGT: Increased levels are diagnostic of hepatitis, cirrhosis, liver tumor or metastasis, as well as injury from drugs toxic to the liver. GGT levels may increase with alcohol ingestion, heart attack, pancreatitis, infectious mononucleosis, and Reye's syndrome.

**LDH:** Elevated LDH is seen with heart attack, kidney disease, hemolysis, viral hepatitis, infectious mononucleosis, Hodgkin's disease, abdominal and lung cancers, germ cell tumors, progressive muscular dystrophy, and pulmonary embolism. LD is not normally elevated in cirrhosis.

**Bilirubin:** Increased indirect or total bilirubin levels can indicate various serious anemias, including hemolytic disease of the newborn and **transfusion** reaction. Increased direct bilirubin levels can be diagnostic of bile duct obstruction, gallstones, cirrhosis, or hepatitis. It is important to note that if total bilirubin levels in the newborn reach or exceed critical levels, exchange transfusion is necessary to avoid kernicterus, a condition that causes brain damage from bilirubin in the brain.

**Ammonia:** Increased levels are seen in primary liver cell disease, Reye's syndrome, severe heart failure, hemolytic disease of the newborn, and hepatic encephalopathy.

**Albumin:** Albumin levels are increased due to dehydration. They are decreased due to a decrease in synthesis of the protein which is seen in severe liver failure and in conditions such as burns or renal disease that cause loss of albumin from the blood.

#### ***Patient education***

Health-care providers should inform the patient of any abnormal results and explain how these values reflect the status of their liver disease. It is important to guide the patient in ways to stop behaviors such as taking drugs or drinking alcohol, if these are the causes of the illness.

#### **Resources**

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Liver removal see **Hepatectomy**

## **Liver transplantation**

### **Definition**

Liver transplantation is a surgery that removes a diseased liver and replaces it with a healthy donor liver.

### **Purpose**

A liver transplant is needed when the liver's function is reduced to the point that the life of the patient is threatened.

### **Demographics**

Compared to whites, those with African-American, Asian, Pacific Islander, or Hispanic descent are three times more likely to suffer from end-stage renal disease (ESRD). Both children and adults can suffer from liver failure and require a transplant.

Patients with advanced heart and lung disease, who are human immunodeficiency virus (HIV) positive, and who abuse drugs and alcohol are poor candidates for liver transplantation. Their ability to survive the surgery and the difficult recovery period, as well as their long-term prognosis, is hindered by their conditions.

### **Description**

The liver is the body's principle chemical factory. It receives all nutrients, drugs, and toxins, which are absorbed from the intestines, and performs the final stages of digestion, converting food into energy and replacement parts for the body. The liver also filters the blood of all waste products, removes and detoxifies poisons, and excretes many of these into the bile. It further processes other chemicals for excretion by the kidneys. The liver is also an energy storage organ, converting food energy to a chemical called glycogen that can be rapidly converted to fuel.

When other medical treatment interferes with the functioning of a damaged liver, a transplant is necessary. Since 1963, when the first human liver transplant was performed, thousands more have been performed each year. Cirrhosis, a disease that kills healthy liver cells, replacing them with scar tissue, is the most common reason for liver transplantation in adults. The most frequent reason for transplantation in children is biliary atresia—a disease in which the ducts that carry bile out of the liver, are missing or damaged.

Included among the many causes of liver failure that bring patients to **transplant surgery** are:



## KEY TERMS

**Acetaminophen**—A common pain reliever (e.g., Tylenol).

**Anesthesia**—A safe and effective means of alleviating pain during a medical procedure.

**Antibody**—An antibody is a protein complex used by the immune system to identify and neutralize foreign objects, such as like bacteria and viruses. Each antibody recognizes a specific antigen unique to its target.

**Antigen**—Any chemical that provokes an immune response.

**Ascites**—A buildup of fluid in the stomach as a result of liver failure.

**Bile ducts**—Tubes carrying bile from the liver to the intestines.

**Biliary atresia**—A disease in which the ducts that carry bile out of the liver are missing or damaged is the most frequent reason for transplantation in children. Biliary atresia of the major bile ducts causes cholestasis and jaundice, which does not become apparent until several days after birth; periportal fibrosis develops and leads to cirrhosis, with proliferation

of small bile ducts unless these are also atretic; giant cell transformation of hepatic cells also occurs.

**Biliary system**—The tree of tubes that carries bile.

**Cirrhosis**—A disease in which healthy liver cells are killed and replaced with scar tissue. Cirrhosis is the most common reason for liver transplantation in adults and is often a result of alcoholism.

**Computed tomography (CT or CAT) scan**—A radiologic imaging modality that uses computer processing to generate an image of the tissue density in a “slice” as thin as 1–10 mm in thickness through the patient’s body. These images are spaced at intervals of 0.5 cm–1 cm. Cross-sectional anatomy can be reconstructed in several planes without exposing the patient to additional radiation. Called also computerized axial tomography (CAT) and computerized transaxial tomography (CTAT).

**Electrocardiogram (EKG)**—A graphic record showing the electrical activity of the heart.

**Endoscopy**—An instrument (endoscope) used to visualize a hollow organ’s interior.

- Progressive hepatitis, mostly due to virus infection, accounts for more than one-third of all liver transplants.
- Alcohol damage accounts for approximately 20% of transplants.
- Scarring, or abnormality of the biliary system, accounts for roughly another 20% of liver transplants.
- The remainder of transplants come from various cancers, uncommon diseases, and a disease known as fulminant liver failure.

Fulminant liver failure most commonly happens during acute viral hepatitis, but is also the result of mushroom poisoning by *Amanita phalloides* and toxic reactions to overdose of some medicines, such as acetaminophen—a medicine commonly used to relieve pain and reduce fever. The person who is the victim of mushroom poisoning is a special category of candidate for a liver transplant because of the speed of the disease and the immediate need for treatment.

As the liver fails, all of its functions diminish. Nutrition suffers, toxins build, and waste products accumulate. Scar tissue accumulates on the liver as the disease progresses. Blood flow is increasingly restricted in the portal vein, which carries blood from

the stomach and abdominal organs to the liver. The resulting high blood pressure (hypertension) causes swelling of and bleeding from the blood vessels of the esophagus. Toxins build in the blood (liver encephalopathy), resulting in severe jaundice (yellowing of the skin and eyes), fluid accumulation in the abdomen (ascites), and deterioration of mental function. Eventually, **death** occurs.

There are three types of liver transplantation methods. They include:

- Orthotopic transplantation, the replacement of a whole diseased liver with a healthy donor liver.
- Heterotrophic transplantation, the addition of a donor liver at another site, while the diseased liver is left intact.
- Reduced-size liver transplantation, the replacement of a whole diseased liver with a portion of a healthy donor liver. Reduced-size liver transplants are most often performed on children.

When an orthotopic transplantation is performed, a segment of the inferior vena cava (the body’s main vein to the heart) attached to the liver is taken from the donor, as well. The same parts are removed from the recipient and replaced by connecting the inferior vena

**Hepatic artery**—The blood vessel supplying arterial blood to the liver.

**Heterotrophic transplantation**—The addition of a donor liver at another site, while the diseased liver is left intact.

**Interleukin-2 (IL-2)**—A cytokine derived from T helper lymphocytes that causes proliferation of T-lymphocytes and activated B lymphocytes.

**Immunosuppression**—A disorder or condition where the immune response is reduced or absent.

**Inferior vena cava**—The biggest vein in the body, returning blood to the heart from the lower half of the body.

**Jaundice**—Yellowing of the skin and eyes caused by a buildup of bile or excessive breakdown of red blood cells.

**Leukemia**—A cancer of the white blood cells (WBCs).

**Lymphoma**—A cancer of lymphatic tissue.

**Lymphoproliferative**—An increase in the number of lymphocytes. Lymphocytes are a white blood cell (WBC) formed in lymphatic tissue throughout

the body in the lymph nodes, spleen, thymus, tonsils, Peyer patches, and sometimes in bone marrow), and in normal adults, comprising approximately 22–28% of the total number of leukocytes in the circulating blood.

**Magnetic resonance imaging (MRI)**—A test that provides pictures of organs and structures inside the body by using a magnetic field and pulses of radio wave energy to detect tumors, infection, and other types of tissue disease or damage, and helps to diagnose conditions that affect blood flow. The area of the body being studied is positioned inside a strong magnetic field.

**Nephrotoxicity**—The quality or state of being toxic to kidney cells.

**Orthotopic transplantation**—The replacement of a whole diseased liver with a healthy donor liver.

**Portal vein**—The blood vessel carrying venous blood from the abdominal organs to the liver.

**Receptor**—A structural protein molecule on the cell surface or within the cytoplasm that binds to a specific factor, such as a drug, hormone, antigen, or neurotransmitter.

cava, the hepatic artery, the portal vein, and the bile ducts.

When there is a possibility that the afflicted liver may recover, a heterotypic transplantation is performed. The donor liver is placed in a different site, but it still has to have the same connections. It is usually attached very close to the patient's original liver; if the original liver recovers, the donor liver will wither away. If the patient's original liver does not recover, that liver will dry up, leaving the donor in place.

Reduced-size liver transplantation puts part of a donor liver into a patient. A liver can actually be divided into eight pieces—each supplied by a different set of blood vessels. In the past, just two of these sections have been enough to save a patient suffering from liver failure, especially if it is a child. It is possible, therefore, to transplant one liver into at least two patients and to transplant part of a liver from a living donor—and for both the donor and recipients to survive. Liver tissue grows to accommodate its job provided that the organ is large enough initially. Patients have survived with only 15–20% of their original liver intact, assuming that that portion was healthy from the beginning.

As of 2003, the availability of organs for transplant was in crisis. In October 1997, a national distribution system was established that gives priority to patients who are most ill and in closest proximity to the donor livers. Livers, however, are available nationally. It is now possible to preserve a liver out of the body for 10–20 hours by flushing it with cooled solutions of special chemicals and nutrients, if necessary. This enables transport cross-country.

## Description

Once a donor liver has been located and the patient is in the **operating room** and under **general anesthesia**, the patient's heart and blood pressure are monitored. A long cut is made alongside of the ribs; sometimes, an upwards cut may also be made. When the liver is removed, four blood vessels that connect the liver to the rest of the body are cut and clamped shut. After getting the donor liver ready, the transplant surgeon connects these vessels to the donor vessels. A connection is made from the bile duct (a tube that drains the bile from the liver) of the donor liver to the bile duct of the liver of the patient's bile duct. In some cases, a small piece of the intestine is connected to the new donor bile duct. This connection is called

Roux-en-Y. The operation usually takes between six and eight hours; another two hours is spent preparing the patient for surgery. Therefore, a patient will likely be in the operating room for eight to 10 hours.

Split-liver techniques means that a single, perfect donor liver from a larger cadaver may be split for transplantation into more than one patient. Usually, the left lobe (comprising about 40% of the entire liver) will go to a small adult, adolescent, or child, while the larger right lobe (comprising about 60% of the entire liver) will go to an adult. When an infant requires a liver transplant, 20% of a normal-sized liver may be utilized, and the other 80% can go to another individual awaiting transplant. The success rate of this split-liver technique is somewhat lower than with whole organs (about 80% success rate versus about 90% success rate), but the obvious advantage is that more patients awaiting transplant can be served.

The United Network for Organ Sharing (UNOS) data indicates that patients in need of organ transplants outnumber available organs three to one.

### Diagnosis/Preparation

The liver starts to fail only when more than half of it is damaged. Thus, once a person demonstrates symptoms of liver failure, there is not much liver function left. Signs and symptoms of liver failure include:

- jaundice
- muscle wasting (loss of muscle)
- forgetfulness, confusion, or coma
- fatigue
- itching
- poor blood clotting
- build-up of fluid in the stomach (ascites)
- infections
- bleeding in the stomach

A doctor will diagnose liver disease; a liver specialist, a transplant surgeon, and other doctors will have to be consulted, as well, before a patient can be considered for a liver transplant. Before transplantation takes place, the patient is first determined to be a good candidate for transplantation by going through a rigorous medical examination. Blood tests, consultations, and x rays will be needed to determine if the patient is a good candidate. Other tests that may be conducted are: computed tomography (CAT or CT) scan, magnetic resonance image (MRI), **ultrasound**, routine **chest x ray**, endoscopy, sclerotherapy and rubber-band ligation, transjugular intrahepatic portosystemic shunt (TIPS), creatinine clearance, cardiac testing (echocardiogram [ECHO]) and/or **electrocardiogram** [EKG or

ECG]), and pulmonary function test [PFTs]), **liver biopsy**, and nutritional evaluation. A dietitian will evaluate the patient's nutritional needs and design an eating plan. Since a patient's emotional state is as important as their physical state, a psychosocial evaluation will be administered.

Once test results are reviewed and given to the liver transplant selection committee, the patient will be assessed for whether he or she is an appropriate candidate. Some patients are deemed too healthy for a transplant and will be followed and retested at a later date if their liver gets worse. Other patients are determined to be too sick to survive a transplant. The committee will not approve a transplant for these patients. Once a patient is approved, they will be placed on a waiting list for a donor liver. When placed on the waiting list, a patient will be given a score based on the results of the blood tests. The higher a patient's score, the sicker the patient is. This results in the patient earning a higher place on the waiting list.

Suitable candidates boost their nutritional intakes to ensure that they are as healthy as possible before surgery. Drugs are administered that will decrease organ rejection after surgery. The medical committee consults with the patient and family, if available, to explain the surgery and any potential complications. Many problems can arise during the waiting period. Medicines should be changed as needed, and blood tests should be done to ensure a patient is in the best possible health for the transplant surgery. Psychological counseling during this period is recommended, as well.

When a donor is found, it is important that the transplant team be able to contact the patient. The patient awaiting the organ must not eat or drink anything from the moment the hospital calls. On the other hand, the liver may not be good enough for transplantation. Then, the operation will be cancelled, although this does not happen often.

### Aftercare

Following surgery, the patient will wake up in the surgical **intensive care unit** (SICU). During this time, a tube will be inserted into the windpipe to facilitate breathing. It is removed when the patient is fully awake and strong enough to breathe on his or her own. There may be other tubes that are removed as the patient recovers. When safe to leave the SICU, the patient is moved to the transplant floor. Walking and eating will become the primary focus. Physical therapy may be started to help the patient become active, as it is an important part of recovery. When the patient

begins to feel hungry and the bowels are working, regular food that is low in salt will be given.

A patient should expect to spend about 10–14 days in the hospital, although some stays may be shorter or longer. Before leaving the hospital, a patient will be advised of: signs of infection or rejection, how to take medications and change **dressings**, and how to understand general health problems. Infection can be a real danger, because the medications taken compromise the body's defense systems. The doctors will conduct blood tests, ultrasounds, and x rays to ensure that the patient is doing well.

The first three months after transplant are the most risky for getting infections, such as the flu, so patients should follow these precautions:

- Avoid from people who are ill.
- Wash hands frequently.
- Tell the doctor if you are exposed to any disease.
- Tell the doctor if a cold sore, rash, or water blister appears on the body or spots appear in the throat or on the tongue.
- Stay out of crowds and rooms with poor circulation.
- Do not swim in lakes or community pools during the three months following transplant.
- Eat meats that are well-cooked.
- Stay away from soil, including those in which houseplants are grown, and gardens, during the three months following transplant.
- Take all medications as directed.
- Learn to report the early symptoms of infection.

To ensure that the transplant is successful and that the patient has a long and healthy life, a patient must get good medical care, prevent and treat complications, keep in touch with doctors and nurses, and follow their advice. Nutrition plays a big part in the success of a liver transplant, so what a patient eats after the transplant is very important.

#### ***Medications needed following liver transplantation***

Successfully receiving a transplanted liver is only the beginning of a lifelong process. Patients with transplanted livers have to stay on **immunosuppressant drugs** for the rest of their lives to prevent organ rejection. Although many patients can reduce the dosage after the initial few months, virtually none can discontinue drugs altogether. For adolescent transplant recipients, post transplantation is a particularly difficult time, as they must learn to take responsibility for their own behavior and medication, as well as balance their developing sexuality in a body that has been

transformed by the adverse effects of immunosuppression. Long-term outcome and tailoring of immunosuppression is of great importance.

Cyclosporine has long been the drug of experimentation in the immunosuppression regimen, and has been well-tolerated and effective. Hypertension, nephrotoxicity, and posttransplant lymphoproliferative disease (PTLD) are some of the long-term adverse effects. Tacrolimus has been developed more recently, and has improved the cosmetic adverse effects of cyclosporine, but has similar rates of hypertension and nephrotoxicity, and possibly a higher rate of PTLD. Prednisone, azathioprine, and tacrolimus are often combined with cyclosporine for better results. Newer immunosuppressive agents promise even better results.

There has been a recent, welcome development in renal sparing drugs, such as mycophenolate mofetil, which has no cosmetic adverse effects, does not require drug level monitoring, and is thus particularly attractive to teenagers. If started prior to irreversible renal dysfunction, recent research demonstrates recovery of renal function with mycophenolate mofetil. There is little published data on the use of sirolimus (rapamycin) in the pediatric population, but preliminary studies suggest that the future use of interleukin-2 receptor antibodies may be beneficial for immediate post-transplant induction of immunosuppression. When planning immunosuppression for adolescents, it is important to consider the effects of drug therapy on both males and females in order to maintain fertility and to ensure safety in pregnancy. Adequate practical measures and support should reduce noncompliance in this age group, and allow good, long-term function of the transplanted liver.

#### **Risks**

Early failure of the transplant occurs once in four surgeries and has to be repeated. Some transplants never work, some patients succumb to infection, and some suffer immune rejection. Primary failure is apparent within one or two days. Rejection usually starts at the end of the first week. There may be problems like bleeding of the bile duct after surgery, or blood vessels of the liver may become too narrow. The surgery itself may need revision because of narrowing, leaking, or blood clots at the connections. These issues may be solved with or without more surgery depending on the severity.

Infections are a constant risk while on immunosuppressive agents, because the immune system is supposed to prevent them. A method has not yet been devised to control rejection without hampering immune



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A transplant surgeon will perform the surgery in a hospital that has a special unit called a transplant center.

defenses against infections. Not only do ordinary infections pose a threat, but because of the impaired immunity, transplant patients are susceptible to the same opportunistic infections (OIs) that threaten acquired immune deficiency syndrome (AIDS) patients—pneumocystis pneumonia, herpes and cytomegalovirus (CMV) infections, fungi, and a host of bacteria.

Drug reactions are also a continuing threat. Every drug used to suppress the immune system has potential problems. As previously stated, hypertension, nephrotoxicity, and PTLT are some of the long-term adverse effects with immunosuppressive drugs like cyclosporine. Immunosuppressants also hinder the body's ability to resist cancer. All drugs used to prevent rejection increase the risk of leukemias and lymphomas.

There is also a risk of the original disease returning. In the case of hepatitis C, reoccurrence is a risk factor for orthotopic liver transplants. Newer antiviral drugs hold out promise for dealing with hepatitis. In alcoholics, the urge to drink alcohol will still be a problem. Alcoholics Anonymous (AA) is the most effective treatment known for alcoholism.

Transplant recipients can get high blood pressure, diabetes, high cholesterol, thinning of the bones, and can become obese. Close medical care is needed to prevent these conditions.

### Normal results

For a successful transplant, good medical care is important. Patients and families must stay in touch with their medical teams and drugs must be taken as advised to prevent infection and rejection of the new organ. However, sometimes because of the way it is preserved, the new liver doesn't function as it should, and a patient may have to go back on to the waiting list to receive a new liver.

### Morbidity and mortality

Twenty-five million or one in 10 Americans are or have been afflicted with liver or biliary diseases. As of July 1, 2006, there were 17,298 patients on the UNOS

## QUESTIONS TO ASK THE DOCTOR

- What should I do to prepare for this operation?
- Who will tell me about the transplant process?
- Can I tour the transplant center?
- Who are the members of the transplant team and what are their jobs?
- Is there a special nursing unit for transplant patients?
- How many attending surgeons are available to do my type of transplant?
- Does the hospital do living donor transplants?
- Is a living donor transplant a choice in my case? If so, where will the living donor evaluation be done?
- What is the organ recovery cost if I have a living donor?
- Will I also need to change my lifestyle?
- How long will I have to stay in the hospital?
- Why is recovery such a slow process?

National Transplant Waiting List who were waiting for a liver transplantation. During the year running from July 2006 to July 2007, 6,532 liver transplants were performed. Of these, 6,274 were deceased donor transplants, and 258 were living donor transplants. For liver transplants performed from July 1, 1999 through June 30, 2001, the one-year survival rate was 86% for adults; 1,861 patients died while on the UNOS waiting list for the year ending June 30, 2002. More than 80% of children survive transplantation to adolescence and adulthood.

Since the introduction of cyclosporine and tacrolimus (drugs that suppress the immune response and keep it from attacking and damaging the new liver), success rates for liver transplantation have reached 80–90%.

Infections occur in about half of transplant patients and often appear during the first week. Biliary complications are apparent in about 22% of recipient patients (and 6% of donors), and vascular complications occur in 9.8% of recipient patients. Other complications in donors include re-operation (4.5%) and death (0.2%).

There are potential social, economic, and psychological problems, and a vast array of possible medical and surgical complications. Close medical surveillance must continue for the rest of the patient's life.

## Alternatives

There is no treatment that can help the liver with all of its functions; thus, when a person reaches a certain stage of liver disease, a liver transplant may be the only way to save the patient's life.

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### ORGANIZATIONS

American Liver Foundation. 75 Maiden Lane, Suite 603, New York, NY. 10038. (800) 465 4837 or (888) 443

7872. Fax: (212) 483.8179. E mail: [info@liverfoundation.org](mailto:info@liverfoundation.org). <http://www.liverfoundation.org>.

Hepatitis Foundation International (HFI). 504 Blick Drive, Silver Spring, MD. 20904 2901. (800) 891 0707 or (301) 622 4200. Fax: (301) 622 4702. Email: [hfi@comcast.net](mailto:hfi@comcast.net). <http://www.hepfi.org>

National Digestive Diseases, Information Clearinghouse. 2 Information Way, Bethesda, MD. 20892 3570. Email: [nddic@info.niddk.nih.gov](mailto:nddic@info.niddk.nih.gov).

National Institutes of Health, 9000 Rockville Pike, Bethesda, Maryland. 20892. (301) 496 4000. Email: [NIHInfo@OD.NIH.GOV](mailto:NIHInfo@OD.NIH.GOV). <http://www.nih.gov>.

United Network for Organ Sharing. 500 1100 Boulders Parkway, P.O. Box 13770. Richmond, VA. 23225. (888) 894 6361 or (804) 330 8500. <http://www.unos.org>

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## Living will

### Definition

A living will is a legal document with which patients instruct healthcare providers about their wishes with respect to medical procedures, in case they become incapacitated. The living will and the durable medical **power of attorney** are two federally mandated parts of what is known as advance medical directives.

### Purpose

Advance medical directives are legal mechanisms to assure that patients' wishes about medical procedures are carried out in their final days or when they are incapacitated. The documents reflect patients' rights of consent and medical choice under conditions in which patients can no longer choose for themselves what medical interventions they wish to undergo.

In 1990, recognizing the importance of patient treatment wishes at the end of life, Congress enacted the Patient Self-Determination Act (PSDA). This federal law requires that patients admitted to hospitals, **nursing homes**, home health agencies, HMOs, and hospices be informed of their right under state law to prepare advance healthcare directives and to have the

## KEY TERMS

**Durable medical power of attorney**—A legal document that empowers a person to make medical decisions for the patient should the patient be unable to make the decisions.

**Medical directives**—Legal documents that include a declaration of wishes pertaining to medical treatment (living will) and the stipulation of a proxy decision maker (power of attorney).

**Patient Self-Determination Act (PSDA)**—Federal law that ensures that medical providers offer the option of medical directives to patients and include the documents in their medical records.

**Surrogate**—A person who represents the wishes of the patient, chosen by the patient and stipulated by a legal document as power of attorney.

documents entered into their medical record. Each state has different requirements for the living will and the power of attorney. It is important to research and create advance medical directives before an accident or illness. Living wills have become customary in many parts of the country and are broadly respected by health care providers. However, most Americans do not have a living will or a medical power of attorney to ensure its compliance.

### Description

The living will can be a very broad or a very focused document, according to the wishes of the patient. It is the patient's declaration, a written statement of what he or she wants to occur in the event of a serious accident or illness. It is primarily directed to medical personnel about the type of care the patient wishes to receive or not receive, in situations of terminal illness or incapacitation.

The document commonly includes medical procedures that are usually administered to patients who are seriously ill, such as:

- blood or plasma transfusion
- cardiopulmonary resuscitation (CPR)
- dialysis
- administration of drugs
- use of a respirator
- surgery
- tissue and organ donation

The living will declaration can also include issues of pain medication, food, and water. Most states recognize that relief from pain and discomfort are procedures that most people wish to have and these are not considered life-prolonging treatments. In some states, however, food and water may be considered life prolonging, and the consideration to forego them may fall within the rights of the patient to refuse. What may be included in the living will depends upon the state.

The living will—in some states called instructions, directive to physicians, or declaration—does not require a surrogate (an appointed person) to make decisions for the patient. Most states include these types of instructions in their medical durable power of attorney forms. Not all states, however, recognize separate living wills as legally binding; California, for instance, does not.

### Preparation

The living will should be given careful thought, and be talked about with patient's family, physician, and care providers. It is highly recommended that discussion of patient wishes occur before medical treatment is necessary, because the living will involves the patient's family and loved ones, who are expected to assist in its implementation. It should be researched for the state in which the patient is most likely to receive medical care, and be dated and signed before two witnesses.

The living will may be drafted on standardized forms, with or without the assistance of an attorney. The document may be revoked in writing, or orally, by either the patient (the person making the advance directive) or by a designated proxy (a surrogate) at any time. If the patient does not specify in the living will a particular element of treatment or treatment withdrawal, then it is not included. It is important that living wills be as specific and detailed as possible.

Most hospitals offer advance medical directive resources, commonly in the religious office attached to the hospital. Coupled with a durable medical power of attorney, the living will ensures in advance that patient wishes about the quality of **death** are respected.

### Normal results

The living will, whether prepared prior to hospitalization or prepared once the patient is admitted, is placed in the patient's medical chart along with other documents such as the medical power of attorney declaration. Providers are required by federal law to honor this declaration of the patient's wishes. The document serves as a statement of intentions on the part of the patient and can be very important to family

members, healthcare providers, and patient proxy during a very distressful and uncertain time.

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Caring Connections. 1700 Diagonal Road, Suite 625, Alexandria, Virginia 22314. (703) 837 1500. Fax: (703) 837 1233. Toll free hotline: (800) 658 8898. <http://www.caringinfo.org/> (accessed April 1, 2008).

U.S. Living Will Registry. 523 Westfield Ave., P.O. Box 2789, Westfield, NJ 07091 2789. Toll free: (800) LIV WILL or (800) 548 9455. <http://www.uslivingwillregistry.com/> (accessed April 1, 2008).

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Lobectomy, hepatic see **Hepatectomy**

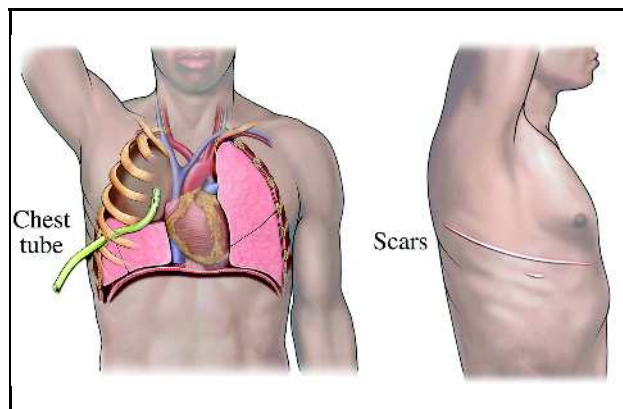
## Lobectomy, pulmonary

### Definition

A lobectomy is the removal of a lobe, or section, of the lung.

### Purpose

Lobectomies are performed to prevent the spread of cancer to other parts of the lung or other parts of the body, as well as to treat patients with such noncancerous diseases as chronic obstructive pulmonary disease



**A post-operative lobectomy.** (Nucleus Medical Art, Inc. / Alamy)

(COPD). COPD includes emphysema and chronic bronchitis, which cause airway obstruction.

## Demographics

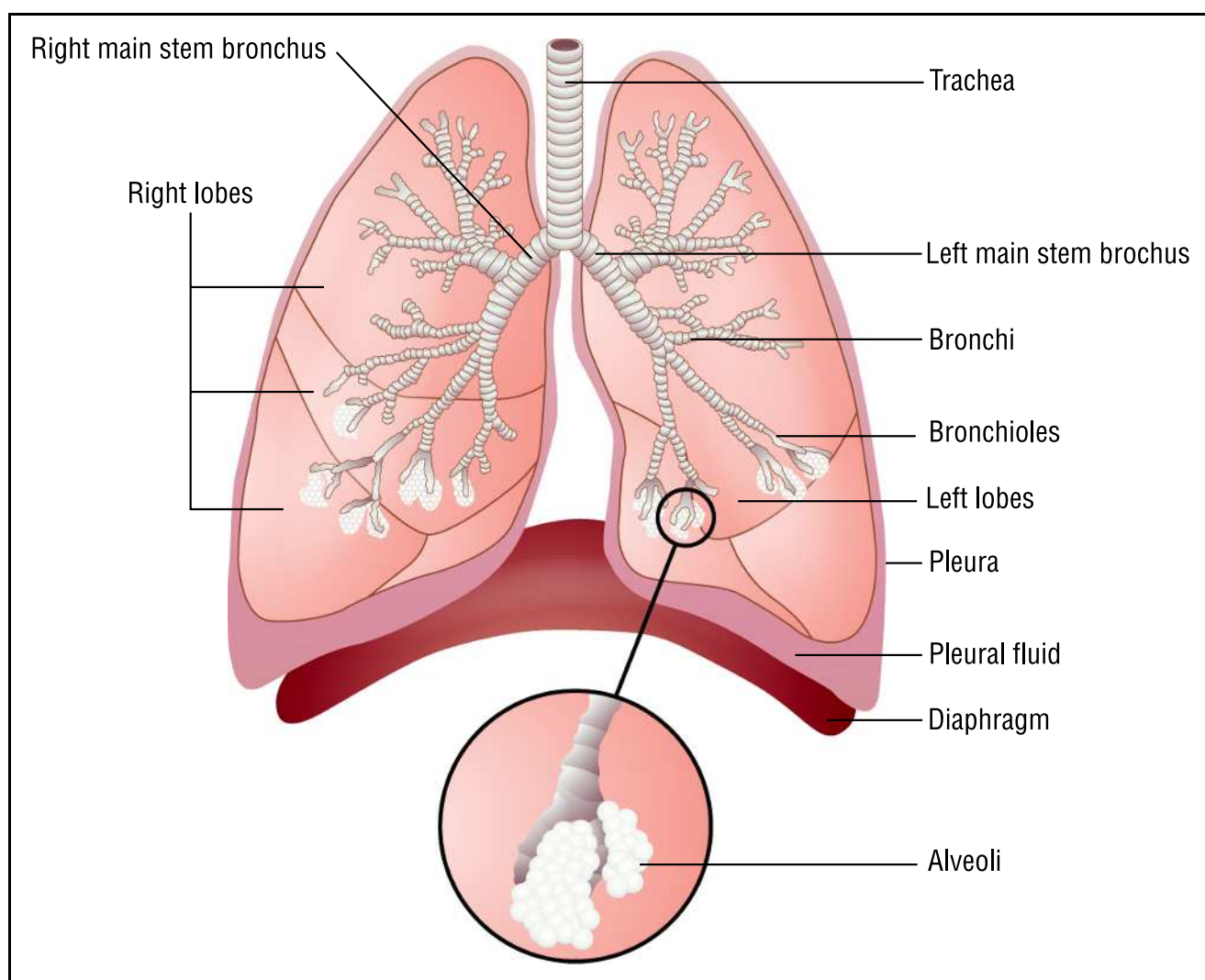
### Lung cancer

Lung cancer is the leading cause of cancer-related deaths in the United States. About 213,380 patients were newly diagnosed with lung cancer in 2007 (about 114,760 in men and 98,620 in women). It is expected to claim nearly 160,390 lives in 2007 (89,510 in men and 70,880 in women). Lung cancer kills more people than cancers of the breast, prostate, colon, and pancreas combined. Cigarette smoking accounts for nearly 90% of cases of lung cancer in the United States.

Lung cancer is the second most common cancer among both men and women and is the leading cause of **death** from cancer in both sexes. In addition to the use of tobacco as a major cause of lung cancer among smokers, second-hand smoke contributes to the development of lung cancer among nonsmokers. Exposure to asbestos and other hazardous substances is also known to cause lung cancer. Air pollution is also a probable cause, but makes a relatively small contribution to incidence and mortality rates. Indoor exposure to radon may also make a small contribution to the total incidence of lung cancer in certain geographic areas of the United States.

In each of the major racial/ethnic groups in the United States, the rates of lung cancer among men are about two to three times greater than the rates among women. Among men, age-adjusted lung cancer incidence rates (per 100,000) range from a low of about 14 among Native Americans to a high of 117 among African Americans, an eight-fold difference. For women, the rates range from approximately 15





(Cengage Learning, Gale.)

per 100,000 among Japanese Americans to nearly 51 among Native Alaskans, only a three-fold difference.

### ***Chronic obstructive pulmonary disease***

The following are risk factors for COPD:

- current smoking or a long-term history of heavy smoking
- employment that requires working around dust and irritating fumes
- long-term exposure to second-hand smoke at home or in the workplace
- a productive cough (with phlegm or sputum) most of the time
- shortness of breath during vigorous activity

- shortness of breath that grows worse even at lower levels of activity
- a family history of early COPD (before age 45)

### **Description**

Lobectomies of the lung are also called pulmonary lobectomies. The lungs are a pair of cone-shaped breathing organs within the chest. The function of the lungs is to draw oxygen into the body and release carbon dioxide, which is a waste product of the body's cells. The right lung has three lobes: a superior lobe, a middle lobe, and an inferior lobe. The left lung has only two, a superior and an inferior lobe. Some lobes exchange more oxygen than others. The lungs are covered by a thin membrane called the pleura. The bronchi are two tubes which lead from the trachea

## KEY TERMS

**Bronchodilator**—A drug that relaxes the bronchial muscles, resulting in expansion of the bronchial air passages.

**Corticosteroids**—Any of various adrenal-cortex steroids used as anti-inflammatory agents.

**Emphysema**—A chronic disease characterized by loss of elasticity and abnormal accumulation of air in lung tissue.

**Mycobacterium**—Any of a genus of nonmotile, aerobic, acid-fast bacteria that include numerous saprophytes and the pathogens causing tuberculosis and leprosy.

**Perfusion scan**—A lung scan in which a tracer is injected into a vein in the arm. It travels through the bloodstream and into the lungs to show areas of the lungs that are not receiving enough air or that retain too much air.

**Pulmonary rehabilitation**—A program to treat COPD, which generally includes education and counseling, exercise, nutritional guidance, techniques to improve breathing, and emotional support.

**Ventilation scan**—A lung scan in which a tracer gas is inhaled into the lungs to show the quantity of air that different areas of the lungs are receiving.

**V/Q scan**—A test in which both a perfusion scan and ventilation scan are done (separately or together) to show the quantity of air that different areas of the lungs are receiving.

(windpipe) to the right and left lungs. Inside the lungs are tiny air sacs called alveoli and small tubes called bronchioles. Lung cancer sometimes involves the bronchi.

To perform a lobectomy, the surgeon makes an incision (**thoracotomy**) between the ribs to expose the lung while the patient is under **general anesthesia**. The chest cavity is examined and the diseased lung tissue is removed. A drainage tube (chest tube) is then inserted to drain air, fluid, and blood out of the chest cavity. The ribs and chest incision are then closed.

A newer, minimally invasive lobectomy technique is called video-assisted thorascopic surgery (or VATS). This technique involves the use of three tiny incisions and micro-surgery tools, along with a scope. Thus far, research suggests that this technique offers many of the advantages of the classic technique, with fewer complications and a quicker recovery time. VATS, however, is

still only practiced at certain select centers, where surgeons have been specially trained in the relatively new method.

Lung surgery may be recommended for the following reasons:

- presence of tumors
- small areas of long-term infection (such as highly localized pulmonary tuberculosis or mycobacterial infection)
- lung cancer
- abscesses
- permanently enlarged (dilated) airways (bronchiectasis)
- permanently dilated section of lung (lobar emphysema)
- injuries associated with lung collapse (atelectasis, pneumothorax, or hemothorax)
- a permanently collapsed lung (atelectasis)

## Diagnosis/Preparation

### Diagnosis

In some cases, the diagnosis of a lung disorder is made when the patient consults a physician about chest pains or other symptoms. The symptoms of lung cancer vary somewhat according to the location of the tumor; they may include persistent coughing, coughing up blood, wheezing, fever, and weight loss. Patients with a lung abscess often have symptoms resembling those of pneumonia, including a high fever, loss of appetite, general weakness, and putrid sputum. The doctor will first take a careful history and listen to the patient's breathing with a **stethoscope**. Imaging studies include x-ray studies of the chest and **CT scans**. If lung cancer is suspected, the doctor will obtain a tissue sample for a biopsy. If a lung abscess is suspected, the doctor will send a sample of the sputum to a laboratory for culture and analysis.

For patients with lungs that have been damaged by emphysema or chronic bronchitis, pulmonary function tests are conducted prior to surgery to determine whether the patient will have enough healthy lung tissue remaining after surgery. A test may be used before surgery to help determine how much of the lung can safely be removed. This test is called a quantitative ventilation/perfusion scan, or a quantitative V/Q scan.

### Preparation

Patients should not take **aspirin** or ibuprofen for seven to 10 days before surgery. Patients should also consult their physician about discontinuing any blood-thinning medications such as Coumadin (warfarin).

The night before surgery, patients should not eat or drink anything after midnight.

### Aftercare

If no complications arise, the patient is transferred from the surgical **intensive care unit (ICU)** to a regular hospital room within one to two days. Patients may need to be hospitalized for seven to 10 days after a lobectomy. A tube in the chest to drain fluid will probably be required, as well as a mechanical ventilator to help the patient breathe. The chest tube normally remains in place until the lung has fully re-expanded. Oxygen may also be required, either on a temporary or permanent basis. A respiratory therapist will visit the patient to teach him or her deep breathing exercises. It is important for the patient to perform these exercises in order to re-expand the lung and lower the risk of pneumonia or other infections. The patient will be given medications to control postoperative pain. The typical recovery period for a lobectomy is one to three months following surgery.

### Risks

The specific risks of a lobectomy vary depending on the specific reason for the procedure and the general state of the patient's health; they should be discussed with the surgeon. In general, the risks for any surgery requiring a general anesthetic include reactions to medications and breathing problems. As previously mentioned, patients having part of a lung removed may have difficulty breathing and may require the use of oxygen. Excessive bleeding, wound infections, and pneumonia are possible complications of a lobectomy. The chest will hurt for some time after surgery, as the surgeon must cut through the patient's ribs to expose the lung. Patients with COPD may experience shortness of breath after surgery.

### Normal results

The outcome of lobectomies depends on the general condition of the patient's lung. This variability is related to the fact that lung tissue does not regenerate after it is removed. Therefore, removal of a large portion of the lung may require a person to need oxygen or ventilator support for the rest of his or her life. On the other hand, removal of only a small portion of the lung may result in very little change to the patient's quality of life.

## QUESTIONS TO ASK THE DOCTOR

Lobectomies are performed in a hospital by a thoracic surgeon, who is a physician who specializes in chest, heart, and lung surgery. Thoracic surgeons may further specialize in one area, such as heart surgery or lung surgery. They are board-certified through the Board of Thoracic Surgery, which is recognized by the American Board of Medical Specialties. A doctor becomes board certified by completing training in a specialty area and passing a rigorous examination.

### Morbidity and mortality rates

A small percentage of patients undergoing lung lobectomy die during or soon after the surgery. This percentage varies from about 3–6% depending on the amount of lung tissue removed. Of cancer patients with completely removable stage-1 non-small cell cancer of the lung (a disease in which malignant cancer cells form in the tissues of the lung), 50% survive five years after the procedure.

### Alternatives

#### *Lung cancer*

The treatment options for lung cancer are surgery, radiation therapy, and chemotherapy, either alone or in combination, depending on the stage of the cancer.

After the cancer is found and staged, the cancer care team discusses the treatment options with the patient. In choosing a treatment plan, the most significant factors to consider are the type of lung cancer (small cell or non-small cell) and the stage of the cancer. It is very important that the doctor order all the tests needed to determine the stage of the cancer. Other factors to consider include the patient's overall physical health; the likely side effects of the treatment; and the probability of curing the disease, extending the patient's life, or relieving his or her symptoms.

#### *Chronic obstructive pulmonary disease*

Although surgery is rarely used to treat COPD, it may be considered for people who have severe symptoms that have not improved with medication therapy. A significant number of patients with advanced COPD face a miserable existence and are at high risk of death, despite advances in medical technology. This

## QUESTIONS TO ASK THE DOCTOR

- What benefits can I expect from a lobectomy?
- What are the risks of this operation?
- What are the normal results?
- How long will my recovery take?
- Are there any alternatives to this surgery?

group includes patients who remain symptomatic despite the following:

- smoking cessation
- use of inhaled bronchodilators
- treatment with antibiotics for acute bacterial infections, and inhaled or oral corticosteroids
- use of supplemental oxygen with rest or exertion
- pulmonary rehabilitation

After the severity of the patient's airflow obstruction has been evaluated, and the foregoing interventions implemented, a pulmonary disease specialist should examine him or her, with consideration given to surgical treatment.

Surgical options for treating COPD include laser therapy or the following procedures:

- **Bullectomy.** This procedure removes the part of the lung that has been damaged by the formation of large air-filled sacs called bullae.
- **Lung volume reduction surgery.** In this procedure, the surgeon removes a portion of one or both lungs, making room for the remaining lung tissue to work more efficiently. Its use is considered experimental, although it has been used in selected patients with severe emphysema.
- **Lung transplant.** In this procedure a healthy lung from a donor who has recently died is given to a person with COPD.

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### ORGANIZATIONS

- American Cancer Society. 1599 Clifton Road, N.E., Atlanta, GA 30329 4251. (800) 227-2345. [www.cancer.org](http://www.cancer.org).
- American Lung Association, National Office. 1740 Broadway, New York, NY 10019. (800) LUNG USA. [www.lungusa.org](http://www.lungusa.org).
- National Cancer Institute (NCI), Building 31, Room 10A03, 31 Center Drive, Bethesda, MD 20892 2580. Phone: (800) 4 CANCEER. (301) 435-3848. [www.nci.nih.gov](http://www.nci.nih.gov).
- National Comprehensive Cancer Network. 50 Huntingdon Pike, Suite 200, Rockledge, PA 19046. (215) 728-4788. Fax: (215) 728-3877. [www.nccn.org/](http://www.nccn.org/).
- National Heart, Lung and Blood Institute (NHLBI). 6701 Rockledge Drive, P.O. Box 30105, Bethesda, MD 20824 0105. (301) 592-8573. [www.nhlhi.nih.gov/](http://www.nhlhi.nih.gov/).

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Local anesthesia see **Anesthesia, local**

## Long-term care insurance

### Definition

Long-term care (LTC) insurance provides for a person's care in cases of chronic illness or disability. Policies for LTC provide insurance coverage for times when an individual cannot independently manage the essential activities of daily living (ADLs). These are universally known as feeding, dressing, bathing, toileting, and walking, as well as moving oneself from a bed to a chair (transferring). However, disabilities are not



confined to these physical situations; they can be mental as well. The key element is that they limit the individual's ability to perform any of these functions.

### Purpose

The purpose of LTC insurance is to provide coverage for a succession of caregiving services for the elderly, the chronically ill, the disabled, or the seriously injured. This care may be provided in a skilled nursing facility (SNF); a nursing home; a mental hospital; in a person's home with a registered nurse (RN); a licensed practical nurse (LPN) or nurse's aide; or even in an assisted living facility (ALF). It is important to note the societal changes responsible for the increased need for professional services to care for our loved ones. Although today's families are smaller and a number of women are working outside the home, the majority of LTC continues to be provided by unpaid, informal caregivers—family members and friends.

In 2003, more than 24 million households in the United States included a caregiver who was 50 years of age or older. Approximately three in four unpaid caregivers were women—and one-third of them are more than 65 years old. Many caregivers, especially women, balance multiple roles by providing care for both their parents and their children. Caring for a loved one full-time can overwhelm even the most devoted family member. As a result, more caregivers than ever are turning to outside resources to help with the care of a family member.

### Demographics

In 2030, it is anticipated that people aged 65 and over will comprise 20% of the population. The United States Census Bureau is projecting that the population aged 65 and over will be 39.7 million in 2010, 53.7 million in 2020, and 70.3 million in 2030. As of 2003, at least 6.4 million people aged 65 and over require LTC; one in two people over the age of 85 require this kind of care now, and at least half of the population who are over the age of 85 will need help with ADLs.

Although the elderly rely on LTC most frequently, younger persons who have chronic illnesses, severe disabilities, or have experienced a serious injury may also benefit from having LTC insurance.

### Advantages to purchasing LTC insurance

The financial risks of illness and injury are rarely considered when one is healthy and able, but that is also when the greatest choice of products with the best flexibility in cost is available for those considering LTC insurance. Having a LTC insurance policy

KEY TERMS

**Chronic illness**—A condition that lasts a year or longer, limits activity, and may require ongoing care.

**Estate planning**—Preparation of a plan of administration and disposition of one's property before or after death, including will, trusts, gifts, and power of attorney.

**Indemnity**—Protection, as by insurance, against damage or loss.

**Long-term care (LTC)**—The type of care one may need if one can no longer perform activities of daily living (ADLs) alone, such as eating, bathing or getting dressed. It also includes the kind of care one would need with a severe cognitive impairment, such as Alzheimer's disease. Care can be received in a variety of settings, including the home, assisted living facilities, adult day care centers, or hospice facilities.

**Medicaid**—Public assistance funded through the state to individuals unable to pay for health care. Medicaid can be accessed only when all prior assets and funds are depleted.

**Medicare**—A government program, administered by the Social Security Administration, which provides financial assistance to individuals over the age of 65 for hospital and medical expenses. Medicare does not cover long-term care expenses.

**Skilled nursing facility (SNF)**—A facility equipped to handle individuals with 24-hour nursing needs, postoperative recuperation, or complex medical care demands, as well as chronically-ill individuals who can no longer live independently. These facilities must be licensed by the state in which they operate to meet standards of safety, staffing, and care procedures.

enables access to quality care and choice of care provider when the need is greatest. Purchasing a policy when a person does not need it gives them the opportunity to investigate the company's financial stability (whether it is solid and how it is rated), operating performance, insurance industry rating, and its claims ratio. Rates should be guaranteed renewable; and coverage should not be canceled because of age or a change in a person's health; nor should premiums be increased on a class-wide basis.

There are several government organizations that can be of assistance in the purchase, evaluation, and

monitoring of LTC insurance. One is the state health insurance assistance program—SHIP—that can review the policy before the actual purchase. Another excellent organization is the Health Insurance Association of America (HIAA), which protects consumers from the financial risks of injury and illness by providing affordable and flexible services that represent a choice. In the United States, HIAA focuses on managed care, and, specifically, advocates on issues such as disability income and LTC insurance.

The mission of the Health Insurance Association of America is to preserve financial security, freedom of choice, and dignity in LTC insurance. Because of its mission, HIAA seeks to:

- provide access to quality care and let a person choose where care is obtained
- eliminate out-of-pocket costs and avoid reliance on government programs for the poor
- ensure quality of life for a patient's caregivers

## Description

### *Advantages*

Having a LTC insurance policy cuts out-of-pocket costs and keeps the patient from having to rely on government assistance programs. Studies from the United States Department of Health and Human Services estimate that people with LTC insurance save between \$60,000 and \$75,000 in nursing home costs, more than \$100,000 for assisted living, and actually ensure a higher quality of life for their caregiver. By having LTC at home, spouses and other family members are able to continue working or run errands while their loved one is being care for.

People of all ages usually prefer to receive LTC in their own homes, or in homelike assisted-living facilities. More than three-quarters of older Americans in need of LTC live in their communities. Most receive no paid services. The majority of LTC is provided by unpaid, informal caregivers, such as family members and friends.

### *Government assistance*

Long-term care options can be uncoordinated and expensive for individuals, their families, and public programs. According to AARP (formerly known as American Association of Retired Persons) millions of Americans have no access to LTC services. They are caught in the trap of having too much money to qualify for government assistance, but not enough money to afford the types of services they need.

Recent changes in the United States federal tax law allow for a portion of a long-term insurance premium to be tax-deductible. The amount of the deduction increases with the insured person's age.

**Medicare** may cover a month or two of home health care after a stay in the hospital, but benefits are then usually capped. This government program, administered by the Social Security Administration, is well known for providing financial assistance to seniors 65 years of age and older and to the disabled—for medical and hospital expenses—but it does not cover LTC expenses. Medicare Supplement Insurance does not cover LTC either.

The federal/state **Medicaid** program is available, but the criteria to qualify for assistance is strict. Those who meet the guidelines for Medicaid must demonstrate financial need to receive assistance; most individuals must deplete most or all of their savings and assets before becoming eligible for any benefits. In 2006, approximately two-thirds of nursing home residents were dependent on Medicaid to finance at least some of their care. For the majority of residents, LTC insurance is cost-prohibitive. To make matters worse, preexisting conditions often prevent them from obtaining coverage for which they might qualify.

### *Personal policies*

Long-term care insurance policies are often complex. People who purchase them may not read the fine print and are later forced to cancel their policies because they do not fit their needs. Increasing rates factored into some long-term policies, known as climbing premiums, may also become prohibitively expensive. However, long-term care insurance can benefit consumers, provided that such items as affordability, coverage gaps, and timing of purchase are carefully considered.

It is advisable to check the financial stability and the claims ratio of an insurance company. Long-term insurance is a serious financial investment and should be considered a part of estate planning. A qualified, independent professional should be consulted to review the policy before purchase. The state health insurance assistance program (SHIP) is also available to answer questions.

The type of care that an individual seeks or requires is an important consideration before purchasing a policy. Currently, there is no universal standard for defining long-term care facilities. A placement that is covered under one company's policy may not be covered by another. Physicians can also play a part in denial of a placement by stating that the facility of

choice is either not adequate or too advanced for an individual's needs.

When to purchase a policy is another important consideration. Individuals with a preexisting diagnosis for a debilitating condition or illness may not be eligible for coverage. This clause is common in most insurance policies of any type. However, purchasing a policy too far in advance of an anticipated need can work against a buyer. The health care industry is currently in a state of flux, and technological advances are rapid. The benefits provided in a policy that is purchased at one point in time may not match the care available in the distant future, giving the company reason to deny benefits.

Generally, LTC insurance operates as an indemnity program for potential nursing home and home health care costs. Additionally, many policies provide coverage for adult daycare, for care delivered in an assisted living facility, and for **hospice** care. Rarely are all costs covered. Some LTC policies are pure indemnity programs, which pay the insured a daily benefit contracted for by the insured. The pure indemnity program pays the full daily benefit regardless of the amount of care that the insured receives each day.

Other LTC policies pay for covered losses, or the cost of care actually received each day, up to the selected daily benefit level. This type of policy is referred to as a pool-of-money contract.

Insurance for LTC is available either as part of a group or as individual coverage, although most policies are currently purchased by individuals. Most policies cover skilled, custodial, and intermediate LTC services. A purchaser would be wise to consider a contract that covers all of these levels.

Benefits under a LTC contract are triggered in a tax-qualified policy when an insured person becomes unable to perform a number of activities associated with normal daily living or develops a cognitive impairment that requires supervision. Non-tax-qualified policies usually offer more liberal eligibility criteria. This includes long-term benefits required due to medical necessity.

### Risks

Long-term care insurance policies can be expensive and may be restrictive in what they provide. Before purchasing the policy, persons should be certain that the cost is within their means and that the plan will meet their anticipated needs. Some policies allow policy holders to use survivor **death** benefits for health care needs. It is advisable for several different policies to be compared in detail. Policies that seem

## QUESTIONS TO ASK BEFORE PURCHASING LTC INSURANCE

- Will the policy meet my needs?
- Is the policy affordable?
- What restrictions or exemptions exist?
- Under what conditions, if any, can this plan be canceled?
- Are there any laws to protect me from insurance companies or LTC facilities that provide substandard conditions and/or services?

too inexpensive when compared against the competition should be carefully evaluated. There may be hidden clauses in the contracts that limit coverage.

### Organizations that can help consumers

The Health Insurance Association of America (HIAA) protects consumers from the financial risks of illness and injury by providing flexible and affordable products and services that embody freedom of choice, and advocates on a number of issues—including LTC insurance.

The United States Department of Health and Human Services oversees the Administration on Aging's Ombudsmen Program. Established in 1972 by the Older Americans Act, the Program operates throughout the country on behalf of aging residents. Its purpose is to investigate over 260,000 complaints annually regarding various topics, including selection and payment of LTC insurance policies. The ombudsmen advocate for residents of **nursing homes**, LTC homes, assisted living facilities, and similar adult care facilities; they have made dramatic differences in the lives of LTC residents. On behalf of individuals and groups of residents, they provide information to residents and their families about the LTC system and work to improve local, state and national level programs. Ombudsmen also provide an ongoing presence in LTC facilities, monitoring care and conditions and providing a voice for those who are unable to speak for themselves.

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#### ORGANIZATIONS

- AARP. 601 E. Street NW, Washington, DC 20049. (888) 687 2277. <http://www.aarp.org>.
- American College of Healthcare Executives. One North Franklin, Suite 1700, Chicago, IL 60606 4425. (312) 424 2800. <http://www.ache.org>.
- American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464 5000. <http://www.ama-assn.org>.
- Health Insurance Association of America. 601 Pennsylvania Avenue, NW, South Building, Washington, DC 20004 1204. (202) 778 3200. <http://www.hiaa.org>.
- U.S. Administration on Aging (AOA), United States Department of Health and Human Services. 330 Independence Avenue, SW, Washington, DC 20201. (202) 619 0724. <http://www.aoa.gov>.
- United States Department of Health and Human Services, 200 Independence Avenue, SW, Washington, DC 20201. (877) 696 6775. <http://www.hhs.gov>.

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Lower GI exam see **Barium enema**

LTC insurance see **Long-term care insurance**

Lumbar laminectomy see **Laminectomy**

Lumbar puncture see **Cerebrospinal fluid (CSF) analysis**

## Lumpectomy

### Definition

Lumpectomy is a type of surgery for breast cancer. It is considered "breast-conserving" surgery because only the malignant tumor and a surrounding margin of normal breast tissue are removed. Lymph nodes in the armpit (axilla) may also be removed. This procedure is also called lymph node dissection.

### Purpose

Lumpectomy is a surgical treatment for newly diagnosed breast cancer. It is estimated that at least 50% of women with breast cancer are good candidates for this procedure. The location, size, and type of tumor are of primary importance when considering breast cancer surgery options. The size of the breast is another factor the surgeon considers when recommending surgery. The patient's psychological outlook, as well as her lifestyle and preferences, should also be taken into account when treatment decisions are being made.

The extent and severity of a cancer is evaluated, or "staged," according to a fairly complex system. Staging considers the size of the tumor and whether the cancer has spread (metastasized) to adjacent tissues, such as the chest wall, the lymph nodes, and/or to distant parts of the body. Women with early stage breast cancers are usually better candidates for lumpectomy. In most cases, a course of radiation therapy after surgery is part of the treatment. Chemotherapy or hormone treatment may also be prescribed.

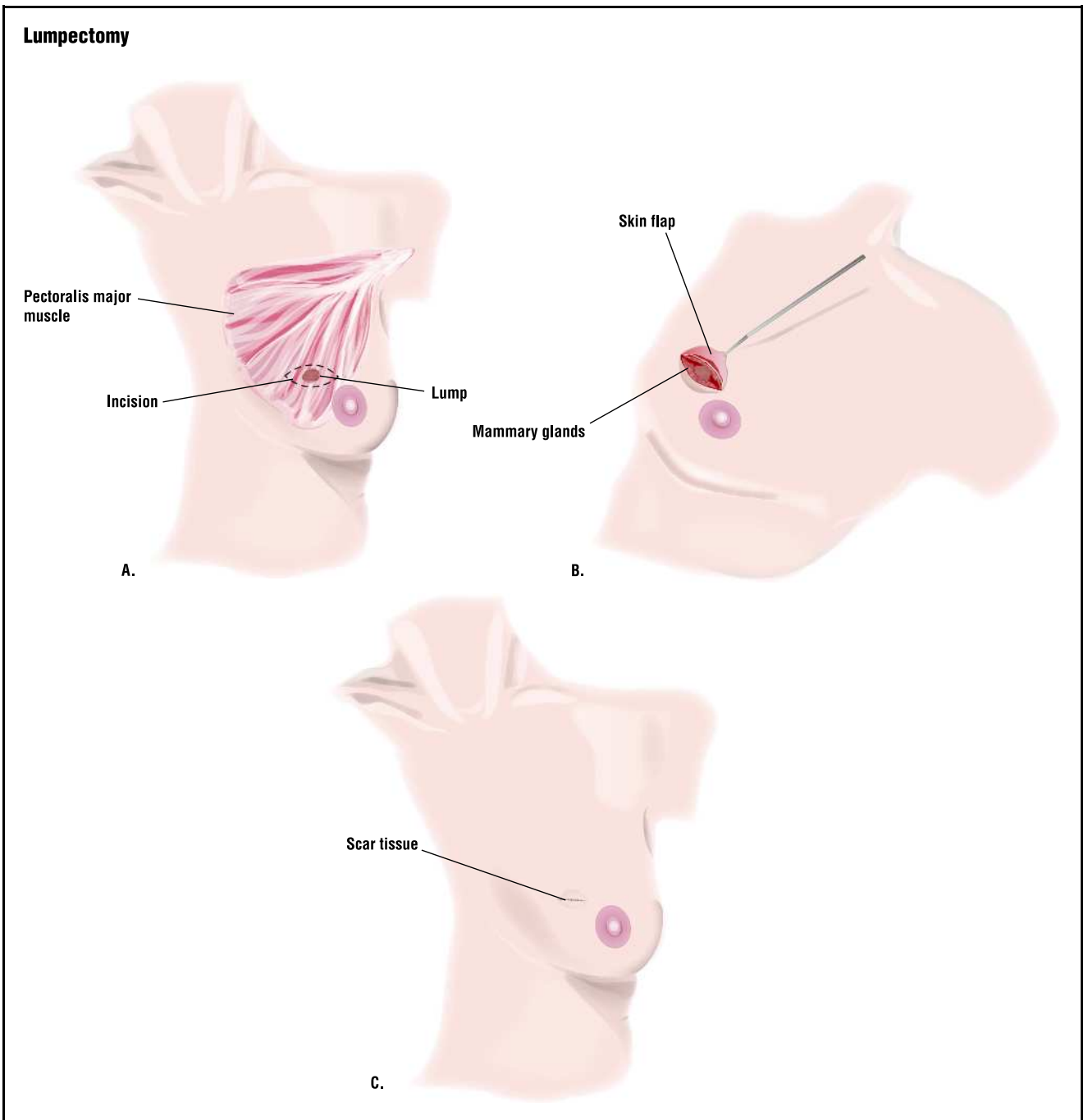
In some instances, women with later stage breast cancer may be able to have lumpectomies. Chemotherapy may be administered before surgery to decrease tumor size and the chance of metastasis in selected cases.

### Contraindications to lumpectomy

There are a number of factors that may prevent or prohibit a breast cancer patient from having a lumpectomy. The tumor itself may be too large or located in an area where it would be difficult to remove with good cosmetic results. Sometimes several areas of cancer are found in one breast, so the tumor cannot be removed as a single lump. A cancer that has already attached itself to nearby structures, such as the skin or the chest wall, needs more extensive surgery.

Certain medical or physical circumstances may also eliminate lumpectomy as a treatment option. Sometimes lumpectomy may be attempted, but the surgeon is unable to remove the tumor with a sufficient amount of surrounding normal tissue. This may





During a lumpectomy, a small incision is made around the area of the lump (A). The skin is pulled back, and the tumor removed (B). The incision is closed (C). (Illustration by GGS Information Services. Cengage Learning, Gale.)

be termed “persistently positive margins,” or “lack of clear margins.” Lumpectomy is suitable for women who have had previous lumpectomies and have a recurrence of breast cancer.

Because of the need for radiation therapy after lumpectomy, this surgery may be medically unacceptable. A

breast cancer discovered during pregnancy is not amenable to lumpectomy because radiation therapy is part of the treatment. Radiation therapy cannot be administered to pregnant women because it may injure the fetus. If, however, delivery would be completed prior to the need for radiation, pregnant women may undergo lumpectomy. A woman who has already had therapeutic

## KEY TERMS

**Axillary lymph node**—Lymph nodes under the arm.

**Lymph node**—A small mass of tissue in the form of a knot or protuberance. They are the primary source of lymph fluid, which serves in the body's defense by removing toxic fluids and bacteria.

**Quadrantectomy**—Removal of a quadrant, or about a quarter of the breast.

radiation to the chest area for other reasons cannot undergo additional exposure for breast cancer therapy.

The need for radiation therapy may also be a barrier due to nonmedical concerns. Some women simply fear this type of treatment and choose more extensive surgery so that radiation will not be required. The commitment of time, usually five days a week for six weeks, may not be acceptable for others. This may be due to financial, personal, or job-related constraints. Finally, in geographically isolated areas, a course of radiation therapy may require lengthy travel and perhaps unacceptable amounts of time away from family and other responsibilities.

## Demographics

The American Cancer Society estimated that in 2007, 240,510 new cases of breast cancer would be diagnosed in the United States and 40,460 women would die as a result of the disease. Approximately one in eight women will develop breast cancer at some point in her life. The risk of developing breast cancer increases with age: women aged 30 to 40 have a one in 252 chance of developing breast cancer; women aged 40 to 50 have a one in 68 chance; women aged 50 to 60 have a one in 35 chance; and women aged 60 to 70 have a one in 27 chance—and these statistics do not even account for genetic and environmental factors.

## Description

Any amount of tissue, from 1–50% of the breast, may be removed and called a lumpectomy. Breast conservation surgery is a frequently used synonym for lumpectomy. Partial **mastectomy**, **quadrantectomy**, segmental excision, wide excision, and tylectomy are other, less commonly used names for this procedure.

The surgery is usually done while the patient is under general anesthetic. Local anesthetic with additional sedation may be used for some patients. The

tumor and surrounding margin of tissue is removed and sent to a pathologist for examination. The surgical site is then closed. Newer techniques may use **magnetic resonance imaging** guidance to more accurately identify the breast tissue to be removed. Additionally, laser instruments may be used to perform the actual lumpectomy.

If axillary lymph nodes were not removed before, a second incision may be made in the armpit. The fat pad that contains lymph nodes is removed from this area and is also sent to the pathologist for analysis. This portion of the procedure is called an axillary lymph node dissection; it is critical for determining the stage of the cancer. Typically, 10 to 15 nodes are removed, but the number may vary. A newer alternative to axillary lymph node dissection involves removal of only one lymph node. This technique, called sentinel node biopsy, samples just the first lymph node to which the breast tissue drains. If the sentinel node is negative, it is likely that no cancer has spread to more distant lymph nodes. If the sentinel node is positive, then the surgeon may have to proceed with an axillary lymph node dissection. Surgical drains may be left in place in either location to prevent fluid accumulation. The surgery may last from one to three hours.

## Diagnosis/Preparation

Routine preoperative preparations, such as having nothing to eat or drink the night before surgery, are typically ordered for a lumpectomy. Information about expected outcomes and potential complications is also part of preparation for lumpectomy, as it is for any surgical procedure. It is especially important that women know about sensations they might experience after the operation, so the they are not misinterpreted as signs of further cancer or poor healing.

If the tumor is not able to be felt (not palpable), a pre-operative localization procedure is needed. A fine wire, or other device, is placed at the tumor site, using x ray or **ultrasound** for guidance. This is usually done in the radiology department of a hospital. The woman is most often sitting up and awake, although some sedation may be administered.

## Aftercare

The patient may stay in the hospital one or two days, or return home the same day. This generally depends on the extent of the surgery, the medical condition of the patient, and physician and patient preferences. A woman usually goes home with a small bandage. The inner part of the surgical site usually

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Lumpectomy is usually performed by a general surgeon or surgical oncologist. Radiation therapy is administered by a radiation oncologist, and chemotherapy by a medical oncologist. The procedure is frequently done in a hospital setting (especially if lymph nodes are to be removed at the same time), but specialized outpatient facilities are sometimes preferred.

has dissolvable **stitches**. The skin may be sutured or stitched; or the skin edges may be held together with steristrips, which are special thin, clear pieces of tape.

After a lumpectomy, patients are usually cautioned against lifting anything that weighs over five pounds for several days. Other activities may be restricted (especially if the axillary lymph nodes were removed) according to individual needs. Pain is often enough to limit inappropriate motion. Women are often instructed to wear a well-fitting support bra both day and night for approximately one week after surgery.

Pain is usually well controlled with prescribed medication. If it is not, the patient should contact the surgeon, as severe pain may be a sign of a complication, which needs medical attention. A return visit to the surgeon is normally scheduled approximately ten days to two weeks after the operation.

Radiation therapy is usually started as soon as possible after lumpectomy. Other additional treatments, such as chemotherapy or hormone therapy, may also be prescribed. The timing of these is specific to each individual patient.

### Risks

The risks are similar to those associated with any surgical procedure. Risks include bleeding, infection, breast asymmetry, anesthesia reaction, or unexpected scarring. A lumpectomy may also cause loss of sensation in the breast. The size and shape of the breast will be affected by the operation. Fluid can accumulate in the area where tissue was removed, requiring drainage.

If lymph node dissection is performed, there are several potential complications. A woman may experience decreased feeling in the back of her armpit. She may also experience other sensations, including numbness, tingling, or increased skin sensitivity. An

## QUESTIONS TO ASK THE DOCTOR

- Why is a lumpectomy recommended?
- What method of anesthesia/pain relief will be used?
- Will radiation or chemotherapy be administered?
- Will a lymph node dissection be performed?
- Am I a candidate for sentinel node biopsy?

inflammation of the arm vein, called phlebitis, can occur. There may be injury to the nerves controlling arm motion.

There is a risk of developing lymphedema (swelling of the arm) after axillary lymph node dissection. This swelling can range from mild to very severe. It can be treated with elastic **bandages** and specialized physical therapy, but it is a chronic condition, requiring continuing care. Lymphedema can arise at any time, even years after surgery.

### Normal results

When lumpectomy is performed, it is anticipated that it will be the definitive surgical treatment for breast cancer. Other forms of therapy, especially radiation, are often prescribed as part of the total treatment plan. The expected outcome is no recurrence of the breast cancer.

### Morbidity and mortality rates

The outcome of breast cancer is very dependent of the stage at the time of diagnosis. For stage 0 disease, the five-year survival is almost 100%. For stage I (early/lymph node negative), the five-year survival is also almost 100%. For stage II (early/lymph node positive), the five-year survival decreases to 81-92%. For stage III disease (locally advanced), the five-year survival is 54-67%. For women with stage IV (metastatic) breast cancer, the five-year survival is about 20%.

Approximately 17% of patients develop lymphedema after axillary lymph node dissection, while only 3% of patients develop lymphedema after sentinel node biopsy. Five percent of women are unhappy with the cosmetic effects of the surgery.

### Alternatives

A procedure in which the entire affected breast is removed, called a mastectomy, has been shown to be

equally effective in treating breast cancer as lumpectomy, in terms of rates of recurrence and survival. Some women may choose to have a mastectomy because they strongly fear a recurrence of breast cancer, and may consider a lumpectomy too risky. Others may feel uncomfortable with a breast that has had a cancer, and would experience more peace of mind with the entire breast removed.

## Resources

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- Khatri, VP and JA Asensio. *Operative Surgery Manual*. 1st ed. Philadelphia: Saunders, 2003.
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### PERIODICALS

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- Dershaw, D. David. "Breast imaging and the conservative treatment of breast cancer." *Radiologic Clinics of North America* 40, no. 3 (May 2002): 501-16.

### ORGANIZATIONS

- American Cancer Society. 1599 Clifton Rd. NE, Atlanta, GA 30329-4251. (800) 227-2345. <http://www.cancer.org>.
- National Cancer Institute (NCI). (800) 4-CANCER. <<http://cancertrials.nci.nih.gov/types/breast/treatment/sentnode>>.
- National Lymphedema Network. 2211 Post St., Suite 404, San Francisco, CA 94115-3427. (800) 541-3259 or (415) 921-1306. <http://www.wenet.net/~lymphnet>.

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## Lung biopsy

### Definition

Lung biopsy is a procedure for obtaining a small sample of lung tissue for examination. The tissue is usually examined under a microscope, and may be sent to a microbiological laboratory for culture. Microscopic examination is performed by a pathologist.

### Purpose

A lung biopsy is usually performed to determine the cause of abnormalities, such as nodules that appear on chest x rays. It can confirm a diagnosis of cancer, especially if malignant cells are detected in the

patient's sputum or bronchial washing. In addition to evaluating lung tumors and their associated symptoms, lung biopsies may be used to diagnose lung infections, especially tuberculosis and *Pneumocystis pneumonia*, drug reactions, and chronic diseases of the lungs such as sarcoidosis and pulmonary fibrosis.

A lung biopsy can be used for treatment as well as diagnosis. **Bronchoscopy**, a type of lung biopsy performed with a long, flexible slender instrument called a bronchoscope, can be used to clear a patient's air passages of secretions and to remove airway blockages.

### Demographics

Lung cancer is the leading cause of cancer-related deaths in the United States. About 213,380 patients were newly diagnosed with lung cancer in 2007 (about 114,760 in men and 98,620 in women). It is expected to claim nearly 160,390 lives in 2007 (89,510 in men and 70,880 in women). Lung cancer kills more people than cancers of the breast, prostate, colon, and pancreas combined. Cigarette smoking accounts for nearly 90% of cases of lung cancer in the United States.

### Description

#### Overview

The right and left lungs are separated by the mediastinum, which contains the heart, trachea, lymph nodes, and esophagus. Lung biopsies sometimes involve **mediastinoscopy**.

#### Types of lung biopsies

Lung biopsies are performed using a variety of techniques, depending on where the abnormal tissue is located in the lung, the health and age of the patient, and the presence of lung disease. A bronchoscopy is ordered if a lesion identified on the x ray seems to be located on the wall (periphery) of the chest. If the suspicious area lies close to the chest wall, a needle biopsy can be done. If both methods fail to diagnose the problem, an open lung biopsy may be performed. When there is a question about whether the lung cancer or suspicious mass has spread to the lymph nodes in the mediastinum, a mediastinoscopy is performed.

**BRONCHOSCOPIC BIOPSY.** During the bronchoscopy, a thin, lighted tube (bronchoscope) is passed from the nose or mouth, down the windpipe (trachea) to the air passages (bronchi) leading to the lungs. Through the bronchoscope, the physician views the airways, and is able to clear mucus from blocked airways, and collect cells or tissue samples for laboratory analysis.



## KEY TERMS

**Bronchoscopy**—A medical test that enables the physician to see the breathing passages and the lungs through a hollow, lighted tube.

**Chest x ray**—Brief exposure of the chest to radiation to produce an image of the chest and its internal structures.

**Endotracheal tube**—A hollow tube that is inserted into the windpipe to administer anesthesia.

**Lung nodule**—See pulmonary nodule.

**Lymph nodes**—Small, bean-shaped structures that serve as filters, scattered along the lymphatic vessels. Lymph nodes trap bacteria or cancer cells that are traveling through the lymphatic system.

**Malignant**—Cancerous.

**Mediastinoscopy**—A procedure that allows the physician to see the organs in the mediastinal space using a thin, lighted, hollow tube (a mediastinoscope).

**Mediastinum**—The area between the lungs, bounded by the spine, breastbone, and diaphragm.

**Pleural cavity**—The space between the lungs and the chest wall.

**Pneumothorax**—A condition in which air or gas enters the pleura (area around the lungs) and causes a collapse of the lung.

**Pulmonary nodule**—A lesion surrounded by normal lung tissue. Nodules may be caused by bacteria, fungi, or a tumor (benign or cancerous).

**Sputum**—A mucus-rich secretion that is coughed up from the passageways (bronchial tubes) and the lungs.

**Sputum cytology**—A lab test in which a microscope is used to check for cancer cells in the sputum.

**Thoracentesis**—Removal of fluid from the pleural cavity.

**NEEDLE BIOPSY.** The patient is mildly sedated, but awake during the needle biopsy procedure. He or she sits in a chair with arms folded in front on a table. An x-ray technician uses a computerized axial tomography (CAT) scanner or a fluoroscope to identify the precise location of the suspicious areas. Markers are placed on the overlying skin to identify the biopsy site. The skin is thoroughly cleansed with an antiseptic solution, and a local anesthetic is injected to numb the area. The patient will feel a brief stinging sensation when the anesthetic is injected.

The physician makes a small incision, about half an inch (1.25 cm) in length. The patient is asked to take a deep breath and hold it while the physician inserts the biopsy needle through the incision into the lung tissue to be biopsied. The patient may feel pressure, and a brief sharp pain when the needle touches the lung tissue. Most patients do not experience severe pain. The patient should refrain from coughing during the procedure. The needle is withdrawn when enough tissue has been obtained. Pressure is applied at the biopsy site and a sterile bandage is placed over the incision. A **chest x ray** is performed immediately after the procedure to check for potential complications. The entire procedure takes 30–60 minutes.

**OPEN BIOPSY.** Open biopsies are performed in a hospital **operating room** under **general anesthesia**. Once the anesthesia has taken effect, the surgeon makes an incision over the lung area, a procedure called a **thoracotomy**. Some lung tissue is removed and the incision is closed with sutures. Chest tubes are placed with one end inside the lung and the other end protruding through the closed incision. Chest tubes are used to drain fluid and blood, and re-expand the lungs. They are usually removed the day after the procedure. The entire procedure normally takes about an hour. A chest x ray is performed immediately after the procedure to check for potential complications.

**VIDEO-ASSISTED THORACOSCOPIC SURGERY.** A minimally-invasive technique, video-assisted thoracoscopic surgery (VATS) can be used to biopsy lung and mediastinal lesions. VATS may be performed on selected patients in place of open lung biopsy. While the patient is under general anesthesia, the surgeon makes several small incisions in the his or her chest wall. A thorascope, a thin, hollow, lighted tube with a tiny video camera mounted on it, is inserted through one of the small incisions. The other incisions allow the surgeon to insert special instruments to retrieve tissue for biopsy.

**MEDIASTINOSCOPY.** This procedure is performed under general anesthesia. A 2–3 inch (5–8 cm) incision is made at the base of the neck. A thin, hollow, lighted tube, called a mediastinoscope, is inserted through the incision into the space between the right and the left lungs. The surgeon removes any lymph nodes or tissues that look abnormal. The mediastinoscope is then removed, and the incision is sutured and bandaged. A mediastinoscopy takes about an hour.

## Diagnosis/Preparation

### Diagnosis

Before scheduling a lung biopsy, the physician performs a careful evaluation of the patient's medical

history and symptoms, and performs a **physical examination**. Chest x rays and sputum cytology (examination of cells obtained from a deep-cough mucus sample) are other diagnostic tests that may be performed. An **electrocardiogram** (EKG) and laboratory tests may be performed before the procedure to check for blood clotting problems, anemia, and blood type, should a **transfusion** become necessary.

### *Preparation*

During a preoperative appointment, usually scheduled within one to two weeks before the procedure, the patient receives information about what to expect during the procedure and the recovery period. During this appointment or just before the procedure, the patient usually meets with the physician (or physicians) performing the procedure (the pulmonologist, interventional radiologist, or thoracic surgeon).

A chest x ray or CAT scan of the chest is used to identify the area to be biopsied.

About an hour before the biopsy procedure, the patient receives a sedative. Medication may also be given to dry up airway secretions. General anesthesia is not used for this procedure.

For at least 12 hours before the open biopsy, VATS, or mediastinoscopy procedures, the patient should not eat or drink anything. Prior to these procedures, an intravenous line is placed in a vein in the patient's arm to deliver medications or fluids as necessary. A hollow tube, called an endotracheal tube, is passed through the patient's mouth into the airway leading to the lungs. Its purpose is to deliver the general anesthetic. The chest area is cleansed with an antiseptic solution. In the mediastinoscopy procedure, the neck is also cleansed to prepare for the incision.

### *Smoking cessation*

Patients who will undergo surgical diagnostic and treatment procedures should be encouraged to stop smoking and stop using tobacco products. The patient needs to make the commitment to be a nonsmoker after the procedure. Patients able to stop smoking several weeks before surgical procedures have fewer postoperative complications. **Smoking cessation** programs are available in many communities. The patient should ask a health care provider for more information if he or she needs help with smoking cessation.

### *Informed consent*

**Informed consent** is an educational process between health care providers and patients. Before any procedure is performed, the patient is asked to

sign a consent form. Prior to signing the form, the patient should understand the nature and purpose of the diagnostic procedure or treatment, its risks and benefits, and alternatives, including the option of not proceeding with the test or treatment. During the discussions, the health care providers are available to answer the patient's questions about the consent form or procedure.

### *Aftercare*

#### *Needle biopsy*

Following a needle biopsy, the patient is allowed to rest comfortably. He or she may be required to lie flat for two hours following the procedure to prevent the risk of bleeding. The nurse checks the patient's status at two-hour intervals. If there are no complications after four hours, the patient can go home once he or she has received instructions about resuming normal activities. The patient should rest at home for a day or two before returning to regular activities, and should avoid strenuous activities for one week after the biopsy.

#### *Open biopsy, VATS, or mediastinoscopy*

After an open biopsy, VATS, or mediastinoscopy, the patient is taken to the **recovery room** for observation. The patient receives oxygen via a face mask or nasal cannula. If no complications develop, the patient is taken to a hospital room. Temperature, blood oxygen level, pulse, blood pressure, and respiration are monitored. Chest tubes remain in place after surgery to prevent the lungs from collapsing, and to remove blood and fluids. The tubes are usually removed the day after the procedure.

The patient may experience some grogginess for a few hours after the procedure. He or she may have a sore throat from the endotracheal tube. The patient may also have some pain or discomfort at the incision site, which can be relieved by pain medication. It is common for patients to require some pain medication for up to two weeks following the procedure.

After receiving instructions about resuming normal activities and caring for the incision, the patient usually goes home the day after surgery. The patient should not drive while taking narcotic pain medication.

Patients may experience fatigue and muscle aches for a day or two because of the general anesthesia. The patient can gradually increase activities, as tolerated. Walking is recommended. Sutures are usually removed after one to two weeks.

The physician should be notified immediately if the patient experiences extreme pain, light-headedness, or difficulty breathing after the procedure. Sputum may be slightly bloody for a day or two after the procedure. Heavy or persistent bleeding requires evaluation by the physician.

### Risks

Lung biopsies should not be performed on patients who have a bleeding disorder or abnormal blood clotting because of low platelet counts, or prolonged **prothrombin time (PT)** or **partial thromboplastin time (PTT)**. Platelets are small blood cells that play a role in the blood clotting process. PT and PTT measure how well blood is clotting. If clotting times are prolonged, it may be unsafe to perform a biopsy because of the risk of bleeding. If the platelet count is lower than 50,000/cubic mm, the patient may be given a platelet transfusion as a temporary relief measure, and a biopsy can then be performed.

In addition, lung biopsies should not be performed if other tests indicate the patient has enlarged alveoli associated with emphysema, pulmonary hypertension, or enlargement of the right ventricle of the heart (cor pulmonale).

The normal risks of any surgical procedure include bleeding, infection, or pneumonia. The risk of these complications is higher in patients undergoing open biopsy procedures, as is the risk of pneumothorax (lung collapse). In rare cases, the lung collapses because of air that leaks in through the hole made by the biopsy needle. A chest x ray is done immediately after the biopsy to detect the development of this potential complication. If a pneumothorax occurs, a chest tube is inserted into the pleural cavity to re-expand the lung. Signs of pneumothorax include shortness of breath, rapid heart rate, or blueness of the skin (a late sign). If the patient has any of these symptoms after being discharged from the hospital, it is important to call the health care provider or emergency services immediately.

### *Bronchoscopic biopsy*

Bronchoscopy is generally safe, and complications are rare. If they do occur, complications may include spasms of the bronchial tubes that can impair breathing, irregular heart rhythms, or infections such as pneumonia.

### *Needle biopsy*

Needle biopsy is associated with fewer risks than open biopsy because it does not involve general

anesthesia. Some hemoptysis (coughing up blood) occurs in 5% of needle biopsies. Prolonged bleeding or infection may also occur, although these are very rare complications.

### *Open biopsy*

Possible complications of an open biopsy include infection or pneumothorax. If the patient has very severe breathing problems before the biopsy, breathing may be further impaired following the operation. Patients with normal lung function prior to the biopsy have a very small risk of respiratory problems resulting from or following the procedure.

### *Mediastinoscopy*

Complications due to mediastinoscopy are rare. Possible complications include pneumothorax or bleeding caused by damage to the blood vessels near the heart. Mediastinitis, infection of the mediastinum, may develop. Injury to the esophagus or larynx may occur. If the nerves leading to the larynx are injured, the patient may be left with a permanently hoarse voice. All of these complications are rare.

### Normal results

Normal results indicate no evidence of infection in the lungs, no detection of lumps or nodules, and cells that are free from cancerous abnormalities.

Abnormal results of needle biopsy, VATS, and open biopsy may be associated with diseases other than cancer. Nodules in the lungs may be due to active infections such as tuberculosis, or may be scars from a previous infection. In 33% of biopsies using a mediastinoscope, the biopsied lymph nodes prove to be cancerous. Abnormal results should always be considered in the context of the patient's medical history, physical examination, and other tests such as sputum examination, and chest x rays before a final diagnosis is made.

### Morbidity and mortality rates

The risk of **death** from needle biopsy is rare. The risk of death from open biopsy is one in 3,000 cases. In mediastinoscopy, death occurs in fewer than one in 3,000 cases.

### Alternatives

The type of alternative diagnostic procedures available depend upon each patient's diagnosis.

Some people may be eligible to participate in clinical trials, research programs conducted with patients

## WHO PERFORMS THIS PROCEDURE AND WHERE IS IT PERFORMED?

Fiberoptic bronchoscopy is performed by pulmonologists, physician specialists in pulmonary medicine. CAT guided needle biopsy is done by interventional radiologists, physician specialists in radiological procedures. Thoracic surgeons perform open biopsies and VATS. Specially trained nurses, x-ray, and laboratory technicians assist during the procedures and provide pre- and postoperative education and supportive care.

The procedures are performed in an operating or procedure room in a hospital.

to evaluate a new medical treatment, drug, or device. The purpose of clinical trials is to find new and improved methods of treating different diseases and special conditions. For more information on current clinical trials, visit the National Institutes of Health's ClinicalTrials.gov at <http://www.clinicaltrials.gov> or call (888) FIND-NLM [(888) 346-3656] or (301) 594-5983.

The National Cancer Institute (NCI) has conducted a clinical trial to evaluate a technology—low-dose helical computed tomography—for its effectiveness in screening for lung cancer. One study concluded that this test is more sensitive in detecting specific conditions related to lung cancer than other screening tests.

### Resources

#### BOOKS

Abeloff, MD et al. *Clinical Oncology*. 3rd ed. Philadelphia: Elsevier, 2004.

Mason, RJ et al. *Murray & Nadel's Textbook of Respiratory Medicine*. 4th ed. Philadelphia: Saunders, 2007.

#### ORGANIZATIONS

American Association for Respiratory Care (AARC). 11030 Ables Lane, Dallas, TX 75229. E mail: [info@aarc.org](mailto:info@aarc.org). <http://www.aarc.org>.

American Cancer Society. 1599 Clifton Road, N.E., Atlanta, GA 30329. (800) 227 2345 or (404) 320 3333. <http://www.cancer.org>.

American College of Chest Physicians. 3300 Dundee Road, Northbrook, IL 60062 2348. (847) 498 1400. <http://www.chestnet.org>.

American Lung Association and American Thoracic Society. 1740 Broadway, New York, NY 10019 4374. (800)

## QUESTIONS TO ASK THE DOCTOR

- Why is this procedure being performed?
- Are there any alternative options to having this procedure?
- What type of lung biopsy procedure is recommended?
- Is minimally invasive surgery an option?
- Will the patient be awake during the procedure?
- Who will be performing the procedure? How many years of experience does this physician have? How many other lung biopsies has the physician performed?
- Can medications be taken the day of the procedure?
- Can the patient have food or drink before the procedure? If not, how long before the procedure should these activities be stopped?
- How long is the hospitalization?
- After discharge, how long will it take to recover from the procedure?
- How is pain or discomfort relieved after the procedure?
- What types of symptoms should be reported to the physician?
- When can normal activities be resumed?
- When can driving be resumed?
- When can the patient return to work?
- When will the results of the procedure be given to the patient?
- How often are follow-up physician visits needed after the procedure?

586 4872 or (212) 315 8700. <http://www.lungusa.org> and <http://www.thoracic.org>.

Cancer Research Institute. 681 Fifth Avenue, New York, NY 10022. (800) 992 2623. <http://www.cancerresearch.org>.

Lung Line National Jewish Medical and Research Center. 14090 Jackson Street, Denver, CO 80206. (800) 222 5864. E mail: [lungline@njc.org](mailto:lungline@njc.org). <http://www.nationaljewish.org>.

National Cancer Institute (National Institutes of Health). 9000 Rockville Pike, Bethesda, MD 20892. (800) 422 6237. <http://www.nci.nih.gov>.

National Heart, Lung and Blood Institute. Information Center. P.O. Box 30105, Bethesda, MD 20824 0105. (301) 251 2222. <http://www.nhlbi.nih.gov>.



**OTHER**

Dailylung.com. <http://www.dailylung.com>.

Chest Medicine On Line. <http://www.priory.com/chest.htm>.

National Lung Health Education Program. <http://www.nlhep.com>.

Pulmonary Forum. <http://www.pulmonarychannel.com>.

Pulmonarypaper.org. P.O. Box 877, Ormond Beach, FL 32175. (800) 950 3698. <http://www.pulmonarypaper.org>.

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Lung surgery see **Lobectomy, pulmonary**

## Lung transplantation

### Definition

Lung transplantation involves removal of one or both diseased lungs from a patient and the replacement of the lungs with healthy organs from a donor. Lung transplantation may refer to single, double, or even **heart-lung transplantation**.

### Purpose

The purpose of lung transplantation is to replace a lung that no longer functions with a healthy lung. To perform a lung transplantation, there should be potential for rehabilitated breathing function. Other medical treatments should be attempted before transplantation is considered. Many candidates for this procedure have end-stage fibrotic lung disease, are dependent on **oxygen therapy**, and are likely to die of their disease in 12–18 months.

### Demographics

In order to qualify for lung transplantation, a patient must suffer from severe lung disease such as:

- emphysema
- cystic fibrosis
- pulmonary fibrosis
- pulmonary hypertension
- bronchiectasis
- sarcoidosis
- silicosis

Patients with emphysema or chronic obstructive pulmonary disease (COPD) should be under 60 years

of age, have a life expectancy without transplantation of two years or less, progressive deterioration, and emotional stability in order to be considered for lung transplantation. Young patients with end-stage silicosis may be candidates for lung or heart-lung transplantation. Patients with stage III or stage IV sarcoidosis with cor pulmonale (right-sided heart failure) should be considered as early as possible for lung transplantation.

### Description

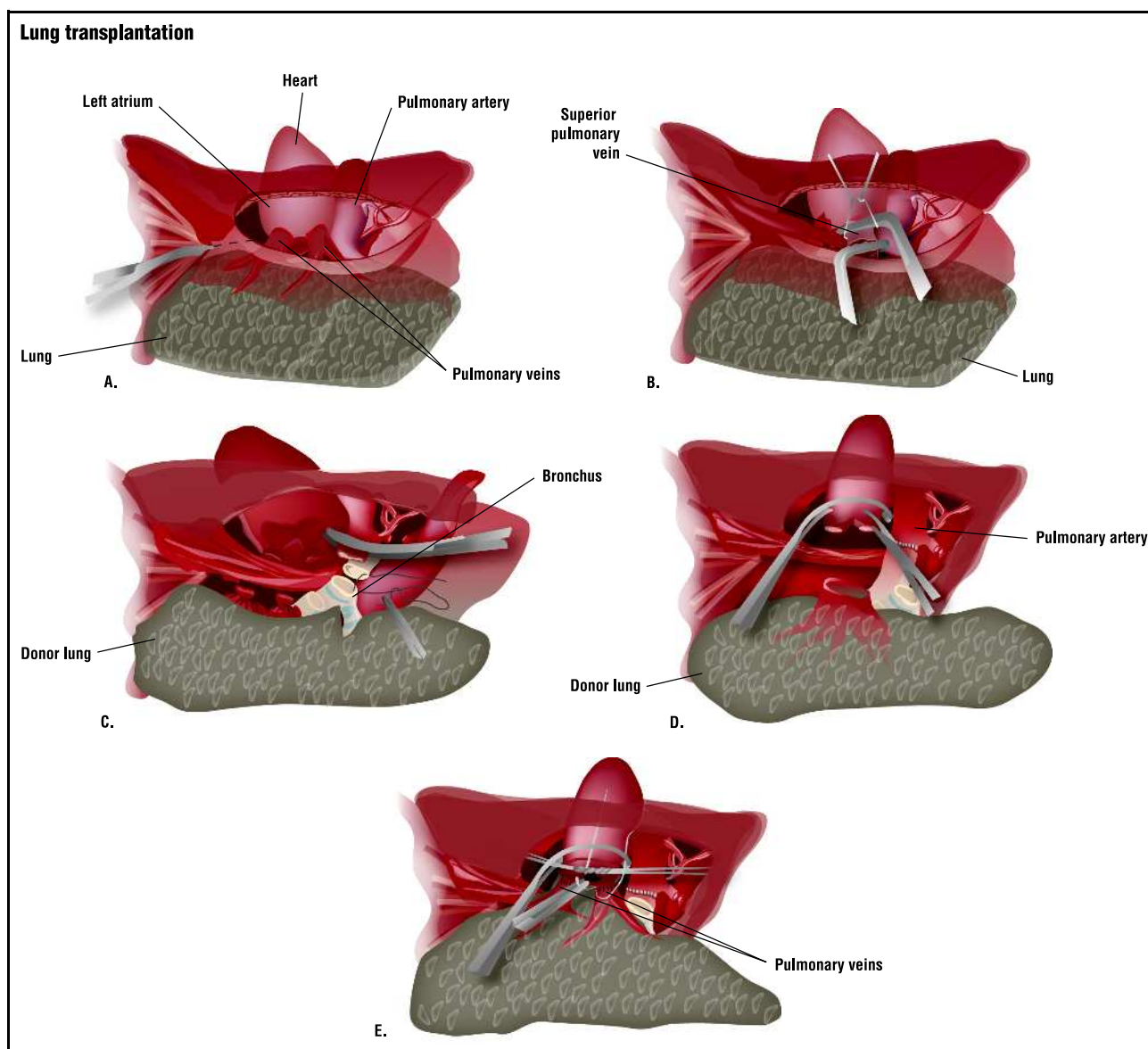
Once a patient has been selected as a possible organ recipient, the process of waiting for a donor organ match begins. The donor organ must meet specific requirements for tissue match in order to reduce the chance of organ rejection. It is estimated that it takes an average of one to two years to receive a suitable donor lung, and the wait is made less predictable by the necessity for tissue match. Patients on a recipient list must be available and ready to come to the hospital immediately when a donor match is found, since the life of the lungs outside the body is brief.

Single lung transplantation is performed via a standard **thoracotomy** (incision in the chest wall) with the patient under **general anesthesia**. Cardiopulmonary bypass (diversion of blood flow from the heart) is not always necessary for a single lung transplant. If bypass is necessary, it involves re-routing of the blood through tubes to a heart-lung bypass machine. Double lung transplantation involves implanting the lungs as two separate lungs, and cardiopulmonary bypass is usually required. The patient's lung or lungs are removed and the donor lungs are stitched into place. Drainage tubes are inserted into the chest area to help drain fluid, blood, and air out of the chest.

Heart-lung transplants always require the use of cardiopulmonary bypass. An incision is made through the middle of the sternum. The heart, lung, and supporting structures are transplanted into the recipient at the same time.

### Diagnosis/Preparation

Patients who have diseases or conditions that may make them more susceptible to organ rejection are not selected for lung transplant. This includes patients who are acutely ill and unstable; have uncontrolled or untreatable pulmonary infection; significant dysfunction of other organs, particularly the liver, kidney, or central nervous system; and those with significant coronary disease or left ventricular dysfunction. Patients who actively smoke cigarettes or are dependent on drugs or alcohol may not be selected. There are a variety of protocols that are used to determine if a



During a lung transplant, the chest is opened to reveal the heart, lungs, and major blood vessels (A). 2. Inferior and superior pulmonary veins and pulmonary artery are separated, and lung is removed (B). The bronchus of the donor lung is connected to the patient's existing bronchus (C). The pulmonary artery is attached (D), and the pulmonary vein and other blood vessels are also connected (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

patient will be placed on a transplant recipient list, and criteria may vary depending on location.

The following diagnostic tests are usually performed to evaluate a patient for lung transplantation:

- Arterial blood gases (ABG) test, which measures the amount of oxygen that the blood is able to carry to body tissues.
- Pulmonary function tests (PFTs), which measure lung volume and the rate of air flow through the lungs; the results measure the progress of the lung disease.
- Radiographic studies (x rays). The most common is the chest x ray (CXR), which takes an internal picture of the chest including the lungs, ribs, heart, and the contours of the major vessels of the chest.
- Computerized tomography (CT) scan. A chest CT scan is taken of horizontal slices of the chest to provide detailed images of the structure of the chest.
- Ventilation perfusion scan (lung scan, V/Q scan) is a test that compares right and left lung function.
- Electrocardiogram (EKG) is performed by placing electrodes on the chest and one electrode on each of

## KEY TERMS

**Anesthesia**—The loss of feeling or sensation induced by use of drugs called anesthetics.

**Bronchi**—Any of the larger air passages of the lungs.

**Bronchiectasis**—Persistent and progressive dilation of bronchi or bronchioles as a consequence of inflammatory disease such as lung infections, obstructions, tumors, or congenital abnormality.

**Bronchioles**—The tiny branches of air tubes within the lungs that are the continuation of bronchi and connect to the lung air sacs (alveoli).

**Cor pulmonale**—Enlargement of the right ventricle of the heart caused by pulmonary hypertension that may result from emphysema or bronchiectasis; eventually, the condition leads to congestive heart failure.

**Cystic fibrosis**—A generalized disorder of infants, children, and young adults characterized by widespread dysfunction of the exocrine glands, and chronic pulmonary disease due to excess mucus production in the respiratory tract.

**Emphysema**—A pathological accumulation of air in tissues or organs, especially in the lungs.

**Immunosuppressive**—Relating to the weakening or reducing of the immune system's responses to

foreign material; immunosuppressive drugs reduce the immune system's ability to reject a transplanted organ.

**Pulmonary**—Refers to the respiratory system, or breathing function and system.

**Pulmonary fibrosis**—Chronic inflammation and progressive formation of fibrous tissue in the pulmonary alveolar walls, with steadily progressive shortness of breath, resulting in death from lack of oxygen or heart failure.

**Pulmonary hypertension**—Abnormally high blood pressure within the pulmonary artery.

**Rejection**—Occurs when the body tries to attack a transplanted organ because it reacts to the organ or tissue as a foreign object and produces antibodies to destroy it. Anti-rejection (immunosuppressive) drugs help prevent rejection.

**Sarcoidosis**—A chronic disease with unknown cause that involves formation of nodules in bones, skin, lymph nodes, and lungs.

**Silicosis**—A progressive disease that results in impairment of lung function and is caused by inhalation of dust containing silica.

the four limbs. A recording of the electrical activity of the heart is obtained to provide information about the rate and rhythm of the heartbeat, and to assess any damage.

- **Echocardiogram (ECHO)** is an ultrasound of the heart, performed to evaluate the impact of lung disease on the heart. It examines the chambers, valves, aorta, and the wall motion of the heart. ECHO also provides information concerning the blood pressure in the pulmonary arteries. This information is required to plan the transplantation surgery.
- **Blood tests.** Blood samples are required for both routine and specialized testing.

In addition to tests and criteria for selection as a candidate for transplantation, patients are prepared by discussing at length the procedure, risks, and expected prognosis with the doctor. Patients should continue to follow all therapies and medications for treatment of the underlying disease, unless otherwise instructed by their physician. Since lung transplantation takes place under general anesthesia, patients are advised not to take food or drink from midnight before the surgery.

## Aftercare

Transplantation requires a long hospital stay, and recovery can last up to six months. Careful monitoring will take place in a **recovery room** immediately following the surgery and in the patient's hospital room. Patients must take immunosuppressive, or anti-rejection, drugs to reduce the risk of rejection of the transplanted organ. The body considers the new organ an invader and will fight its presence. The anti-rejection drugs lower the body's immune function in order to improve acceptance of the new organs. This also makes the patient more susceptible to infection.

Frequent check-ups, including x-ray and blood tests, will be necessary following surgery, probably for a period of several years.

## Risks

Lung transplantation is a complicated and risky procedure, partly because of the organs and systems involved, and also because of the risk of rejection by the recipient's body. Acute rejection most often occurs within the first four months following surgery, but

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Lung transplantations are performed in a specialized organ transplantation hospital. Every transplant hospital in the United States is a member of the United Network for Organ Sharing (UNOS) and must meet specific requirements.

Lung transplantations involve specialized transplant teams usually consisting of an anesthesiologist, an infectious disease specialist, a thoracic surgeon, an ear, nose, and throat (ENT) specialist, a cardiologist, and a transplant dietician who all perform with a high level of coordination.

may occur years later. Infection is a substantial risk for organ recipients. An early complication of the surgery can be poor healing of the bronchial and tracheal openings created during the surgery. A late complication and risk is chronic rejection. This can result in inflammation of the bronchial tubes or in late infection from the prolonged use of immunosuppressive drugs to fight rejection.

### Normal results

Demonstration of normal results for lung transplantation patients include adequate lung function and improved quality of life, as well as lack of infection and rejection.

### Morbidity and mortality rates

According to the Scientific Registry of Transplant Recipients (SRTR), a total of 1,000 lung transplants were performed in the United States in 2005, although the waiting list was comprised of 3,500 people. The survival rate after single-lung transplant was more than 82% at one year, almost 60% at three years, and almost 48% at five years.

### Resources

#### BOOKS

- Khatri, VP and JA Asensio. *Operative Surgery Manual*. 1st ed. Philadelphia: Saunders, 2003.
- Mason, RJ et al. *Murray & Nadel's Textbook of Respiratory Medicine*. 4th ed. Philadelphia: Saunders, 2007.
- Townsend, CM et al. *Sabiston Textbook of Surgery*. 17th ed. Philadelphia: Saunders, 2004.

## QUESTIONS TO ASK THE DOCTOR

- Are there organizations who can help me afford the cost of transplantation?
- How does the lung matching process work?
- How do I get on the lung waiting list?
- How will they find the right donor for me?
- How many lung transplantations do you perform each year?
- What happens during transplantation?

### PERIODICALS

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- American Society of Transplantation (AST). 17000 Commerce Parkway, Suite C, Mount Laurel, NJ 08054. (856) 439-9986. <http://www.ast.org>.
- Children's Organ Transplant Association, Inc. 2501 COTA Drive, Bloomington, IN 47403. (800) 366-2682. <http://www.cota.org>.
- The National Heart, Lung, and Blood Institute (NHLBI). P.O. Box 30105, Bethesda, MD 20824-0105. (301) 592-8573. <http://www.nhlbi.nih.gov/index.htm>.
- Second Wind Lung Transplant Association, Inc. 9030 West Lakeview Court, Crystal River, FL 34428. (888) 222-2690. <http://www.arthouse.com/secondwind>.



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Teresa Norris, RN  
Monique Laberge, PhD

Luque rod see **Spinal instrumentation**

Lymph node biopsy see **Sentinel lymph node biopsy**

Lymph node removal see **Lymphadenectomy**

## Lymphadenectomy

### Definition

Lymphadenectomy, also called lymph node dissection, is a surgical procedure in which lymph glands are removed from the body and examined for the presence of cancerous cells. A limited or modified lymphadenectomy removes only some of the lymph nodes in the area around a tumor; a total or radical lymphadenectomy removes all of the lymph nodes in the area.

### Purpose

The lymphatic system is responsible for returning excess fluid from body tissues to the circulatory system and for defending against foreign or harmful agents such as bacteria, viruses, or cancerous cells. The major components of the lymphatic system are lymph capillaries, lymph vessels, and lymph nodes. Lymph is a clear fluid found in tissues that originates from the circulatory system. Lymph capillaries are tiny vessels that carry excess lymph to larger lymph vessels; these in turn empty to the circulatory system. Lymph nodes are small, oval- or bean-shaped masses found throughout the lymphatic system that act as filters against foreign materials. They tend to group in clusters in such areas as the neck (cervical lymph nodes), under the arm (axillary lymph nodes), the pelvis (iliac lymph nodes), and the groin (inguinal lymph nodes).

The lymphatic system plays an important role in the spread of cancerous cells throughout the body. Cancer cells can break away from their primary site of growth and travel through the bloodstream or lymphatic system to other sites in body. They may then begin growing at these distant sites or in the lymph nodes themselves; this process is called metastasis. Removal of the lymph

nodes, then, is a way that doctors can determine if a cancer has begun to metastasize. Lymphadenectomy may also be pursued as a cancer treatment to help prevent further spread of abnormal cells.

### Demographics

The American Cancer Society estimates that approximately 1,444,920 new cases of cancer were diagnosed in 2007, excluding carcinoma-in-situ and basal and squamous cell skin cancers. In 2007, 559,650 Americans are expected to die of cancer. This is 25% of all deaths within any year.

### Description

Although the specific surgical procedure may differ according to which lymph nodes are to be removed, some steps are common among all lymphadenectomies. **General anesthesia** is usually administered for the duration of surgery; this ensures that the patient remain unconscious and relaxed, and awaken with no memory of the procedure.

First, an incision is made into the skin and through the subcutaneous layers in the area where the lymph nodes are to be removed. The lymph nodes are identified and isolated. They are then carefully taken out from surrounding tissues (that is, muscles, blood vessels, and nerves). In the case of axillary node dissection, the pad of fat under the skin of the armpit is removed; generally, about 10 to 20 lymph nodes are embedded in the fat and separately removed. The incision is sutured (stitched) closed with a drain left in place to remove excess fluid from the surgical site.

Alternatively, **laparoscopy** may be used as a less invasive method of removing lymph nodes. The laparoscope is a thin, lighted tube that is inserted into the abdominal cavity through a small incision. Images taken by the laparoscope may be seen on a video monitor connected to the scope. Certain lymph nodes, such as the pelvic and aortic lymph nodes, may be removed using this technology.

### Diagnosis/Preparation

Lymph nodes may become swollen or enlarged as result of invasion by cancer cells. Swollen lymph nodes may be palpated (felt) during a physical exam. Before lymph nodes are removed, a small amount of tissue is usually removed. A biopsy will be performed on it to check for the presence of abnormal cells.

The patient will be asked to stop taking **aspirin** or aspirin-containing drugs for a period of time prior to surgery, as these can interfere with the blood’s ability to

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Lymphadenectomy is usually performed in a hospital operating room by a surgical oncologist, a medical doctor who specializes in the surgical diagnosis and treatment of cancers.

clot. Such drugs may include prescription blood thinners (for example, Coumadin and Heparin—generically known as warfarin. However, patients should discuss their medications with regard to their upcoming surgery with their doctors, and not make any adjustments or prescription changes on their own. No food or drink after midnight the night before surgery will be allowed.

### Aftercare

Directly following surgery, the patient will be taken to the **recovery room** for constant monitoring and to recover from the effects of anesthesia. The patient may then be transferred to a regular room. If axillary nodes have been removed, the patient's arm will be elevated to help prevent postsurgical swelling. Likewise, the legs will be elevated if an inguinal lymphadenectomy had been performed. A drain placed during surgery to remove excess fluids from the surgical site will remain until the amount of fluid collected in the drain decreases significantly. The patient will generally remain in the hospital for one day.

Specific steps should be taken to minimize the risk of developing lymphedema, a condition in which excess fluid is not properly drained from body tissues, resulting in swelling. This swelling can sometimes become severe enough to interfere with daily activity. Common sites where lymphedema can develop are the arm or leg. Prior to being discharged, the patient will receive the following instructions for care of areas of the body that may be affected by lymph node removal:

- All cuts to the area should be properly cleaned, treated with an antibiotic ointment, and covered with a bandage.
- Heavy lifting should be avoided; bags should be carried on the unaffected arm.
- Tight jewelry and clothing with tight elastic bands should be avoided.
- Injections, blood draws, and blood pressure measurements should be done on the unaffected arm.
- Sunblock should be worn on the affected area to minimize the risk of sunburn.

## QUESTIONS TO ASK THE DOCTOR

- Why is lymphadenectomy recommended?
- How many lymph nodes will be removed?
- How long will the procedure take?
- When will I find out the results?
- Am I a candidate for sentinel node biopsy?
- What will happen if the results are positive for cancer?

- Steps should be taken to avoid cuts to the skin. For example, an electric razor should be used to shave the affected area; protective gloves should be worn when working with abrasive items.

### Risks

Some of the risks associated with lymphadenectomy include excessive bleeding, infection, pain, excessive swelling, vein inflammation (phlebitis), and damage to nerves during surgery. Nerve damage may be temporary or permanent and may result in weakness, numbness, tingling, and/or drooping. Lymphedema is also a risk whenever lymph nodes have been removed; it may occur immediately following surgery or from months to years later.

### Normal results

After removed lymph nodes have been examined microscopically for the presence of cancerous cells, they may be labeled node-negative (no presence of cancer cells) or node-positive (presence of cancer cells). These findings are the basis for deciding the next step in cancer treatment, if one is indicated.

### Morbidity and mortality rates

The rate of complications following lymphadenectomy depends on the specific lymph nodes being removed. For example, following axillary lymphadenectomy, there is a 17% chance of chronic lymphedema and 20% chance of abnormal skin sensations. The overall rate of complications following inguinal lymphadenectomy is approximately 15%, and 5–7% following pelvic lymphadenectomy.

### Alternatives

A technique designed to spare the unnecessary removal of normal lymph nodes is called sentinel

node biopsy. When lymph fluid moves out of a region, the sentinel lymph node is the first node it reaches. The theory behind **sentinel lymph node biopsy** is that if cancer is not present in the sentinel node, it is unlikely to have spread to other nearby nodes. This procedure may allow individuals with early stage cancers to avoid the complications associated with partial or radical removal of lymph nodes if there is little or no chance that cancer has spread to them. For example, while 17% of women have lymphedema after axillary node dissection, only 3% of women have this unpleasant complication after sentinel node biopsy.

## Resources

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American Cancer Society. 1599 Clifton Rd. NE, Atlanta, GA 30329 4251. (800) 227 2345. <http://www.cancer.org>.

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Stephanie Dionne Sherk

# M

## Magnetic resonance angiogram

### Definition

A magnetic resonance angiogram uses the equipment and technology of magnetic resonance imaging (MRI) to assess the arterial system in the body. Unlike other radiologic techniques (x rays, CT scans), magnetic resonance imaging does not involve radiation. Instead, MRI employs a combination of magnetic fields and radio waves to generate images. The magnets cause hydrogen atoms in the subject's body to line up in a particular way; the radio waves then bounce off of these aligned hydrogen atoms. This signal is captured and recorded by a computer, which uses the information to create a two- or three-dimensional image of the tissue being studied. In order to be able to adequately image the arteries during a magnetic resonance angiogram, radioactive contrast is injected in the patient. This circulates throughout the arterial system, and "lights up" the arterial system. In this way, the outline of the arteries can be visualized, and any blockages, bulges, leaks, or other abnormalities can be evaluated.

### Purpose

A magnetic resonance angiogram can be performed to assess a variety of conditions involving the arterial system throughout the body, including to

- Diagnose and monitor aneurysms
- Evaluate the extent of atherosclerosis in the coronary arteries, the carotid arteries in the neck, or in the major leg veins; may be useful prior to surgery to remove atherosclerotic plaques or to place a bypass stent
- Evaluate and monitor arteriovenous malformations, such as in the brain
- Diagnose aortic dissection

- Evaluate the arterial system that supplies the kidneys prior to kidney transplantation
- Assess the coronary arteries prior to bypass surgery
- Map out the arteries that supply a tumor prior to surgery to remove that tumor
- Evaluate any area of narrowing (stenosis) throughout the arterial system

### Description

Prior to starting the scanner for an MRA, radioactive contrast is injected through an IV in the patient's arm. The classic MRI unit consists of an examination



**Patient undergoing magnetic resonance imaging.** (PhotoSpin, Inc / Alamy)





**Doctors study MRA scans of the brain.** (Richard T. Nowitz / Phototake. Reproduced by permission.)

table on which the patient lies, and a doughnut-shaped scanner into which the table slides. During the course of the MRA, which may take between thirty minutes and two hours, the patient must lie very still, and may at times be asked to hold his or her breath. Some people are bothered by the sounds that the MRI scanner makes, which include a variety of tapping, bumping, and fan sounds. Although no one is in the room with the patient, the patient can usually communicate with the MRI technician through a two-way sound system installed within the MRI unit.

### Preparation

Because the strong magnetic field employed in MRA can interact with anything else that contains metal, it is crucial that the patient remove any jewelry, including from any piercings, prior to undergoing MRA. Other personal objects that should be removed include hearing aids, dentures, eyeglasses, hairpins. Pockets should be emptied of any metal-containing items, including coins, credit cards. Patients should inform the radiologist about any potentially metal-containing objects or medical devices that they have, such as tattooed eyeliner, a pacemaker, implanted defibrillator, aneurysm clips, cochlear implant, artificial limb, bone pin, medication patch, artificial heart valve, stent, infusion pump, or intrauterine device. People who have occupations in which they work frequently with metal should also inform the radiologist of this fact. In some cases, the MRA cannot be performed due to the presence of metal that cannot be removed and would be unsafe to expose to the magnetic fields of an MRI scanner. Sometimes, an x-ray will be ordered prior to an MRA in order to verify that there is not other metal in the body that would preclude performing the test.

## KEY TERMS

**Aneurysm**—A weakness in the wall of an artery which can cause an area of outpouching or bulging. This weakness can break, resulting in massive bleeding.

**Aortic dissection**—A situation in which a tear in the interior lining of the wall of the aorta causes bleeding between the layers of that major artery.

**Arteriovenous malformation**—An anomaly present since birth in which the arteries and veins in a particular part of the body are caught up in a complex tangle, and in which there is an abnormal pattern of blood flowing from the arteries directly into the veins.

**Atherosclerosis**—A condition in which the major arteries throughout the body become obstructed by fatty plaques, causing narrowing, obstruction of blood flow, and ultimately hardening and stiffening of the arterial walls.

Some patients with a strong history of anxiety or claustrophobia find it difficult to be enclosed in the doughnut-shaped MRI machine. There are some open machines available that may cause less anxiety. Sometimes, a sedative can be used to help the patient relax during the MRA.

Women who are pregnant or who think they may be pregnant are advised against undergoing MRA. Women who are breastfeeding and who require MRA should feed their baby with formula for two days following the procedure, and should pump and discard their breast milk, since it will be contaminated with the radioactive dye.

Most MRI units have an upper limit of weight that they can hold. Patients over 300 pounds may not be able to undergo MRI, or may need to seek an open MRI unit for their study.

### Aftercare

There is no aftercare necessary following an MRA. The patient can return to a normal diet and normal activities.

### Risks

An MRA poses very little risk to the patient. Rarely, a patient may have an allergy to the radioactive contrast utilized.

## Normal results

Normal results of an MRA would reveal normal arterial architecture, with fully patent arteries throughout the arterial tree. No narrowing, blockages, reduced blood flow, or outpouchings of the arterial walls are visualized in a normal MRA.

## Abnormal results

An MRA is abnormal if there is reduced blood flow through any part of the arterial tree. This may result in being unable to visualize an area of an artery, due to an obstruction which prevents any blood flow (and therefore any dye) from reaching that part of the arterial system. Stenosis of an artery will cause the channel of dye to appear of smaller caliber than normal. An abnormal collection of dye may accumulate in an aneurysm pocket. An aortic dissection would reveal leakage of dye between the tissue planes of the aorta. Abnormal flow of dye into the venous system may indicate the presence of an arteriovenous malformation.

## Morbidity and mortality rates

Under rare circumstances, patients may exhibit signs of allergy to the tracer.

## Resources

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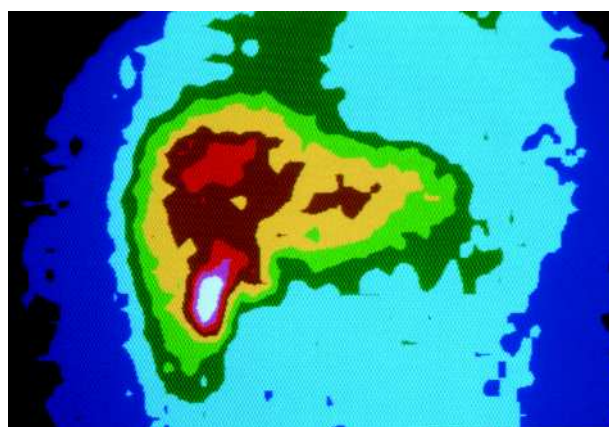
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Magnetic resonance angiography  
see **Magnetic resonance imaging**

# Magnetic resonance imaging

## Definition

Magnetic resonance imaging (MRI) is the newest, and perhaps most versatile, medical imaging technology available. Doctors can get highly refined images of the body's interior without surgery, using MRI. By using strong magnets and pulses of radio waves to manipulate the natural magnetic properties in the body, this technique makes better images of organs and soft tissues than those of other scanning technologies. MRI is particularly



**Nuclear scan of the liver and gallbladder.** (Collection CNRI / Phototake. Reproduced by permission.)

useful for imaging the brain and spine, as well as the soft tissues of joints and the interior structure of bones. The entire body is visible to the technique, which poses few known health risks.

## Purpose

MRI was developed in the 1980s. The latest additions to MRI technology are **angiography** (MRA) and spectroscopy (MRS). MRA was developed to study blood flow, while MRS can identify the chemical composition of diseased tissue and produce color images of brain function. The many advantages of MRI include:

- **Detail.** MRI creates precise images of the body based on the varying proportions of magnetic elements in different tissues. Very minor fluctuations in chemical composition can be determined. MRI images have greater natural contrast than standard x rays, computed tomography scan (CT scan), or ultrasound, all of which depend on the differing physical properties of tissues. This sensitivity lets MRI distinguish fine variations in tissues deep within the body. It also is particularly useful for spotting and distinguishing diseased tissues (tumors and other lesions) early in their development. Often, doctors prescribe an MRI scan to more fully investigate earlier findings of the other imaging techniques.
- **Scope.** The entire body can be scanned, from head to toe and from the skin to the deepest recesses of the brain. Moreover, MRI scans are not obstructed by bone, gas, or body waste, which can hinder other imaging techniques. (Although the scans can be degraded by motion such as breathing, heartbeat, and normal bowel activity.) The MRI process produces cross-sectional images of the body that are as sharp in the middle as on the edges, even of the brain through the skull. A close series of these

two-dimensional images can provide a three-dimensional view of a targeted area.

- **Safety.** MRI does not depend on potentially harmful ionizing radiation, as do standard x-ray and CT scans. There are no known risks specific to the procedure, other than for people who might have metal objects in their bodies.

MRI is being used increasingly during operations, particularly those involving very small structures in the head and neck, as well as for preoperative assessment and planning. Intraoperative MRIs have shown themselves to be safe as well as feasible, and to improve the surgeon's ability to remove the entire tumor or other abnormality.

Given all the advantages, doctors would undoubtedly prescribe MRI as frequently as **ultrasound** scanning, but the MRI process is complex and costly. The process requires large, expensive, and complicated equipment; a highly trained operator; and a doctor specializing in radiology. Generally, MRI is prescribed only when serious symptoms and/or negative results from other tests indicate a need. Many times another test is appropriate for the type of diagnosis needed.

Doctors may prescribe an MRI scan of different areas of the body.

- **Brain and head.** MRI technology was developed because of the need for brain imaging. It is one of the few imaging tools that can see through bone (the skull) and deliver high quality pictures of the brain's delicate soft tissue structures. MRI may be needed for patients with symptoms of a brain tumor, stroke, or infection (like meningitis). MRI also may be needed when cognitive and/or psychological symptoms suggest brain disease (like Alzheimer's or Huntington's diseases, or multiple sclerosis), or when developmental retardation suggests a birth defect. MRI can also provide pictures of the sinuses and other areas of the head beneath the face. Recent refinements in MRI technology may make this form of diagnostic imaging even more useful in evaluating patients with brain cancer, stroke, schizophrenia, or epilepsy. In particular, a new 3-D approach to MRI imaging known as diffusion tensor imaging, or DTI, measures the flow of water within brain tissue, allowing the radiologist to tell where the normal flow of fluid is disrupted, and to distinguish more clearly between cancerous and normal brain tissue. The introduction of DTI has led to a technique known as fiber tracking, which allows the neurosurgeon to tell whether a space-occupying brain tumor has damaged or displaced the nerve pathways in the white matter of the brain. This information in turn improves the surgeon's accuracy during the actual operation.

- **Spine.** Spinal problems can create a host of seemingly unrelated symptoms. MRI is particularly useful for identifying and evaluating degenerated or herniated spinal discs. It can also be used to determine the condition of nerve tissue within the spinal cord.
- **Joint.** MRI scanning is most commonly used to diagnose and assess joint problems. MRI can provide clear images of the bone, cartilage, ligament, and tendon that comprise a joint. MRI can be used to diagnose joint injuries due to sports, advancing age, or arthritis. MRI can also be used to diagnose shoulder problems, like a torn rotator cuff. MRI can also detect the presence of an otherwise hidden tumor or infection in a joint, and can be used to diagnose the nature of developmental joint abnormalities in children.
- **Skeleton.** The properties of MRI that allow it to see through the skull also allow it to view the inside of bones. It can be used to detect bone cancer, inspect the marrow for leukemia and other diseases, assess bone loss (osteoporosis), and examine complex fractures.
- **The rest of the body.** While CT and ultrasound satisfy most chest, abdominal, and general body imaging needs, MRI may be needed in certain circumstances to provide better pictures or when repeated scanning is required. The progress of some therapies, like liver cancer therapy, needs to be monitored, and the effect of repeated x-ray exposure is a concern.

### Precautions

MRI scanning should not be used when there is the potential for an interaction between the strong MRI magnet and metal objects that might be imbedded in a patient's body. The force of magnetic attraction on certain types of metal objects (including surgical steel) could move them within the body and cause serious injury. Metal may be imbedded in a person's body for several reasons.

- **Medical.** People with implanted cardiac pacemakers, metal aneurysm clips, or who have had broken bones repaired with metal pins, screws, rods, or plates must tell their radiologist prior to having an MRI scan. In some cases (like a metal rod in a reconstructed leg) the difficulty may be overcome.
- **Injury.** Patients must tell their doctors if they have bullet fragments or other metal pieces in their body from old wounds. The suspected presence of metal, whether from an old or recent wound, should be confirmed before scanning.
- **Occupational.** People with significant work exposure to metal particles (working with a metal grinder, for example) should discuss this with their doctor and



radiologist. The patient may need pre-scan testing—usually a single, regular x ray of the eyes to see if any metal is present.

Chemical agents designed to improve the picture and/or allow for the imaging of blood or other fluid flow during MRA may be injected. In rare cases, patients may be allergic to or intolerant of these agents, and these patients should not receive them. If these chemical agents are to be used, patients should discuss any concerns they have with their doctor and radiologist.

The potential side effects of magnetic and electric fields on human health remain a source of debate. In particular, the possible effects on an unborn baby are not well known. Any woman who is, or may be, pregnant should carefully discuss this issue with her doctor and radiologist before undergoing a scan.

As with all medical imaging techniques, obesity greatly interferes with the quality of MRI.

## Description

In essence, MRI produces a map of hydrogen distribution in the body. Hydrogen is the simplest element known, the most abundant in biological tissue, and one that can be magnetized. It will align itself within a strong magnetic field, like the needle of a compass. The earth's magnetic field is not strong enough to keep a person's hydrogen atoms pointing in the same direction, but the superconducting magnet of an MRI machine can. This comprises the “magnetic” part of MRI.

Once a patient's hydrogen atoms have been aligned in the magnet, pulses of very specific radio wave frequencies are used to knock them back out of alignment. The hydrogen atoms alternately absorb and emit radio wave energy, vibrating back and forth between their resting (magnetized) state and their agitated (radio pulse) state. This comprises the “resonance” part of MRI.

The MRI equipment records the duration, strength, and source location of the signals emitted by the atoms as they relax and translates the data into an image on a television monitor. The state of hydrogen in diseased tissue differs from healthy tissue of the same type, making MRI particularly good at identifying tumors and other lesions. In some cases, chemical agents such as gadolinium can be injected to improve the contrast between healthy and diseased tissue.

A single MRI exposure produces a two-dimensional image of a slice through the entire target area. A series of these image slices closely spaced (usually less than half an inch) makes a virtual three-dimensional view of the area.

Magnetic resonance spectroscopy (MRS) is different from MRI because MRS uses a continuous band of radio wave frequencies to excite hydrogen atoms in a variety of chemical compounds other than water. These compounds absorb and emit radio energy at characteristic frequencies, or spectra, which can be used to identify them. Generally, a color image is created by assigning a color to each distinctive spectral emission. This comprises the “spectroscopy” part of MRS. MRS is still experimental and is available in only a few research centers.

Doctors primarily use MRS to study the brain and disorders, like epilepsy, Alzheimer's disease, brain tumors, and the effects of drugs on brain growth and metabolism. The technique is also useful in evaluating metabolic disorders of the muscles and nervous system.

Magnetic resonance angiography (MRA) is another variation on standard MRI. MRA, like other types of angiography, looks specifically at fluid flow within the blood (vascular) system, but does so without the injection of dyes or radioactive tracers. Standard MRI cannot make a good picture of flowing blood, but MRA uses specific radio pulse sequences to capture usable signals. The technique is generally used in combination with MRI to obtain images that show both vascular structure and flow within the brain and head in cases of stroke, or when a blood clot or aneurysm is suspected.

Regardless of the exact type of MRI planned, or area of the body targeted, the procedure involved is basically the same and occurs in a special MRI suite. The patient lies back on a narrow table and is made as comfortable as possible. Transmitters are positioned on the body and the cushioned table that the patient is lying on moves into a long tube that houses the magnet. The tube is as long as an average adult lying down, and the tube is narrow and open at both ends. Once the area to be examined has been properly positioned, a radio pulse is applied. Then a two-dimensional image corresponding to one slice through the area is made. The table then moves a fraction of an inch and the next image is made. Each image exposure takes several seconds and the entire exam will last anywhere from 30-90 minutes. During this time, the patient is not allowed to move. If the patient moves during the scan, the picture will not be clear.

Depending on the area to be imaged, the radio-wave transmitters will be positioned in different locations.

- For the head and neck, a helmet-like hat is worn.
- For the spine, chest, and abdomen, the patient will be lying on the transmitters.
- For the knee, shoulder, or other joint, the transmitters will be applied directly to the joint.



Additional probes will monitor **vital signs** (like pulse, respiration, etc.).

The process is very noisy and confining. The patient hears a thumping sound for the duration of the procedure. Since the procedure is noisy, music supplied via earphones is often provided. Some patients get anxious or panic because they are in the small, enclosed tube. This is why vital signs are monitored and the patient and medical team can communicate between each other. If the chest or abdomen are to be imaged, the patient will be asked to hold his/her breath as each exposure is made. Other instructions may be given to the patient, as needed. In many cases, the entire examination will be performed by an MRI operator who is not a doctor. However, the supervising radiologist should be available to consult as necessary during the exam, and will view and interpret the results sometime later.

### Preparation

In some cases (such as for MRI brain scanning or an MRA), a chemical designed to increase image contrast may be given by the radiologist immediately before the exam. If a patient suffers from anxiety or claustrophobia, drugs may be given to help the patient relax.

The patient must remove all metal objects (watches, jewelry, eye glasses, hair clips, etc). Any magnetized objects (like credit and bank machine cards, audio tapes, etc.) should be kept far away from the MRI equipment because they can be erased. Patients cannot bring their wallet or keys into the MRI machine. The patient may be asked to wear clothing without metal snaps, buckles, or zippers, unless a medical gown is worn during the procedure. The patient may be asked to remove any hair spray, hair gel, or cosmetics that may interfere with the scan.

### Aftercare

No aftercare is necessary, unless the patient received medication or had a reaction to a contrast agent. Normally, patients can immediately return to their daily activities. If the exam reveals a serious condition that requires more testing and/or treatment, appropriate information and counseling will be needed.

### Risks

MRI poses no known health risks to the patient and produces no physical side effects. Again, the potential effects of MRI on an unborn baby are not well known. Any woman who is, or may be, pregnant,

## KEY TERMS

**Angiography**—Any of the different methods for investigating the condition of blood vessels, usually via a combination of radiological imaging and injections of chemical tracing and contrasting agents.

**Diffusion tensor imaging (DTI)**—A refinement of magnetic resonance imaging that allows the doctor to measure the flow of water and track the pathways of white matter in the brain. DTI is able to detect abnormalities in the brain that do not show up on standard MRI scans.

**Gadolinium**—A very rare metallic element useful for its sensitivity to electromagnetic resonance, among other things. Traces of it can be injected into the body to enhance the MRI pictures.

**Hydrogen**—The simplest, most common element known in the universe. It is composed of a single electron (negatively charged particle) circling a nucleus consisting of a single proton (positively charged particle). It is the nuclear proton of hydrogen that makes MRI possible by reacting resonantly to radio waves while aligned in a magnetic field.

**Ionizing radiation**—Electromagnetic radiation that can damage living tissue by disrupting and destroying individual cells. All types of nuclear decay radiation (including x rays) are potentially ionizing. Radio waves do not damage organic tissues they pass through.

**Magnetic field**—The three-dimensional area surrounding a magnet, in which its force is active. During MRI, the patient's body is permeated by the force field of a superconducting magnet.

**Radio waves**— Electromagnetic energy of the frequency range corresponding to that used in radio communications, usually 10,000 cycles per second to 300 billion cycles per second. Radio waves are the same as visible light, x rays, and all other types of electromagnetic radiation, but are of a higher frequency.

should carefully discuss this issue with her doctor and radiologist before undergoing a scan.

### Normal results

A normal MRI, MRA, or MRS result is one that shows the patient's physical condition to fall within normal ranges for the target area scanned.

## Abnormal results

Generally, MRI is prescribed only when serious symptoms and/or negative results from other tests indicate a need. There often exists strong evidence of a condition that the scan is designed to detect and assess. Thus, the results will often be abnormal, confirming the earlier diagnosis. At that point, further testing and appropriate medical treatment is needed. For example, if the MRI indicates the presence of a brain tumor, an MRS may be prescribed to determine the type of tumor so that aggressive treatment can begin immediately without the need for a surgical biopsy.

## Morbidity and mortality rates

Morbidity rates are excessively miniscule. The most common problems are minor bleeding and bruising at the site of contrast injection. Since neither are reportable events, morbidity can only be estimated. Occasionally, an unknown allergy to seafood is discovered after injecting contrast. No deaths have been reported from MRI tests.

## Alternatives Resources

Alternative resources include traditional x-rays and computed axial tomography (CT) scans.

## Precautions

The main precaution needed is to clean the venipuncture site with alcohol before injecting contrast. Persons with claustrophobia should be given adequate medication to sedate them.

## Side effects

The most common side effects of MRI are mild feelings of discomfort due to being enclosed during the test.

## Resources

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- American Society of Radiologic Technologists. 15000 Central Ave. SE, Albuquerque, NM 87123-3917. (505) 298-4500. <http://www.asrt.org>.
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Magnetic resonance spectroscopy  
see Magnetic **resonance imaging**

## Magnetic resonance venogram

### Definition

A magnetic resonance venogram uses the equipment and technology of magnetic resonance imaging (MRI) to assess the body's venous system. Unlike other radiologic techniques (x-rays, CT scans), magnetic resonance imaging does not involve radiation.

Instead, MRI employs a combination of magnetic fields and radio waves to generate images. The magnets cause hydrogen atoms in the subject's body to line up in a particular way; the radio waves then bounce off of these aligned hydrogen atoms. This signal is captured and recorded by a computer, which uses the information to create a two- or three-dimensional image of the tissue being studied. In order to be able to adequately image the veins during a magnetic resonance venogram, radioactive contrast is injected in the patient. This circulates throughout the venous system, and "lights up" the venous system. In this way, the outline of the veins can be visualized, and any blockages, narrowing (stenosis), leaks, or other abnormalities can be evaluated.

### Purpose

A magnetic resonance venogram can be performed to assess a variety of conditions involving the venous system throughout the body. MRV is particularly useful for the diagnosis of thrombosis (obstruction by blood clots) in the inferior vena cava (one of the very large major veins into which many of the veins in the body drain), renal (kidney) vein, and portal vein (a major vein in the liver). A thromboembolism (a blood clot that has traveled through the venous system to a point distant from its origination) in the pulmonary system can also be visualized. MRV can be used to demonstrate deep venous thrombosis anywhere in the body, such as the major leg veins or veins deep in the pelvis. Pelvic vein varicosities (enlarged, twisted, tortuous varicose veins) can also be assessed with MRV. MRV is an important method used to evaluate cerebral sinus venous thrombosis, a serious condition in which a clot blocks the drainage of blood from the brain. Lesions that occur in multiple sclerosis may also be visualized with MRV.

### Description

Prior to beginning the MRV scan, radioactive contrast is injected through an IV. The classic MRI unit consists of an examination table on which the patient lies, and a doughnut-shaped scanner into which the table slides. During the course of the MRV, which may take between thirty minutes and two hours, the patient must lie very still, and may at times be asked to hold his or her breath. Some people are bothered by the sounds that the MRI scanner makes, which include a variety of tapping, bumping, and fan sounds. Although no one is in the room with the patient, the patient can usually communicate with the MRI technician through a two-way sound system installed within the MRI unit.

## KEY TERMS

**Multiple sclerosis**—A chronic degenerative neurological disease in which demyelination of the nerves causes progressive weakness and loss of motor function.

**Thromboembolism**—A blood clot that originates in one area of the body, but travels through the venous system to another area, where it obstructs blood flow. This is particularly problematic when the thromboembolus lodges in the lung.

**Thrombus**—A blood clot that is blocking a blood vessel.

**Varicose vein**—A vein that is abnormally enlarged, swollen, and/or dilated, and may be twisted or tortuous.

### Preparation

Because the strong magnetic field employed in MRV can interact with anything else that contains metal, it is crucial that the patient remove any jewelry, including from any piercings, prior to undergoing MRV. Other personal objects that should be removed include hearing aids, dentures, eyeglasses, hairpins. Pockets should be emptied of any metal-containing items, including coins, credit cards. Patients should inform the radiologist about any potentially metal-containing objects or medical devices that they have, such as tattooed eyeliner, a pacemaker, implanted defibrillator, aneurysm clips, cochlear implant, artificial limb, bone pin, medication patch, artificial heart valve, stent, infusion pump, or intrauterine device. People who have occupations in which they work frequently with metal should also inform the radiologist of this fact. In some cases, the MRV cannot be performed due to the presence of metal that cannot be removed and would be unsafe to expose to the magnetic fields of an MRI scanner. Sometimes, an x-ray will be ordered prior to an MRV in order to verify that there is not other metal in the body that would preclude performing the test.

Some patients with a strong history of anxiety or claustrophobia find it difficult to be enclosed in the doughnut-shaped MRI machine. There are some open machines available that may cause less anxiety. Sometimes, a sedative can be used to help the patient relax during the MRV.

Women who are pregnant or who think they may be pregnant are advised against undergoing MRV.

Women who are breastfeeding and who require MRV should feed their baby with formula for two days following the procedure, and should pump and discard their breast milk, since it will be contaminated with the radioactive dye.

Most MRI units have an upper limit of weight that they can hold. Patients over 300 pounds may not be able to undergo MRI, or may need to seek an open MRI unit for their study.

### Aftercare

There is no aftercare necessary following an MRV. The patient can return to a normal diet and normal activities.

### Risks

An MRV poses very little risk to the patient. Rarely, a patient may have an allergy to the radioactive contrast utilized.

### Normal results

Normal results of an MRV would reveal normal venous architecture, with fully patent arteries throughout the venous tree. No narrowing, blockages, reduced blood flow, or outpouchings of the vein walls are visualized in a normal MRV.

### Abnormal results

An MRV is abnormal if the veins appear to be dilated, enlarged, tortuous, or if there is reduced blood flow through any part of the venous tree. If a thrombus is completely obstructing a vein, the vein may not be visualized at all, since the obstruction will prevent any blood flow (and therefore any radioactive contrast) from reaching that part of the venous system. When a thrombus is blocking a vein, the MRV may show the vein to be abnormally dilated, with a rim of increased radioactive intensity around the actual thrombus.

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Mallet toe surgery see **Hammer, claw, and mallet toe surgery**

## Mammography

### Definition

Mammography is the study of the breast using x rays. The actual test is called a mammogram. It is an x ray of the breast which shows the fatty, fibrous, and glandular tissues. There are two types of mammograms. A screening mammogram is ordered for women who have no problems with their breasts. It consists of two x-ray views of each breast: a cranio-caudal (from above) and a mediolateral oblique (from the sides). A diagnostic mammogram is for evaluation of abnormalities in either men or women. Additional x rays from other angles, or special coned views of certain areas, are taken.

### Purpose

The purpose of screening mammography is breast cancer detection. A screening test, by definition, is used for patients without any signs or symptoms, in order to detect disease as early as possible. Many studies have shown that having regular mammograms increases a woman's chances of finding breast cancer in an early stage, when it is more likely to be curable. It has been estimated that a mammogram may find a cancer as much as two or three years before it can be felt. The American Cancer Society (ACS) guidelines recommend an annual screening mammogram for every woman of average risk beginning at age 40. Radiologists look specifically for the presence of microcalcifications and other abnormalities that can be associated with malignancy. New digital mammography and computer-aided reporting can automatically enhance and magnify the mammograms for easier identification of these tiny calcifications.

The highest risk factor for developing cancer is age. Some women are at an increased risk for developing breast cancer, such as those with a positive family history of the disease. Beginning screening mammography at a younger age may be recommended for these women.

Diagnostic mammography is used to evaluate an existing problem, such as a lump, discharge from the nipple, or unusual tenderness in one area. It is also done to evaluate further abnormalities that have been seen on screening mammograms. The radiologist normally views the films immediately and may ask for additional views such as a magnification view of one specific area. Additional studies such as an **ultrasound** of the breast may be performed as well to determine if the lesion is cystic or solid. Breast-specific **positron emission**



## KEY TERMS

**Breast biopsy**—A procedure where suspicious tissue is removed and examined by a pathologist for cancer or other disease. The breast tissue may be obtained by open surgery, or through a needle.

**Craniocaudal**—Head to tail, x-ray beam directly overhead the part being examined.

**Radiographically dense**—An abundance of glandular tissue that results in diminished anatomic detail on the mammogram.

**tomography (PET)** scans as well as an MRI (**magnetic resonance imaging**) may be ordered to further evaluate a tumor, but mammography is still the first choice in detecting small tumors on a screening basis.

## Description

A mammogram may be offered in a variety of settings. Hospitals, outpatient clinics, physician's offices, or other facilities may have mammography equipment. In the United States only places certified by the Food and Drug Administration (FDA) are legally permitted to perform, interpret, or develop mammograms. Mammograms are taken with dedicated machines using high frequency generators, low kvp, molybdenum targets and specialized x-ray beam filtration. Sensitive high contrast film and screen combinations along with prolonged developing enable the visualization of minute breast detail.

In addition to the usual paperwork, a woman will be asked to fill out a questionnaire asking for information on her current medical history. Beyond her personal and family history of cancer, details about menstruation, previous breast surgeries, child bearing, birth control, and hormone replacement therapy are recorded. Information about breast self-examination (BSE) and other breast health issues are usually available at no charge.

At some centers, a technologist may perform a **physical examination** of the breasts before the mammogram. Whether or not this is done, it is essential for the technologist to record any lumps, nipple discharge, breast pain or other concerns of the patient. All visible scars, tattoos and nipple alterations must be carefully noted as well.

Clothing from the waist up is removed, along with necklaces and dangling earrings. A hospital gown or similar covering is put on. A small self-adhesive metal

marker may be placed on each nipple by the x-ray technologist. This allows the nipple to be viewed as a reference point on the film for concise tumor location and easier centering for additional views.

Patients are positioned for mammograms differently, depending on the type of mammogram being performed:

- **Craniocaudal position (CC)**: The woman stands or sits facing the mammogram machine. One breast is exposed and raised to a level position while the height of the cassette holder is adjusted to the same level. The breast is placed mid-film with the nipple in profile and the head turned away from the side being x rayed. The shoulder is relaxed and pulled slightly backward while the breast is pulled as far forward as possible. The technologist holds the breast in place and slowly lowers the compression with a foot pedal. The breast is compressed between the film holder and a rectangle of plastic (called a paddle). The breast is compressed until the skin is taut and the breast tissue firm when touched on the lateral side. The exposure is taken immediately and the compression released. Good compression can be uncomfortable, but it is very necessary. Compression reduces the thickness of the breast, creates a uniform density and separates overlying tissues. This allows for a detailed image with a lower exposure time and decreased radiation dose to the patient. The same view is repeated on the opposite breast.
- **Mediolateral oblique position (MLO)**: The woman is positioned with her side towards the mammography unit. The film holder is angled parallel to the pectoral muscle, anywhere from 30 to 60 degrees depending on the size and height of the patient. The taller and thinner the patient the higher the angle. The height of the machine is level with the axilla (armpit). The arm is placed at the top of the cassette holder with a corner touching the armpit. The breast is lifted forward and upward and compression is applied until the breast is held firmly in place by the paddle. The nipple should be in profile and the opposite breast held away if necessary by the patient. This procedure is repeated for the other breast. A total of four x rays, two of each breast, are taken for a screening mammogram. Additional x rays, using special paddles, different breast positions, or other techniques may be taken for a diagnostic mammogram.

The mammogram may be seen and interpreted by a radiologist right away, or it may not be reviewed until later. If there is any questionable area or abnormality, extra x rays may be recommended. These may be taken during the same appointment. More commonly, especially for screening mammograms, the

woman is called back on another day for these additional films.

A screening mammogram usually takes approximately 15 to 30 minutes. A woman having a diagnostic mammogram can expect to spend up to an hour for the procedure.

The cost of mammography varies widely. Many mammography facilities accept “self referral.” This means women can schedule themselves without a physician’s referral. However, some insurance policies do require a doctor’s prescription to ensure payment. **Medicare** will pay for annual screening mammograms for all women over age 39.

## Preparation

The compression or squeezing of the breast necessary for a mammogram is a concern of many women. Mammograms should be scheduled when a woman’s breasts are least likely to be tender. One to two weeks after the first day of the menstrual period is usually best, as the breasts may be tender during a menstrual period. Some women with sensitive breasts also find that stopping or decreasing caffeine intake from coffee, tea, colas, and chocolate for a week or two before the examination decreases any discomfort. Women receiving hormone therapy may also have sensitive breasts. Over-the-counter pain relievers are recommended an hour before the mammogram appointment when pain is a significant problem.

Women should not put deodorant, powder, or lotion on their upper body on the day the mammogram is performed. Particles from these products can get on the breast or film holder and may show up as abnormalities on the mammogram. Most facilities will have special wipes available for those patients who need to wash before the mammogram.

## Aftercare

No special aftercare is required.

## Risks

The risk of radiation exposure from a mammogram is considered minimal and not significant. Experts are unanimous that any negligible risk is by far outweighed by the potential benefits of mammography. Patients who have **breast implants** must be x rayed with caution and compression is minimally applied so that the sac is not ruptured. Special techniques and positioning skills must be learned before a technologist can x ray a patient with breast implants.

Some breast cancers do not show up on mammograms, or “hide” in dense breast tissue. A normal (or negative) study is not a guarantee that a woman is cancer-free. The false-negative rate is estimated to be 15–20%, higher in younger women and women with dense breasts.

False positive readings are also possible. Breast biopsies may be recommended on the basis of a mammogram, and find no cancer. It is estimated that 75–80% of all breast biopsies resulted in benign (no cancer present) findings. This is considered an acceptable rate, because recommending fewer biopsies would result in too many missed cancers.

## Normal results

A mammography report describes details about the x-ray appearance of the breasts. It also rates the mammogram according to standardized categories, as part of the Breast Imaging Reporting and Data System (BIRADS) created by the American College of Radiology (ACR). A normal mammogram may be rated as BIRADS 1 or negative, which means no abnormalities were seen. A normal mammogram may also be rated as BIRADS 2 or benign findings. This means there are one or more abnormalities but they are clearly benign (not cancerous), or variations of normal. Some kinds of calcifications, enlarged lymph nodes or obvious cysts might generate a BIRADS 2 rating.

Many mammograms are considered borderline or indeterminate in their findings. BIRADS 3 means either additional images are needed, or an abnormality is seen and is probably (but not definitely) benign. A follow-up mammogram within a short interval of six to 12 months is suggested. This helps to ensure that the abnormality is not changing, or is “stable.” Only the affected side will be x rayed at this time. Some women are uncomfortable or anxious about waiting, and may want to consult with their doctor about having a biopsy. BIRADS 4 means suspicious for cancer. A biopsy is usually recommended in this case. BIRADS 5 means an abnormality is highly suggestive of cancer. A biopsy or other appropriate action should be taken.

Screening mammograms are not usually recommended for women under age 40 who have no special risk factors and a normal physical breast examination. A mammogram may be useful if a lump or other problem is discovered in a woman aged 30–40. Below age 30, breasts tend to be “radiographically dense,” which means the breasts contain a large amount of glandular tissue which is difficult to image in fine detail. Mammograms

for this age group are controversial. An ultrasound of the breasts is usually done instead.

### *Patient education*

The mammography technologist must be empathetic to the patient's modesty and anxiety. He or she must explain that compression is necessary to improve the quality of the image but does not harm the breasts. Patients may be very anxious when additional films are requested. Explaining that an extra view gives the radiologist more information will help to ease the patient's tension. One in eight women in North America will develop breast cancer. Educating the public on monthly breast self-examinations and yearly mammograms will help in achieving an early diagnosis and therefore a better cure.

### **Resources**

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- American Cancer Society (ACS), 1599 Clifton Rd., Atlanta, GA 30329. (800) ACS 2345. <http://www.cancer.org>.
- Federal Drug Administration (FDA), 5600 Fishers Ln., Rockville, MD 20857. (800) 532 4440. <http://www.fda.gov>.
- National Cancer Institute (NCI) and Cancer Information Service (CIS), Office of Cancer Communications, Bldg. 31, Room 10A16, Bethesda, MD 20892. (800) 4 CANCER (800) 422 6237. Fax: (800) 624 2511 or (301) 402 5874. <cancermail@cips.nci.nih.gov>. <<http://cancernet.nci.nih.gov>>.

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## **Managed care plans**

### **Definition**

Managed care plans are health-care delivery systems that integrate the financing and delivery of health care. Managed care organizations generally negotiate agreements with providers to offer packaged health care benefits to covered individuals.

### **Purpose**

The purpose for managed care plans is to reduce the cost of health care services by stimulating competition and streamlining administration.

### **Description**

A majority of insured Americans belongs to a managed care plan, a health care delivery system that applies corporate business practices to medical care in order to reduce costs and streamline care. The managed care era began in the late 1980s in response to skyrocketing health-care costs, which stemmed from a number of sources. Under the fee-for-service, or indemnity, model that preceded managed care, doctors and hospitals were financially rewarded for using a multitude of expensive tests and procedures to treat patients. Other contributors to the high cost of health care were the public health advances after World War II that lengthened the average lifespan of Americans. This put increased pressure on the health-care system. In response, providers have adopted state-of-the-art diagnostic and treatment technologies as they have become available.

Managed care companies attempted to reduce costs by negotiating lower fees with clinicians and hospitals in exchange for a steady flow of patients, developing standards of treatment for specific diseases, requiring clinicians to get plan approval before hospitalizing a patient (except in the case of an emergency), and encouraging clinicians to prescribe less expensive medicines. Many plans offer financial incentives to clinicians who minimize referrals and diagnostic tests, and some even apply financial penalties, or disincentives, on those considered to have ordered unnecessary care. The primary watchdog and accreditation agency for managed care organizations is the National Committee for Quality Assurance (NCQA), a non-profit organization that also collects and disseminates health plan performance data.

Three basic types of managed care plans exist: health maintenance organizations (HMOs), preferred provider organizations (PPOs), and point-of-service (POS) plans.

- HMOs, in existence for more than 50 years, are the best known and oldest form of managed care. Participants in HMO plans must first see a primary care provider, who may be a physician or an advanced practice registered nurse (APRN), in order to be referred to a specialist. Four types of HMOs exist: the Staff Model, Group Model, Network Model, and the Independent Practice Association (IPA). The Staff

## KEY TERMS

**Health maintenance organization (HMO)**—Vertically integrated health-care provider employing many clinical professionals and usually owning or controlling a hospital.

**Preferred provider organization (PPO)**—Roster of professionals who have been approved to provide services to members of a particular managed care organization.

Model hires clinicians to work onsite. The Group Model contracts with group practice physicians on an exclusive basis. The Network Model resembles the group model except participating physicians can treat patients who are not plan members. The Independent Practice Association (IPA) contracts with physicians in private practice to see HMO patients at a prepaid rate per visit as a part of their practice.

- PPOs are more flexible than HMOs. Like HMOs, they negotiate with networks of physicians and hospitals to get discounted rates for plan members. But, unlike HMOs, PPOs allow plan members to seek care from specialists without being referred by a primary care practitioner. These plans use financial incentives to encourage members to seek medical care from providers inside the network.
- POS plans are a blend of the other types of managed care plans. They encourage plan members to seek care from providers inside the network by charging low fees for their services, but they add the option of choosing an out-of-plan provider at any time and for any reason. POS plans carry a high premium, a high deductible, or a higher co-payment for choosing an out-of-plan provider.

Several managed care theories such as those stressing continuity of care, prevention, and early intervention are applauded by health-care practitioners and patients alike. But managed care has come under fire by critics who feel patient care may be compromised by managed care cost-cutting strategies such as early hospital discharge and use of financial incentives to control referrals, which may make clinicians too cautious about sending patients to specialists. In general, the rise of managed care has shifted decision-making power away from plan members, who are limited in their choices of providers, and away from clinicians, who must concede to

managed-care administrators regarding what is considered a medically necessary procedure. Many people would like to see managed care restructured to remedy this inequitable distribution of power. Such actions would maximize consumer choice and allow health-care practitioners the freedom to provide the best care possible. According to the American Medical Association, rejection of care resulting from managed care stipulations should be subjected to an independent appeals process.

The health-care industry today is dominated by corporate values of managed care and is subject to corporate principles such as cost cutting, mergers and acquisitions, and layoffs. To thrive in such an environment, and to provide health care in accordance with professional values, health-care practitioners must educate themselves on the business of health care, including hospital operations and administrative decision making, in order to influence institutional and regional health-care policies. A sampling of the roles available for registered nurses in a managed care environment include:

- Primary care provider. The individual responsible for determining a plan of care, including referrals to specialists.
- Case manager. The person who tracks patients through the health-care system to maintain continuity of care.
- Triage nurse. In a managed care organization, these individuals help direct patients through the system by determining the urgency and level of care necessary and advising incoming patients on self-care when appropriate.
- Utilization/Resource reviewer. This individual helps manage costs by assessing the appropriateness of specialized treatments.

## Normal results

It is difficult to predict the effect of the managed care revolution on the health-care profession. All health-care providers will benefit from building broad coalitions at the state and federal levels to publicize their views on patient care issues. These coalitions will also be useful to monitor developing trends in the industry, including the impact of proposed mergers and acquisitions of health-care institutions on the provision of care.

*See also* Long-term insurance.



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- Alden March Bioethics Institute. 47 New Scotland Avenue, MC 153, Albany, NY 12208-3478. (518) 262-6082. <<http://bioethics.org>>.
- American Association of Managed Care Nurses. 4435 Waterfront Drive, Suite 101, Glen Allen, VA 23060. (804) 747-9698. <http://www.aamcn.org/>.
- American College of Physicians. 190 N. Independence Mall West, Philadelphia, PA 19106-1572. (800) 523-1546, x2600, or (215) 351-2600. <http://www.acponline.org>.
- American College of Surgeons. 633 North St. Clair Street, Chicago, IL 60611-3231. (312) 202-5000; Fax: (312) 202-5001. E mail: [postmaster@facs.org](mailto:postmaster@facs.org). <http://www.facs.org>.
- American Hospital Association. One North Franklin, Chicago, IL 60606-3421. (312) 422-3000. [http://www.aha.org/aha\\_app/index.jsp](http://www.aha.org/aha_app/index.jsp).
- American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464-5000. <http://www.ama-assn.org>.
- American Nurses Association. 8515 Georgia Avenue, Suite 400, Silver Spring, MD 20910. (800) 274-4262. <http://www.nursingworld.org>.
- National Committee for Quality Assurance. 1100 13th St., NW, Suite 1000, Washington, DC 20005. (202) 955-3500. <http://www.ncqa.org>.

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## Mantoux test

### Definition

The Mantoux test is used to detect tuberculosis, an infectious disease caused by mycobacteria, usually *Mycobacterium tuberculosis*. Tuberculosis is a relatively common disease that usually affects the lungs, but it may also affect other organ systems and can be deadly.

### Purpose

Many people infected with TB bacteria are asymptomatic and thus have a latent TB infection. Ten percent of latent TB infections will eventually become active TB, with a greater than 50% mortality rate. The Mantoux test is used to diagnose those with a latent TB infection. Once individuals are diagnosed with latent TB infection, treatment may begin which will substantially reduce the chance that a latent TB infection progresses to disease. The detection and treatment of latent TB infection is essential in controlling and potentially eliminating tuberculosis.

### Precautions

Individuals who have been immunized for TB, have had a past cleared TB infection or are infected with a nontuberculous mycobacteria will respond to the Mantoux test similarly to those who have a latent infection, thus the Mantoux test must be interpreted with caution and if a positive result occurs, detailed history should be discussed. Recent scientific advances have led to the development of a more highly specific test for TB infection that may eventually replace the

Mantoux test as it is less likely to show a response in individuals who have been immunized for TB or infected with a nontuberculous mycobacteria.

## Description

The Mantoux test is also known as the PPD test. PPD stands for Purified Protein Derivative. PPD is an antigen that is taken from dead tuberculosis bacteria. The test is administered by using .1 ml or 5 Tuberculin units of PPD. The solution is injected into the skin of the underside of the forearm with a small needle. A small raised bump forms where the solution is administered and the health care professional should mark two edges of the raised bump to mark the injection site. The bacteria that causes tuberculosis produces a delayed hypersensitivity reaction. Within 48-72 hours after the administration of the test, an individual who has been exposed to the bacteria usually reacts to the PPD antigen in the skin of the injection area. The reaction will cause a raised hardened area or induration, at the site of the injection. The size of this area is measured and the measurement of the induration together with the patient's risk factors will determine if the result is considered positive.

## Preparation

In preparation for the test, it is important to remember that the results of the test need to be read by the healthcare provider 48-72 hours after the test is administered. The follow-up visit to have the test read should be planned before having the test administered. The healthcare provider should be notified if any surgeries or medical procedures are planned after the test or if a patient has allergies, is pregnant or breastfeeding. Lastly, the test should be postponed if the patient has a skin rash or sunburn on the underside of the forearms.

## Aftercare

It is important not to scratch, rub or press on the injection site, nor should one use ointments, lotions or sunscreen on the site, until after the test results have been read by the healthcare provider.

## Risks

Some people who are infected with tuberculosis may not have a reaction to the PPD test. This is called a false-negative result. Conversely, some people who are not infected with Mycobacterium Tuberculosis may have a positive PPD test result. This is called a false-positive result. For these reasons, the patient's medical history needs to be carefully taken into account for proper test result interpretation.

## Results

Typically a negative reaction, where there is no induration present, or the induration measurement is below the cut-off for the particular patient's risk category, would indicate that the patient does not have a latent TB infection. There are different cut-offs for the measurement of an induration for different groups of people. If an induration is present and is greater than or equal to 5 mm, this result would be considered positive in individuals who are HIV positive or who are immunosuppressed for other reasons, have had recent contact with people who have TB, or those who have had a chest x-ray that shows changes consistent with TB. If an induration is present and is greater than or equal to 10mm, this result is considered positive in patients who are recent immigrants from areas where TB has a high incidence, IV drug users, individuals who live or work in high-risk settings, have medical conditions that place them at high risk or children under the age of four. If an induration is present and is greater than or equal to 15mm, this is considered positive for any individual, even those with no known risk factors.

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Charles P. Felton National Tuberculosis Center, 2238 Fifth Avenue, First Floor, New York, NY 10037. (212)939 8254. <http://www.harlemtbcenter.org/>.

Renee Laux, M.S.

Marshall-Marchetti-Krantz procedure see  
**Retropubic suspension**

## Mastectomy

### Definition

Mastectomy is the surgical removal of the breast for the treatment or prevention of breast cancer.

### Purpose

Mastectomy is performed as a surgical treatment for breast cancer. The severity of a breast cancer is evaluated according to a complex system called staging. This takes into account the size of the tumor and whether it has spread to the lymph nodes, adjacent tissues, and/or distant parts of the body. A mastectomy usually is the recommended surgery for more advanced breast cancers. Women with earlier stage breast cancers, who might also have breast-conserving surgery (**lumpectomy**), may choose to have a mastectomy. In the United States, approximately 50,000 women a year undergo mastectomy.

The size, location, and type of tumor are important considerations when choosing the best surgery to treat breast cancer. The size of the breast also is an important factor. A woman's psychological concerns and lifestyle choices also should be considered when making a decision.

There are many factors that may make a mastectomy the treatment of choice for a patient. Large tumors are difficult to remove with good cosmetic results. This is especially true if the woman has small breasts. Sometimes multiple areas of cancer are found in one breast, making removal of the whole breast necessary. The surgeon sometimes is unable to remove the tumor with a sufficient amount, or margin, of normal tissue surrounding it. In this situation, the entire breast needs to be removed. Recurrence of breast cancer after a lumpectomy is another indication for mastectomy.

Radiation therapy is almost always recommended following a lumpectomy. If a woman is unable to have radiation, a mastectomy is the treatment of choice. Pregnant women cannot have radiation therapy for fear of harming the fetus. A woman with certain collagen vascular diseases, such as systemic lupus erythematosus or scleroderma, would experience unacceptable scarring and damage to her connective tissue from radiation exposure. Any woman who has had therapeutic radiation to the chest area for other reasons cannot tolerate additional exposure for breast cancer therapy.

The need for radiation therapy after breast conserving surgery may make mastectomy more appealing

for nonmedical reasons. Some women fear radiation and choose the more extensive surgery so radiation treatment will not be required. The commitment of time, usually five days a week for six weeks, may not be acceptable for other women. This may be due to financial, personal, or job-related factors. In geographically isolated areas, a course of radiation therapy may require lengthy travel and perhaps unacceptable amounts of time away from family or other responsibilities.

Some women choose mastectomy because they strongly fear recurrence of the breast cancer, and lumpectomy seems too risky. Keeping a breast that has contained cancer may feel uncomfortable for some patients. They prefer mastectomy, so the entire breast will be removed. However, studies have shown that survival rates for women choosing mastectomy and those undergoing breast-conserving surgery have been the same.

The issue of prophylactic or preventive mastectomy, or removal of the breast to prevent future breast cancer, is controversial. Women with a strong family history of breast cancer and/or who test positive for a known cancer-causing gene may choose to have both breasts removed. Patients who have had certain types of breast cancers that are more likely to recur may elect to have the unaffected breast removed. Although there is some evidence that this procedure can decrease the chances of developing breast cancer, it is not a guarantee. It is not possible to guarantee that all breast tissue has been removed. There have been cases of breast cancers occurring after both breasts have been removed.

Studies have shown that women who choose preventive mastectomy generally are satisfied with their choice, but also believe they lacked enough information before deciding, particularly about the surgery, genetic testing, and **breast reconstruction**. A recent study of women who underwent radical mastectomy of one breast and chose surgical removal of the other breast as a preventive measure reported that 83% were highly satisfied with their decision.

### Precautions

The decision to have mastectomy or lumpectomy should be carefully considered. It is important that the woman be fully informed of all the potential risks and benefits of each surgical treatment before making a choice.

## Description

There are several types of mastectomies. The radical mastectomy, also called the Halsted mastectomy, is rarely performed today. It was developed in the late 1800s, when it was thought that more extensive surgery was most likely to cure cancer. A radical mastectomy involves removal of the breast, all surrounding lymph nodes up to the collarbone, and the underlying chest muscle. Women often were left disfigured and disabled, with a large defect in the chest wall requiring **skin grafting**, and significantly decreased arm sensation and motion. Unfortunately, and inaccurately, it still is the operation many women picture when the word mastectomy is mentioned.

Surgery that removes breast tissue, nipple, an ellipse of skin, and some axillary or underarm lymph nodes, but leaves the chest muscle intact, usually is called a **modified radical mastectomy**. This is the most common type of mastectomy performed today. The surgery leaves a woman with a more normal chest shape than the older radical mastectomy procedure, and a scar that is not visible in most clothing. It also allows for immediate or delayed breast reconstruction.

In a **simple mastectomy**, only the breast tissue, nipple, and a small piece of overlying skin are removed. If a few of the axillary lymph nodes closest to the breast also are taken out, the surgery may be called an extended simple mastectomy.

There are other variations on the term mastectomy. A skin-sparing mastectomy uses special techniques that preserve the patient's breast skin for use in reconstruction, although the nipple still is removed. Total mastectomy is a confusing expression, as it may be used to refer to a modified radical mastectomy or a simple mastectomy. In 2003, surgeons reported on a new technique that spared the nipple in many women with early stage breast cancer.

Many women choose to have breast reconstruction performed in conjunction with the mastectomy. The reconstruction can be done using a woman's own abdominal tissue, or using saline-filled artificial expanders, which leave the breast relatively flat but partially reconstructed. Additionally, there are psychological benefits to coming out of the surgery with the first step to a reconstructed breast. Immediate reconstruction will add time and cost to the mastectomy procedure, but the patient can avoid the physical impact of a later surgery.

A mastectomy typically is performed in a hospital setting, but specialized outpatient facilities sometimes are used. The surgery is done under **general anesthesia**.

The type and location of the incision may vary according to plans for reconstruction or other factors, such as old scars. As much breast tissue as possible is removed. Approximately 10 to 20 axillary lymph nodes usually are removed. All tissue is sent to the pathology laboratory for analysis. If no immediate reconstruction is planned, surgical drains are left in place to prevent fluid accumulation. The skin is sutured and **bandages** are applied.

The surgery may take from two to five hours. Patients usually stay at least one night in the hospital, although outpatient mastectomy is increasingly performed for about 10% of all patients. Insurance usually covers the cost of mastectomy. If immediate reconstruction is performed, the length of stay, recovery period, insurance reimbursement, and fees will vary. In 1998, the Women's Health and Cancer Rights Act required insurance plans to cover the cost of breast reconstruction in conjunction with a mastectomy procedure.

## Preparation

Routine preoperative preparations, such as not eating or drinking the night before surgery, typically are ordered for a mastectomy. On rare occasions, the patient also may be asked to donate blood in case a blood **transfusion** is required during surgery. The patient should advise the surgeon of any medications she is taking. Information regarding expected outcomes and potential complications also should be part of preparation for a mastectomy, as for any surgical procedure. It is especially important that women know about sensations they might experience after surgery, so they are not misinterpreted as a sign of poor wound healing or recurrent cancer.

## Aftercare

In the past, women often stayed in the hospital at least several days. Now many patients go home the same day or within a day or two after their mastectomies. Visits from **home care** nurses can sometimes be arranged, but patients need to learn how to care for themselves before **discharge from the hospital**. Patients may need to learn to change bandages and/or care for the incision. The surgical drains must be attended to properly; this includes emptying the drain, measuring fluid output, moving clots through the drain, and identifying problems that need attention from the doctor or nurse. If the drain becomes blocked, fluid or blood may collect at the surgical site. Left untreated, this accumulation may cause infection and/or delayed wound healing.



After a mastectomy, activities such as driving may be restricted according to individual needs. Pain is usually well controlled with prescribed medication. Severe pain may be a sign of complications, and should be reported to the physician. A return visit to the surgeon is usually scheduled 7 to 10 days after the procedure.

Exercises to maintain shoulder and arm mobility may be prescribed as early as 24 hours after surgery. These are very important in restoring strength and promoting good circulation. However, intense **exercise** should be avoided for a time after surgery in order to prevent injury. The specific exercises suggested by the physician will change as healing progresses. Physical therapy is an integral part of care after a mastectomy, aiding in the overall recovery process.

Emotional care is another important aspect of recovery from a mastectomy. A mastectomy patient may feel a range of emotions including depression, negative self-image, grief, fear and anxiety about possible recurrence of the cancer, anger, or guilt. Patients are advised to seek counseling and/or support groups and to express their emotions to others, whether family, friends, or therapists. Assistance in dealing with the psychological effects of the breast cancer diagnosis, as well as the surgery, can be invaluable for women.

Measures to prevent injury or infection to the affected arm should be taken, especially if axillary lymph nodes were removed. There are a number of specific instructions directed toward avoiding pressure or constriction of the arm. Extra care must be exercised to avoid injury, to treat it properly if it occurs, and to seek medical attention promptly when appropriate.

Additional treatment for breast cancer may be necessary after a mastectomy. Depending on the type of tumor, lymph node status, and other factors, chemotherapy, radiation therapy, and/or hormone therapy may be prescribed.

### Risks

Risks that are common to any surgical procedure include bleeding, infection, anesthesia reaction, or unexpected scarring. After mastectomy and axillary lymph node dissection, a number of complications are possible. A woman may experience decreased feeling in the back of her armpit or other sensations including numbness, tingling, or increased skin sensitivity. Some women report phantom breast symptoms, experiencing itching, aching, or other sensations in the breast that has been removed. There may be scarring around where the lymph nodes were removed, resulting in

## KEY TERMS

**Axillary**—Located in or near the armpit.

**Lymphedema**—Swelling caused by an accumulation of fluid from faulty lymph drainage.

**Mastectomy, modified radical**—Total mastectomy with axillary lymph node dissection, but with preservation of the pectoral muscles.

**Mastectomy, radical**—Removal of the breast, pectoral muscles, axillary lymph nodes, and associated skin and subcutaneous tissue.

**Mastectomy, simple**—Removal of only the breast tissue, nipple and a small portion of the overlying skin

decreased arm mobility and requiring more intense physical therapy.

Approximately 10% to 20% of patients develop lymphedema after axillary lymph node removal. This swelling of the arm, caused by faulty lymph drainage, can range from mild to severe. It can be treated with elevation, elastic bandages, and specialized physical therapy. Lymphedema is a chronic condition that requires continuing treatment. This complication can arise at any time, even years after surgery. A new technique called sentinel lymph node mapping and biopsy often eliminates the need for removing some or all lymph nodes by testing the first lymph node for cancer.

### Normal results

A mastectomy is performed as the definitive surgical treatment for breast cancer. The goal of the procedure is that the breast cancer is completely removed and does not recur.

### Abnormal results

An abnormal result of a mastectomy is the incomplete removal of the breast cancer or a recurrence of the cancer. Other abnormal results include long-lasting (chronic) pain or impairment that does not improve after several months of physical therapy.

### Morbidity and mortality rates

Morbidity rates are modest. The most common problems include post-operative infections, unwanted scarring and issues related to emotional adjustment. A decade ago, exposure to silicone from a ruptured implant

occasionally occurred. This has been eliminated with the use of saline-filled implants. Mortality is extremely uncommon, averaging fewer than ten deaths per year.

## Alternatives Resources

There are no alternatives to mastectomy that is medically indicated. Options do exist for post-mastectomy **reconstructive surgery**. These include the use of pads and breast forms.

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- American College of Surgeons. 633 North Saint Claire Street, Chicago, IL 60611. (312) 202 5000. <http://www.facs.org/>.
- American Society for Aesthetic Plastic Surgery. 11081 Winners Circle, Los Alamitos, CA 90720. (888) 272 7711. <http://www.surgery.org/>.

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L. Fleming Fallon, Jr, MD, DrPH

Mastoid tympanoplasty see **Mastoidectomy**

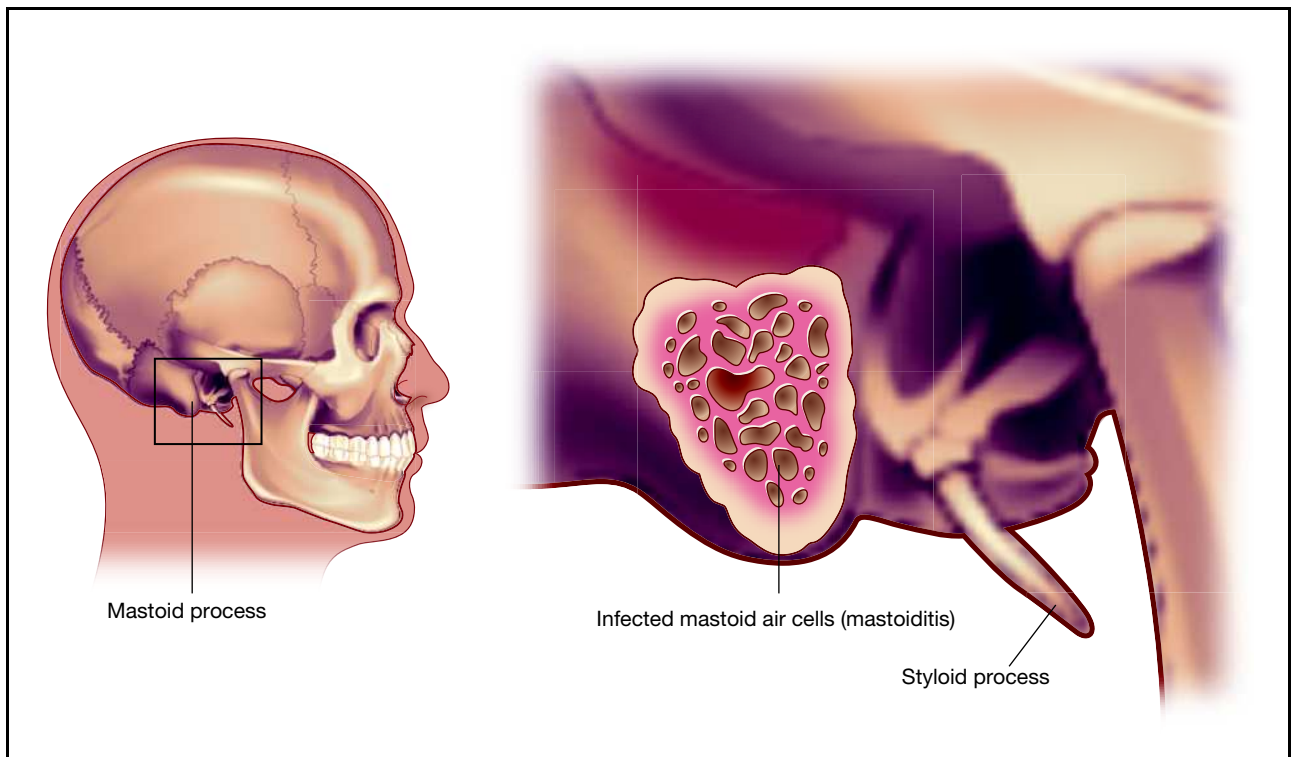
## Mastoidectomy

### Definition

A mastoidectomy is a surgical procedure that removes an infected portion of the mastoid bone when medicinal treatment is not effective.

### Purpose

A mastoidectomy is performed to remove infected mastoid air cells resulting from ear infections, such as mastoiditis or chronic otitis, or by inflammatory disease of the middle ear (cholesteatoma). The mastoid air cells are open spaces containing air that are located throughout the mastoid bone, the prominent bone located behind the ear that projects from the temporal bone of the skull. The air cells are connected to a cavity



(Illustration by Electronic Illustrators Group.)

in the upper part of the bone, which is in turn connected to the middle ear. Aggressive infections in the middle ear can thus sometimes spread through the mastoid bone. When **antibiotics** can't clear this infection, it may be necessary to remove the infected area by surgery. The primary goal of the surgery is to completely remove infection so as to produce an infection-free ear. Mastoidectomies are also performed sometimes to repair paralyzed facial nerves.

### Demographics

According to the American Society for Microbiology, middle ear infections increased in the United States from approximately 3 million cases in 1975 to over 9 million in 1997. Middle ear infections are now the second leading cause of office visits to physicians, and this diagnosis accounts for over 40% of all outpatient antibiotic use. Ear infections are also very common in children between the ages of six months and two years. Most children have at least one ear infection before their eighth birthday.

### Description

A mastoidectomy is performed with the patient fully asleep under **general anesthesia**. There are several

different types of mastoidectomy procedures, depending on the amount of infection present:

- **Simple (or closed) mastoidectomy.** The operation is performed through the ear or through a cut (incision) behind the ear. The surgeon opens the mastoid bone and removes the infected air cells. The eardrum is incised to drain the middle ear. Topical antibiotics are then placed in the ear.
- **Radical mastoidectomy.** The procedure removes the most bone and is usually performed for extensive spread of a cholesteatoma. The eardrum and middle ear structures may be completely removed. Usually the stapes, the "stirrup" shaped bone, is spared if possible to help preserve some hearing.
- **Modified radical mastoidectomy.** In this procedure, some middle ear bones are left in place and the eardrum is rebuilt by tympanoplasty.

After surgery, the wound is stitched up around a drainage tube and a dressing is applied.

### Diagnosis/Preparation

The treating physician gives the patient a thorough ear, nose, and throat examination and uses detailed diagnostic tests, including an audiogram and

## KEY TERMS

**Audiogram**—A test of hearing at a range of sound frequencies.

**Mastoid air cells**—Numerous small intercommunicating cavities in the mastoid process of the temporal bone that empty into the mastoid antrum.

**Mastoid antrum**—A cavity in the temporal bone of the skull, communicating with the mastoid cells and with the middle ear.

**Mastoid bone**—The prominent bone behind the ear that projects from the temporal bone of the skull.

**Mastoiditis**—An inflammation of the bone behind the ear (the mastoid bone) caused by an infection spreading from the middle ear to the cavity in the mastoid bone.

**Otitis**—Inflammation of the ear, which may be marked by pain, fever, abnormalities of hearing, hearing loss, tinnitus and vertigo.

**Tympanoplasty**—Procedure to reconstruct the tympanic membrane (eardrum) and/or middle ear bone as the result of infection or trauma.

imaging studies of the mastoid bone using x rays or **CT scans** to evaluate the patient for surgery.

The patient is prepared for surgery by shaving the hair behind the ear on the mastoid bone. Mild soap and a water solution are commonly used to cleanse the outer ear and surrounding skin.

## Aftercare

The drainage tube inserted during surgery is typically removed a day or two later.

Painkillers are usually needed for the first day or two after the operation. The patient should drink fluids freely. After the **stitches** are removed, the bulky mastoid dressing can be replaced with a smaller dressing if the ear is still draining. The patient is given antibiotics for several days.

The patient should inform the physician if any of the following symptoms occur:

- bright red blood on the dressing
- stiff neck or disorientation (These may be signs of meningitis.)
- facial paralysis, drooping mouth, or problems swallowing

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

An mastoidectomy is performed in a hospital by surgeons specialized in otolaryngology, the branch of medicine concerned with the diagnosis and treatment of disorders and diseases of the ears, nose and throat. The procedure usually takes between two and three hours. It is occasionally performed on an outpatient basis in adults but usually involves hospitalization.

## Risks

Complications do not often occur, but they may include:

- persistent ear discharge
- infections, including meningitis or brain abscesses
- hearing loss
- facial nerve injury (This is a rare complication.)
- temporary dizziness
- temporary loss of taste on the side of the tongue

## Normal results

The outcome of a mastoidectomy is a clean, healthy ear without infection. However, both a modified radical and a radical mastoidectomy usually result in less than normal hearing. After surgery, a hearing aid may be considered if the patient so chooses.

## Morbidity and mortality rates

In the United States, **death** from intracranial complications of cholesteatoma is uncommon due to earlier recognition, timely surgical intervention, and supportive antibiotic therapy. Cholesteatoma remains a relatively common cause of permanent, moderate, and conductive hearing loss.

## Alternatives

Alternatives to mastoidectomy include the use of medications and delaying surgery. However, these alternative methods carry their own risk of complications and a varying degree of success. Thus, most physicians are of the opinion that patients for whom mastoidectomy is indicated should best undergo the operation, as it provides the patient with the best chance of successful treatment and the lowest risk of complications.



## QUESTIONS TO ASK THE DOCTOR

- What are the alternatives to mastoidectomy?
- What are the risks associated with the surgery?
- How will the surgery affect hearing?
- What are the possible alternative treatments?
- How long will it take to recover from the surgery?
- How many mastoidectomies do you perform each year?

### Resources

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Carol A. Turkington  
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## Maze procedure for atrial fibrillation

### Definition

The Maze procedure, also known as the Cox-Maze procedure, is a surgical treatment for chronic atrial fibrillation or atrial flutter. The procedure restores the heart's normal rhythm by surgically interrupting the conduction of abnormal impulses.

### Purpose

When the heart beats too fast, blood no longer circulates effectively in the body. The Maze procedure is used to stop this abnormal beating so that the heart can begin its normal rhythm and pump more efficiently. The procedure is also intended to control heart rate and prevent blood clots and strokes.

### Demographics

The Maze procedure has been performed since 1987 and was developed by Dr. James L. Cox. The average age of patients undergoing this procedure is about 52.

The Maze procedure is used to treat chronic or paroxysmal atrial fibrillation, a type of abnormal heart rhythm in which the upper chamber of the heart quivers instead of pumping in an organized way. In general, patients usually have atrial fibrillation for about eight years before undergoing the Maze procedure. The Maze procedure may be recommended for patients who need surgical treatment for coronary artery disease or valve disease. Therefore, the Maze procedure may be performed in combination with coronary artery bypass surgery (CABG), valve repair, valve replacement, or other cardiac surgery.

The Maze procedure may be recommended for patients whose atrial fibrillation has not been successfully treated with medications or other non-surgical interventional procedures. It may also be a treatment option for patients who have a history of stroke or cardiac thrombus.

Abnormal heart rhythms are slightly more common in men than in women, and the prevalence of abnormal heart rhythms, especially atrial fibrillation, increases with age. Atrial fibrillation is relatively uncommon in people under age 20.

### Description

Elective Maze surgery is usually scheduled in advance. After arriving at the hospital, an intravenous (IV) catheter will be placed in the arm to deliver

## KEY TERMS

**Ablation**—The removal or destruction of tissue.

**Ablation therapy**—A procedure used to treat arrhythmias, especially atrial fibrillation.

**Ambulatory monitors**—Small portable electrocardiograph machines that record the heart's rhythm, and include the Holter monitor, loop recorder, and trans-telephonic transmitter.

**Anti-arrhythmic**—Medication used to treat abnormal heart rhythms.

**Anticoagulant**—A medication, also called a blood thinner, that prevents blood from clotting.

**Atria**—The right and left upper chambers of the heart.

**Cardiac catheterization**—An invasive procedure used to create x rays of the coronary arteries, heart chambers and valves.

**Cardioversion**—A procedure used to restore the heart's normal rhythm by applying a controlled electric shock to the exterior of the chest.

**Echocardiogram**—An imaging procedure used to create a picture of the heart's movement, valves and chambers.

**Electrocardiogram (ECG, EKG)**—A test that records the electrical activity of the heart using small electrode patches attached to the skin on the chest.

**Electrophysiology study (EPS)**—A test that evaluates the electrical activity within the heart.

**Head-upright tilt table test**—A test used to determine the cause of fainting spells.

**Implantable cardioverter-defibrillator (ICD)**—An electronic device that is surgically placed to constantly monitor the patient's heart rate and rhythm. If a very fast, abnormal heart rate is detected, the device delivers electrical energy to the heart to resume beating in a normal rhythm.

**Nuclear imaging**—Method of producing images by detecting radiation from different parts of the body after a radioactive tracer material is administered.

**Pacemaker**—A small electronic device implanted under the skin that sends electrical impulses to the heart to maintain a suitable heart rate and prevent slow heart rates.

**Pulmonary vein isolation**—A surgical procedure used to treat atrial fibrillation.

**Stress test**—A test used to determine how the heart responds to stress.

**Ventricles**—The lower pumping chambers of the heart; the heart has two ventricles: the right and the left.

medications and fluids. **General anesthesia** is administered to put the patient to sleep.

In most cases, a traditional incision is made down the center of the patient's chest, cuts through the breastbone (sternum), and the rib cage is retracted open to expose the heart. The patient is connected to a heart-lung bypass machine, also called a cardiopulmonary bypass pump, which takes over for the heart and lungs during the surgery. The heart-lung machine removes carbon dioxide from the blood and replaces it with oxygen. A tube is inserted into the aorta to carry the oxygenated blood from the bypass machine to the aorta for circulation to the body. The heart-lung machine allows the heart's beating to be stopped so the surgeon can operate on a still heart.

Some patients may be candidates for off-pump surgery, in which the surgery is performed without the use of a heart-lung bypass machine. This is also called beating heart surgery.

The Maze surgery may be an option for some patients. The minimally invasive technique enables

the surgeon to work on the heart through small chest holes called ports and other small incisions. Advantages of minimally invasive surgery over the traditional method include smaller incisions, a shorter hospital stay, a shorter recovery period, and lower costs.

During the procedure, precise incisions, also called lesions, are made in the right and left atria to isolate and stop the unusual electrical impulses from forming. The incisions form a maze through which the impulses can travel in one direction from the top of the heart to the bottom. When the heart heals, scar tissue forms and the abnormal electrical impulses can no longer travel through the heart.

These energy sources may be used during the procedure:

- **Radiofrequency:** A radiofrequency energy catheter is used to create the incisions or lesions in the heart.
- **Microwave:** A wand-like catheter is used to direct microwave energy to create the lesions in the heart.

- Cryotherapy (also called cryoablation): Very cold temperatures are transmitted through a probe (cryoprobe) to create the lesions.

When these energy sources are used, the procedure is called surgical pulmonary vein isolation.

## Diagnosis/Preparation

### *Diagnosis of abnormal heart rhythms*

A doctor may be able to detect an irregular heart-beat during a physical exam by taking the patient's pulse. In addition, the diagnosis may be based upon the presence of certain symptoms, including:

- palpitations (feeling of skipped heartbeats or fluttering in the chest)
- pounding in the chest
- shortness of breath
- chest discomfort
- fainting
- dizziness or feeling light-headed
- weakness, fatigue, or feeling tired

Not everyone with abnormal heart rhythms will experience symptoms, so the condition may be discovered upon examination for another medical condition.

**DIAGNOSTIC TESTS.** Tests used to diagnose an abnormal heart rhythm or determine its cause include:

- blood tests
- chest x rays
- electrocardiogram
- ambulatory monitors such as the Holter monitor, loop recorder, and trans-telephonic transmitter
- stress test
- echocardiogram
- cardiac catheterization
- electrophysiology study (EPS)
- head-upright tilt table test
- nuclear medicine test such as a MUGA scan (multiple-gated acquisition scanning)

### *Preparation*

During a preoperative appointment, usually scheduled within one to two weeks before surgery, the patient will receive information about what to expect during the surgery and the recovery period. The patient will usually meet the cardiologist, anesthesiologist, nurse clinicians, and surgeon during this appointment or just before the procedure.

Medication to thin the blood (blood thinner or anticoagulant) is usually given for at least three weeks before the procedure.

If the patient develops a cold, fever, or sore throat within a few days before the surgery, he or she should notify the surgeon's office.

From midnight before the surgery, the patient should not eat or drink anything.

The morning of the procedure, the patient should take all usual medications as prescribed, with a small sip of water, unless other instructions have been given. Patients who take diabetes medications or anticoagulants should ask their doctor for specific instructions.

The patient is usually admitted to the hospital the same day the surgery is scheduled. The patient should bring a list of current medications, allergies, and appropriate medical records upon **admission to the hospital**.

The morning of surgery, the chest area is shaved and heart monitoring begins. The patient is given general anesthesia before the procedure, so he or she will be asleep during the procedure.

The traditional Maze procedure takes about an hour to perform, while the surgical pulmonary vein isolation procedure generally takes only a few minutes to perform. However, the preparation and recovery time add a few hours to both procedures. The total time in the **operating room** for each of these procedures is about three to four hours.

## Aftercare

### *Recovery in the hospital*

The patient recovers in a surgical **intensive care unit** for one to two days after the surgery. The patient will be connected to chest and breathing tubes, a mechanical ventilator, a heart monitor, and other monitoring equipment. A urinary catheter will be in place to drain urine. The breathing tube and ventilator are usually removed about six hours after surgery, but the other tubes usually remain in place as long as the patient is in the intensive care unit.

Drugs are prescribed to control pain and to prevent unwanted blood clotting. Daily doses of **aspirin** are started within six to 24 hours after the procedure.

The patient is closely monitored during the recovery period. **Vital signs** and other parameters such as heart sounds and oxygen and carbon dioxide levels in arterial blood are checked frequently. The chest tube is checked to ensure that it is draining properly. The patient may be fed intravenously for the first day or two.

Chest physiotherapy is started after the ventilator and breathing tube are removed. The therapy includes coughing, turning frequently, and taking deep breaths. Sometimes oxygen is delivered via a mask to help loosen and clear secretions from the lungs. Other exercises will be encouraged to improve the patient's circulation and prevent complications from prolonged bed rest.

If there are no complications, the patient begins to resume a normal routine around the second day. This includes eating regular food, sitting up, and walking around a bit. Before being discharged from the hospital, the patient usually spends a few days under observation in a non-surgical unit. During this time, counseling is usually provided on eating right and starting a light **exercise** program to keep the heart healthy.

The average hospital stay after the Maze surgery is five to seven days, depending on the patient's rate of recovery.

### *Recovery at home*

**MEDICATIONS.** The doctor may prescribe antiarrhythmic medications (such as beta-blockers, digitalis, or calcium channel blockers) to prevent the abnormal heart rhythm from returning. Some patients may need to take a diuretic for four to eight weeks after surgery to reduce fluid retention that may occur after surgery. Potassium supplements may be prescribed along with the diuretic medications. Some patients may be prescribed anticoagulant medication such as warfarin and aspirin to reduce the risk of blood clots. The medications prescribed may be adjusted over time to determine the best dosage and type of medication so the abnormal heart rhythm is adequately controlled.

**INCISION AND SKIN CARE.** The incision should be kept clean and dry. When the skin is healed, the incision should be washed with soapy water. The scar should not be bumped, scratched, or otherwise disturbed. Ointments, lotions, and **dressings** should not be applied to the incision unless specific instructions have been given.

**DISCOMFORT.** While the incision scar heals, which takes one to two months, it may be sore. Itching, tightness, or numbness along the incision is common. Muscle or incision discomfort may occur in the chest during activity.

**LIFESTYLE CHANGES.** The patient needs to make several lifestyle changes after surgery, including:

- Quitting smoking. Smoking causes damage to blood vessels, increases the patient's blood pressure and heart rate, and decreases the amount of oxygen available in the blood.

- Managing weight. Maintaining a healthy weight, by watching portion sizes and exercising, is important. Being overweight increases the work of the heart.
- Participating in an exercise program. The cardiac rehabilitation exercise program is usually tailored for the patient, who will be supervised by fitness professionals.
- Making dietary changes. Patients should eat a lot of fruits, vegetables, grains, and non-fat or low-fat dairy products, and reduce fats to less than 30% of all calories.
- Taking medications as prescribed. Aspirin and other heart medications may be prescribed, and the patient may need to take these medications for life.
- Following up with health-care providers. An exercise test is often scheduled during one of the first follow-up visits to determine how effective the surgery was and to confirm that progressive exercise is safe. The patient needs to regularly see the physician for follow-up visits to monitor his or her recovery and control risk factors.

### **Risks**

The Maze procedure is major surgery and patients may experience any of the normal complications associated with major surgery and anesthesia, such as the risk of bleeding, pneumonia, or infection. The risk of stroke is 1%. One common complication that has occurred early after surgery is fluid retention. However, **diuretics** are now prescribed to reduce the risk of this complication. To date, minimal long-term adverse effects have been reported in patients undergoing the Maze procedure.

### **Normal results**

Full recovery from the Maze procedure takes six to eight weeks. Upon release from the hospital, the patient will feel weak because of the extended bed rest in the hospital. Within a few weeks, the patient should begin to feel stronger.

Most patients are able to drive in about three to four weeks, after receiving approval from their physician. Sexual activity can generally be resumed in three to four weeks, depending on the patient's rate of recovery.

It takes about six to eight weeks for the sternum to heal. During this time, the patient should not perform activities that cause pressure or put weight on the breastbone or tension on the arms and chest. Pushing and pulling heavy objects (such as mowing the lawn) should be avoided and lifting objects more than 20 lbs (9 kg) is not permitted. The patient should not hold his



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Heart surgeons specially trained in the Maze procedure should perform this procedure. The Maze procedure takes place in an operating room in a hospital. When evaluating where to have the surgery performed, the patient should find out how many Maze procedures have been performed at that facility, how many Maze procedures are performed per month, when the surgeons at that facility started performing the procedure, and what the typical outcomes or results are for their patients.

or her arms above shoulder level for a long period of time. The patient should try not to stand in one place for longer than 15 minutes. Stair climbing is permitted unless other instructions have been given.

Within four to six weeks, people with sedentary office jobs can return to work; people with physical jobs (such as construction work or jobs requiring heavy lifting) must wait longer (up to 12 weeks).

In about 30% of all patients, atrial fibrillation will recur temporarily right after surgery. This is common. Medications are usually prescribed to control atrial fibrillation after surgery. About three months after the surgery, medications are often reduced and then stopped.

In about 7–10% of patients, a permanent pacemaker is needed as a result of the procedure or sometimes due to underlying sinus node dysfunction.

About 90–95% of patients have a return of normal heart rhythm within one year after the surgery. Among U.S. surgeons reporting their data in the January 2000 issue of *Seminars in Thoracic and Cardiovascular Surgery*, the overall success rate of the Maze procedure is from 90–98%. Some hospitals report a 98% success rate in lone atrial fibrillation patients (those who do not have any other underlying heart conditions) undergoing the traditional Maze procedure. An 80–90% success rate has been reported for the surgical pulmonary vein isolation procedure.

### Morbidity and mortality rates

The overall operative mortality for patients undergoing the Maze procedure is 3%. The mortality rate increases among patients over age 65.

## QUESTIONS TO ASK THE DOCTOR

- Am I a candidate for minimally invasive surgery?
- Am I a candidate for the “off-pump” surgery technique?
- Who will be performing the surgery? How many years of experience does this surgeon have? How many other Maze procedures has this surgeon performed?
- Can I take my medications the day of the surgery?
- Can I eat or drink the day of the surgery? If not, how long before the surgery should I stop eating or drinking?
- How long will I have to stay in the hospital after the surgery?
- After I go home from the hospital, how long will it take me to recover from surgery?
- What should I do if I experience symptoms similar to those I felt before surgery?
- What types of symptoms should I report to my doctor?
- What types of medications will I have to take after surgery?
- When will I be able to resume my normal activities, including work and driving?
- When will I find out if the surgery was successful?
- What if the surgery was not successful?
- If I have had the surgery once, can I have it again to correct future blockages?
- Will I have any pain or discomfort after the surgery? If so, how can I relieve this pain or discomfort?
- Are there any medications, foods, or activities I should avoid to prevent my symptoms from recurring?
- How often do I need to see my doctor for follow-up visits after the surgery?

Atrial fibrillation is not immediately life threatening, but it can lead to other heart rhythm problems. Follow-up data from the Framingham Heart Study and the Anti-arrhythmia Versus Implantable Defibrillators Trial have shown that atrial fibrillation is a predictor of increased mortality.

According to a 2002 study published in the *New England Journal of Medicine*, controlling a patient's heart rate is as important as controlling the patient's

heart rhythm to prevent **death** and complications from cardiovascular causes. The study also concluded that anticoagulant therapy is important to reduce the risk of stroke and is appropriate therapy in patients who have recurring, persistent atrial fibrillation even after they received treatment.

### Alternatives

Health care providers usually try to correct the heart rhythm with medication and recommend lifestyle changes and other interventional procedures such as **cardioversion** before recommending the Maze procedure.

Lifestyle changes often recommended to treat abnormal heart rhythms include:

- quitting smoking
- avoiding activities that prompt the symptoms of abnormal heart rhythms
- limiting alcohol intake
- limiting or not using caffeine, which may produce more symptoms in some people with abnormal heart rhythms
- avoiding stimulant-containing medications such as some cough and cold remedies

If the Maze procedure is not successful in restoring the normal heart rhythm, other treatments for abnormal heart rhythms include:

- permanent pacemakers
- implantable cardioverter-defibrillator
- ablation therapy

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- American Heart Association. 7272 Greenville Ave., Dallas, TX 75231. (800) 242-8721 or (214) 373-6300. <http://www.americanheart.org>.

The Cleveland Clinic Heart Center, The Cleveland Clinic Foundation. 9500 Euclid Avenue, F25, Cleveland, OH 44195. (800) 223-2273 ext. 46697 or (216) 444-6697. <http://www.clevelandclinic.org/heartcenter>.

National Heart, Lung and Blood Institute. National Institutes of Health. Building 1. 1 Center Dr., Bethesda, MD 20892. E mail: <NHLBIinfo@rover.nhlbi.gov>. <http://www.nhlbi.nih.gov>.

Texas Heart Institute. Heart Information Service. P.O. Box 20345, Houston, TX 77225-0345. <http://www.tmc.edu/thi>.

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Angela M. Costello

Mean corpuscular hemoglobin see **Red blood cell indices**

Mean corpuscular volume see **Red blood cell indices**

## Mechanical circulation support

### Definition

Mechanical circulatory support is used to treat patients with advanced heart failure. A mechanical pump is surgically implanted to provide pulsatile or non-pulsatile flow of blood to supplement or replace the blood flow generated by the native heart. Types of circulatory support pumps include pneumatic and electromagnetic pumps. Rotary pumps are also available.

### Purpose

Heart failure causes low cardiac output, which results in inadequate blood pressure and reduced blood flow to the brain, kidneys, heart, and/or lungs. Pharmaceutical and surgical treatments (other than transplantation) are all typically exhausted before mechanical circulatory support is initiated. The extent of failure exhibited by one or both ventricles of the heart

## KEY TERMS

**Anticoagulant**—Pharmaceutical to prevent clotting proteins and platelets in the blood to be activated to form a blood clot.

**Cannulae**—Tubes that provide access to the blood once inserted into the heart or blood vessels.

**Cardiac**—Of or relating to the heart.

**Cardiac output**—The liter per minute blood flow generated by contraction of the heart.

**Cardiopulmonary bypass**—Diversion of blood flow away from the right atrium and return of blood beyond the left ventricle to bypass the heart and lungs.

determines if univentricular or biventricular support is required. In either case, blood flow is supplemented or replaced by a mechanical circulatory support device. The device works by removing blood from the inlet of the ventricle(s) and reinjecting it at the outlet of the ventricle(s) in order to increase blood pressure and blood flow to the brain, kidneys, heart, and lungs.

Some devices, along with the intra-aortic balloon pump (IABP), centrifugal pump, and extracorporeal membrane oxygenation (ECMO), are systems that are meant to sustain the patient until the heart recovers. If recovery does not occur, or is not expected, then **heart transplantation** becomes the next desired course of treatment. In this case, intermediate- to long-term mechanical circulatory support devices are required.

### Description

Short-, intermediate-, and long-term support requires bedside monitoring of the equipment and patient throughout treatment. The specialized nature of the equipment and the intensive patient care require dedicated staff who are able to provide continuous bedside treatment.

In most instances, patients receive anticoagulants, drugs that prevent clots in the blood. Frequent laboratory testing determines the proper amount of medication required to prevent blood clots. To mimic the lining of blood vessels, some surfaces of the device attract the body's cells, which stick to the device surface and eliminate the need for anticoagulation.

Blood flow generated by these devices is able to sustain blood pressure and flow to the heart, kidneys, liver, and brain. Temporary assist devices sustain vital organ tissues in situations where recovery of the heart function is anticipated. Long-term support devices

sustain patients until a donor heart is available for transplantation.

### *Short- to intermediate-term support devices*

ECMO circulatory support provides cardiopulmonary bypass. Both cardiac and pulmonary (lung) function can be supplemented with this device. The complexity of care and the need for highly trained staff with specialized equipment limit the availability of ECMO to specialty care facilities. Surgical cannulation (placement of tubes) is required. **Postoperative care** in the critical care unit requires dedicated bedside staffing.

Blood flow to the lungs is reduced as blood is drained from the venous circulation. Blood pumped by the left ventricle is also reduced as blood is returned directly to the systemic circulation. The heart is allowed to rest, pumping less blood than needed to maintain pressure and flow to the vital organs. As cardiac function improves, flow from ECMO support is reduced, allowing the heart to gradually resume normal function. The cannulae are surgically removed from the patient once the heart can maintain adequate cardiac output. Systemic anticoagulation is required throughout the length of support, and often leads to complications of stroke and coagulopathies. Long-term use of ECMO is limited since the patient is immobilized and sedated during treatment.

Ease of insertion for placement in the aorta makes the intra-aorta balloon pump (IABP) the most often used **ventricular assist device**. Specialty care centers provide this service in the **cardiac catheterization laboratory**, **operating room**, critical care unit, and emergency room. Secondary-care-level hospitals can also employ this technology. Well-trained staff are required to monitor equipment at regular intervals and troubleshoot problems.

Left ventricular (the lower left chamber of the heart) support with the IABP reduces the workload of the heart and increases blood flow to the vital organs. The balloon inflates during diastole (the filling phase of the heart) to deliver increased oxygen-saturated blood to the heart; blood flow is also increased to the arteries. Deflation of the balloon occurs prior to systole (the emptying phase of the heart).

With recovery of the heart, the IABP device is timed to inflate with every second or third heart beat. The catheter is removed, non-surgically, when the heart can sustain blood pressure and systemic blood flow. Anticoagulation is achieved with minimal drugs throughout the treatment. The device can be in place up to several weeks, but duration is limited because the patient must be immobilized during the treatment.

Centrifugal pumps are able to provide support to one or both ventricles. Blood is removed from the left or right atrium (upper chamber) and returned to the aorta or pulmonary artery, respectively; therefore, surgery is required to place the device. Specialty care facilities have the staff and equipment to provide treatment to heart failure patients with the use of mechanical circulatory support devices. Postoperative care in critical care units requires continuous monitoring by dedicated staff.

The cannulae are passed through the chest wall to attach to a pump that draws blood into the device and propels it to the arterial cannula. As the heart recovers, blood flow is decreased from the centrifugal pump until the device can be removed. An anticoagulant drug is delivered continuously during treatment with a centrifugal pump, and patient immobilization limits the length of support to several weeks.

### *Intermediate- to long-term support devices*

When short-term support devices such as ECMO, IABP, and the centrifugal pump are ineffective to sustain the patient to recovery or organ transplantation, a medium- or long-term device is required. An advantage of treatment with a medium- to long-term device is that it allows the patient to be mobile. In some instances, patients have been able to leave the hospital for continued treatment at home with the implanted device. Complete recovery of the heart has been demonstrated in 5–15% of patients being supported as a bridge to organ transplantation.

Pulsatile paracorporeal mechanical circulatory support devices provide pulsatile support for the left or right ventricle, or both. Cannulation of the left or right atrium, along with the aorta or pulmonary artery, respectively, requires a surgical approach. The heart is emptied of blood by the assist device, so there is little ejection from the body's heart.

Removal of the device occurs at the time of cardiac transplant, unless the body's heart has healed during support. Anticoagulation is achieved by low doses of drugs. Some patients regain mobility while assisted by these devices.

### *Destination therapies*

Destination therapies intended to supplement or permanently replace the body's heart are provided by chronic implantation of the mechanical circulatory support system. For example, total artificial hearts (TAH) replace the body's heart. Upon removal of the native heart, the TAH will be attached to the major blood vessels, thereby supplying blood pressure and flow to both the pulmonary and systemic circulation. Destination therapies are currently in clinical

## QUESTIONS TO ASK THE DOCTOR

- What type of implant will I require?
- Who will be performing the surgery? How many years of experience does this surgeon have? How many other implants has this surgeon performed?
- Can I take my medications the day of the surgery?
- Can I eat or drink the day of the surgery? If not, how long before the surgery should I stop eating or drinking?
- How long will I have to stay in the hospital after the surgery?
- After I go home from the hospital, how long will it take me to recover from surgery?
- What should I do if I experience symptoms similar to those I felt before surgery?
- What types of symptoms should I report to my doctor?
- What types of medications will I have to take after surgery?
- When will I be able to resume my normal activities, including work and driving?
- When will I find out if the surgery was successful?
- What if the surgery was not successful?
- If I have had the surgery once, will the pump ever need replacement?
- Will I have any pain or discomfort after the surgery? If so, how can I relieve this pain or discomfort?
- Are there any medications, foods, or activities I should avoid to prevent my symptoms from recurring?
- How often do I need to see my doctor for follow-up visits after the surgery?

trials, offering those patients not eligible for organ transplantation a promising future.

## Preparation

General anesthetic is given to the patient if a chest incision will be used to expose the heart or if blood vessels need to be exposed. Sedation with local anesthetic is sufficient if the vessels can be accessed with a needle stick. Cardiac monitoring will be performed, including electrocardiograph and cardiovascular pressures. Blood tests prior to surgery are used to measure blood elements and electrolytes. Once all sterile



connections are complete, the physician will request that mechanical circulatory support be initiated. Adjustments may be frequent initially, but decrease as the patient stabilizes.

### Normal results

Once stable following device implant, the patient is cared for in the **intensive care unit (ICU)**. Any change in patient status is reported to the physician. Around-the-clock bedside care is provided by trained nursing staff.

These patients are very ill when they require device implant, often suffering from multi-system organ failure as a result of poor blood flow. The long-term survival is superior at one year when compared to medical treatment alone. Patients that continue to improve on intermediate-, long-term, and TAH increase in activity level and begin a regular **exercise** program. Eventually, with proper training about device maintenance, they are able to leave the hospital to live at home, returning to a normal lifestyle, until further medical treatment is required.

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Mechanical debridement *see* **Debridement**

## Mechanical ventilation

### Definition

Mechanical ventilation is the use of a mechanical device (machine) to inflate and deflate the lungs.

### Purpose

Mechanical ventilation provides the force needed to deliver air to the lungs in a patient whose own ventilatory abilities are diminished or lost.

### Description

Breathing requires the movement of air into and out of the lungs. This is normally accomplished by the diaphragm and chest muscles. A variety of medical conditions can impair the ability of these muscles to accomplish this task, including:

- muscular dystrophies
- motor neuron disease, including ALS
- damage to the brain's respiratory centers
- polio
- myasthenia gravis
- myopathies affecting the respiratory muscles
- scoliosis

Mechanical ventilation may also be used when the airway is obstructed, especially at night in sleep apnea.

Mechanical ventilation may be required only at night, during limited daytime hours, or around the clock, depending on the patient's condition. Some patients require mechanical ventilation only for a short period, during recovery from traumatic nerve injury, for instance. Others require it chronically, and may increase the number of hours required over time as their disease progresses.

Mechanical ventilation is not synonymous with the use of an oxygen tank. Supplemental oxygen is used in patients whose gas exchange capacity has diminished, either through lung damage or obstruction of a major airway. For these patients, the muscles that deliver air work well, but too little oxygen can be exchanged in the remaining lung, and so a higher concentration is supplied with each breath. By the same token, many patients who require mechanical ventilation do not need supplemental oxygen. Their gas exchange capacity is normal, but they cannot adequately move air into and out of the lungs. In fact, excess oxygen may be dangerous, since it can suppress the normal increased respiration response to excess carbon dioxide in the lungs.

Mechanical ventilation systems come in a variety of forms. Almost all systems use a machine called a ventilator that pushes air through a tube for delivery to the patient's airways. The air may be delivered through a nasal or face mask, or through an opening in the trachea (windpipe), called a tracheostomy. Much rarer are systems that rhythmically change the pressure around a patient's chest when the pressure is low, air flows into the lungs, and when it increases, air flows out.

### *Ventilators*

Ventilators can either deliver a set volume with each cycle, or can be set to a specific pressure regimen. Both are in common use. Volume ventilator settings are adjustable for total volume delivered, timing of delivery, and whether the delivery is mandatory or determined by the patient's initial inspiratory effort.

Pressure ventilators deliver one of two major pressure regimens. Continuous positive airway pressure (CPAP) delivers a steady pressure of air, which assists the patient's inspiration (breathing in) and resists expiration (breathing out). The pressure of CPAP is not sufficient to completely inflate the lungs; instead its purpose is to maintain an open airway, and for this reason it is used in sleep apnea, in which a patient's airway closes frequently during sleep.

Bilevel positive airway pressure (BiPAP) delivers a higher pressure on inspiration, helping the patient obtain a full breath, and a low pressure on expiration, allowing the patient to exhale easily. BiPAP is a common choice for neuromuscular disease.

The choice of ventilator type is partly determined by the knowledge and preferences of the treating physician. Settings are adjusted to maintain patient comfort and appropriate levels of oxygen and carbon dioxide in the blood.

### *Masks vs. tracheostomy*

Delivery of air from a ventilator may be either through a mask firmly held to the face, or through a tube inserted into the trachea toward the bottom of the throat. A mask interface is called noninvasive ventilation, while a tracheostomy tube is called invasive ventilation.

Until the mid-1990s, invasive ventilation was the option used by virtually all patients requiring long-term mechanical ventilation. For some patients, tracheostomy continues to be a preferred option. It is commonly used when 24-hour ventilation assistance is required, and may be preferred by patients who find masks uncomfortable or unsightly. Some patients feel

ventilation through a "trach tube" is more reassuring. Tracheostomy is also the preferred option for most patients with swallowing difficulties. The potential to choke and suffocate on improperly swallowed food is avoided with a tracheostomy.

Tracheostomies may require more frequent suctioning of airway secretions, produced in response to the presence of the tube and the inflatable cuff that some patients require to hold it in place. The risk of infection is higher, and air must be carefully humidified and cleaned, since these functions are not being served by the nasal passages. Tracheostomies do not prevent speech, despite misinformation to the contrary that even some doctors believe. Speech requires passage of air around the trach tube, which can occur either with an uncuffed tube, or with the presence of a special valve that allows air passage past the cuff.

Noninvasive interfaces come in a variety of forms. A simple mouthpiece may be used, which a patient bites down on to seal the lips around the tube as the pressure cycle delivers a breath. Most masks are individually fitted to the patient's face, and held in place with straps. A tight fit is essential, since the pressure must be delivered to the patient's lungs, and not be allowed to blow out the sides of the mask. Masks may be used around the clock. Nasal masks do not prevent speech, though the tone may change. Oral or full-face masks do interfere with speech, and are typically used at night or intermittently throughout the day, for patients who do not need continuous ventilation assistance.

### *Other alternatives*

The iron lung was an early mechanical ventilation device, and is still in use in some hospitals. The patient's head remains outside of it, while the interior depressurizes. This allows air to push in to the lungs. Repressurizing deflates the lungs again.

A device that works on the same principle is the chest shell (something like a turtle's shell swung around to the front). The pneumobelt applies pressure to deflate, and relaxes it to allow inflation. A rocking bed is used for nighttime ventilation. Tilting the head of the bed down deflates the lungs by allowing the abdominal contents to press against the diaphragm. Reversing the angle reverses the process, allowing inflation.

### **Preparation**

Patients with diseases in which mechanical ventilation may be required are advised to learn as much as possible about treatment options before they become

necessary. In particular, it is important to learn about and make decisions about invasive vs. noninvasive ventilation before the time comes. Many patients who begin ventilation with emergency tracheostomy have a difficult time switching to noninvasive ventilation later on (though it is certainly possible).

It is often a good idea to try out different masks and other interfaces before their need arises, and to have these fitted in preparation for a planned transition to the ventilator. Patients can find support groups and other sources of information to learn more about the options and the features of each means of ventilation. Patients may have to help educate their doctors if they are not familiar with noninvasive options.

Patients with neuromuscular disease may have as much or more need for a deep cough as they do for ventilatory assistance, and many patients who undergo emergency tracheostomy do so because their airways have become clogged with mucus build up. Physical therapy cough assistance and a cough assist device are important options for full respiratory health.

### Normal results

Mechanical ventilation is a life saver, and provides comfort and confidence to patients who require it. Proper ventilation restores levels of oxygen and carbon dioxide in the blood, improving sleep at night and increasing the ability to engage in activities during the day. When combined with proper respiratory hygiene, it can prolong life considerably. Patients with progressive diseases such as ALS may wish to consider end-of-life decisions before commencing mechanical ventilation, or before the ability to communicate is lost.

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Muscular Dystrophy Association. 3300 E. Sunrise Drive Tucson, AZ 85718. (800) 572 1717. <http://www.mdausa.org>.

Richard Robinson

## Meckel's diverticulectomy

### Definition

Meckel's diverticulectomy is a surgical procedure that isolates and removes an abnormal diverticulum (Meckel's diverticulum) or pouch, as well as surrounding tissue, in the lining of the small intestine. It is performed to remove an obstruction, adhesions, infection, or inflammation.

### Purpose

Meckel's diverticulum is an intestinal diverticulum (pouch) that results from the inability of the vitelline (umbilical) duct to close at five weeks of embryonic development. The vitelline duct is lined with layers of intestinal tissue containing cells that can develop into many different forms, called pluripotent cells. Meckel's diverticulum is a benign congenital condition that has no symptoms for some people, and develops complications in others.

Ninety percent of diverticula are close to the ileocecal valve in the upper intestine, and tissue made up predominantly of gastric and pancreatic cells is thought to cause chemical changes in the mucosa, or lining of the intestines.

The most common cells found in the mucosa of diverticula are gastric cells (present in 50% of all Meckel's diverticulum cases). The highly acidic secretions of gastric tissue may cause the early symptoms of Meckel's diverticulum. The alkaline secretions of pancreatic tissue are also thought to be a source of diverticula inflammation in a small number—about 5%—of cases.

Inflammation of the diverticula or infection of the intestines around the diverticula results in a condition known as **diverticulitis**, which may be treated with **antibiotics**. However, when it is acute and causes obstructions and bleeding, surgery is the treatment of choice.

### Demographics

Meckel's diverticulum is present in approximately 2% of the population. It is the most commonly encountered congenital anomaly of the small intestine. Although the abnormality occurs in both sexes, men have more

## KEY TERMS

**Diverticulitis**—Inflammation or infection of the diverticula of the intestines.

**Diverticulum**—Pouches or bulges of tissue in the lining of organs or canals that can become infected, especially in the intestines and esophagus.

**Littre's hernia**—A Meckel's diverticulum trapped in an inguinal hernia.

**Merkel's diverticulum**—Tissue faults in the lining of the intestines that are the result of a congenital abnormality originating in the umbilical duct's failure to close. Largely asymptomatic, the diverticula in some cases can become infected or obstructed.

**Perforation**—The rupture or penetration by injury or infection of the lining of an organ or canal that allows infection to spread into a body cavity, as in peritonitis, the infection of the lining of the stomach or intestines.

frequent complications with the condition and are more often diagnosed with it. One 15-year study set the complication risk of the abnormality at 4.2%. A recent 10-year study done retrospectively reported an even age distribution for complications of the diverticulum. Malignancy is found in only 0.5–4.9% of patients with complications of Meckel's diverticulum.

## Description

Open surgery of the intestines is indicated in acute cases. In the surgery, the intestinal segment containing the diverticulum, usually the ileum or upper intestines, is removed. After the diverticulum is removed, the healthy portions of the intestine are joined together. Some debate exists about whether surgery for asymptomatic Meckel's diverticulum found incidentally is recommended. Some researchers have shown that preventive removal of the diverticulum is less risky than surgical complications, and point to the fact that 6.4% of patients with Meckel's diverticulum develop complications of the condition over their lifetime.

Depending on the surgeon's decision, the operation may be minimal, isolating and then removing the pouch containing the inflammation, or it may be more extensive. In the latter cases, surrounding tissue is removed due to the presence of pervasive inflammation, obstruction, or incarceration in an inguinal hernia (Littre's hernia). Removing additional tissue is done to prevent recurrences. Recent studies have demonstrated the

feasibility of laparoscopic, or minimally invasive diverticulectomy, utilizing small incisions and video imagery via tiny cameras. No long-term studies of this procedure have been conducted.

Surgery is performed under general anesthetic. The small intestine is isolated and the diverticulum is removed, sometimes with a small segment of the intestines. Operative techniques are used to conjoin the end sections of the intestines that have been severed. Some surgeons prefer to perform two surgeries, and do not join together the intestinal sections until some healing of the segments has occurred. In this case, a stoma, or temporary outlet for tubal connection to the intestines, is created in the wall of the abdomen where an external appliance, called an ostomy, can receive waste until the intestinal sections are rejoined.

## Diagnosis/Preparation

The vast majority of Meckel's diverticulum diagnoses are incidental, that is, discovered during barium studies, abdominal surgery for other conditions, or autopsy. The most common symptom of the condition is intestinal bleeding, which occurs in 25–50% of patients who have complications. Hemorrhage is the most significant symptom in children two years old and younger. Intestinal obstructions are common, resulting from complications of the tissue surrounding the diverticula. Symptomatic Meckel's diverticulum has symptoms similar to appendicitis. Lower abdominal pain or diverticulitis accounts for 10–20% of cases, and requires careful diagnosis to distinguish it from appendicitis. Left untreated, diverticulitis can lead to perforation of the intestine and peritonitis.

Patients who have diverticulitis symptoms, such as acute abdominal pain are given various imaging tests, including a CT scan, **colonoscopy**, or a **sigmoidoscopy** (view of the lower colon through a tiny video instrument placed in the rectum). For children, a special chemical diagnostic test of sodium Tc-pertechnetate, a radioisotope that reacts to the mucosa in the diverticulum, allows inflammation or infection to be viewed radiographically. In adult patients, barium studies may help with diagnosis. When acute hemorrhaging is present, MR imaging of blood vessels is an effective diagnostic tool.

If surgery is indicated for Meckel's diverticulum, an enema is given (unless contraindicated by complications) to completely clear the bowel and avoid infection during surgery.

## Aftercare

Intestinal surgery is a serious procedure, and recovery may take two weeks. The number of



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Surgery takes place in a hospital setting by a physician with advanced training in surgery and gastrointestinal surgery. If the surgery is minimally invasive, requiring only small incisions, it may be performed in an outpatient surgical area of the hospital.

postoperative days spent in the hospital depends on the extent of the diverticulum surgery and complications of the condition prior to surgery. Barring complications, patients usually stay in the hospital for about one week. Immediately after surgery, the patient is observed carefully, and given intravenous fluids and antibiotics. Surgical catheters, or stents, are removed over the next two days, with food by mouth offered once bowel sounds are heard.

### Risks

Intestinal surgery has the surgical complications associated with any open surgery. These include lung and heart complications, as well as reactions to medications, bleeding, and infection.

### Normal results

The usual results of this surgery are an end to obstruction, pain, and infection. Highly successful results include the return of bowel function and daily activities.

### Morbidity and mortality rates

Patients with complications of Meckel's diverticulum have a 10–12% incidence of early postoperative complications such as an intestinal leak, a suture line leak or intra-abdominal abscess. Later complications occur in about 7% of patients, and include bowel obstructions and intestinal adhesions. The reported mortality rate for surgery on patients with symptomatic diverticulum is 2–5%. With asymptomatic patients who undergo incidental diverticulectomy, both early and late complications occur in 2% of cases, and the mortality rate is 1%.

### Alternatives

Diverticulitis is routinely treated with a change in diet that includes increasing bulk with high-fiber foods

## QUESTIONS TO ASK THE DOCTOR

- Is this surgery necessary or can changing the diet and medical treatment be just as effective?
- Because this surgery was performed on an emergency basis, how extensive was the surgery and how much of the intestine was removed?

and bulk additives like Metamucil. Recurrent attacks, perforation, tissue adhesions, or infections are initially treated with antibiotics, a liquid diet, and bed rest. If medical treatment does not clear the complications, **emergency surgery** may be required.

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International Foundation for Functional Gastrointestinal Disorders (IFFGD). P.O. Box 170864, Milwaukee, WI 53217 8076. (888) 964 2001 or (414) 964 1799. fax: (414) 964 7176. <http://www.iffgd.org>.

National Digestive Diseases Information Clearinghouse. 2 Information Way, Bethesda, Maryland 20892 3570. <http://www.niddk.nih.gov>.

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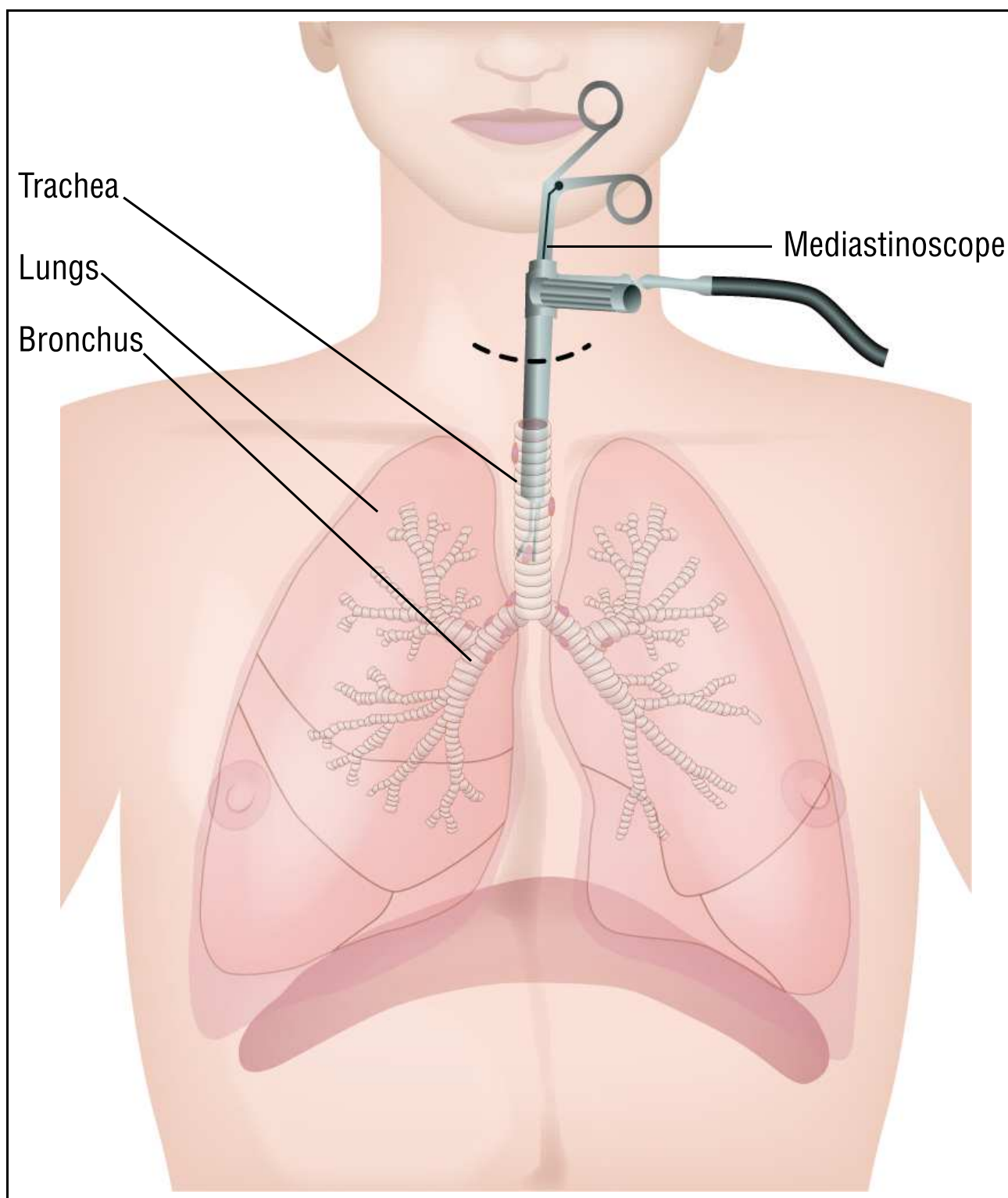
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Nancy McKenzie, Ph.D.

## Mediastinoscopy

### Definition

Mediastinoscopy is a surgical procedure that allows physicians to view areas of the mediastinum, the cavity behind the sternum (breastbone) that lies between the lungs. The organs in the mediastinum



(Cengage Learning, Gale.)

include the heart and its vessels, the lymph nodes, trachea, esophagus, and thymus.

Mediastinoscopy is most commonly used to detect or stage cancer. It is also ordered to detect infection, and to confirm diagnosis of certain conditions and diseases of the respiratory organs. The procedure involves insertion of an endotracheal (within the trachea) tube, followed by a small incision in the chest. A mediastinoscope is inserted through the incision. The purpose of this equipment is to allow the physician to directly see the organs inside the mediastinum, and to collect tissue samples for laboratory study.

### Purpose

Mediastinoscopy is often the diagnostic method of choice for detecting lymphoma, including Hodgkin's disease. The diagnosis of sarcoidosis (a chronic lung disease) and the staging of lung cancer can also be accomplished through mediastinoscopy. Lung cancer staging involves a determination of the level or progression of the cancer into stages. These stages help a physician study cancer and provide consistent cancer definition levels and corresponding treatments. They also provide some guidance as to prognosis. The lymph nodes in the mediastinum are likely to reveal if lung cancer has spread beyond the lungs. Mediastinoscopy allows a physician to observe and extract a sample from the nodes for further study. Involvement of these lymph nodes indicates the diagnosis and stage of lung cancer.

Mediastinoscopy may also be ordered to verify a diagnosis that was not clearly confirmed by other methods, such as certain radiographic and laboratory studies. Mediastinoscopy may aid in some surgical biopsies of nodes or cancerous tissue in the mediastinum. In fact, a surgeon may immediately perform a surgical procedure if a malignant tumor is confirmed while the patient is undergoing mediastinoscopy. In these cases, the diagnostic exam and surgical procedure are combined into one operation.

Mediastinoscopy provides a diagnosis in 10–75% of cases, depending on histology, location, and size of cancer. The false positive rate, however can be as high as 20%.

### Demographics

Approximately 130,000 new pulmonary nodules are diagnosed each year in the United States. Of those, half are malignant. The majority of pulmonary nodules are diagnosed via mediastinoscopy.

## KEY TERMS

**Endotracheal**—Placed within the trachea, also known as the windpipe.

**Hodgkin's disease**—A malignancy of lymphoid tissue found in the lymph nodes, spleen, liver, and bone marrow.

**Lymph nodes**—Small round structures located throughout the body; contain cells that fight infections.

**Pleural space**—Space between the layers of the pleura (membrane lining the lungs and thorax).

**Sarcoidosis**—A chronic disease characterized by nodules in the lungs, skin, lymph nodes, and bones; however, any tissue or organ in the body may be affected.

**Thymus**—An unpaired organ in the mediastinal cavity that is important in the body's immune response.

### Description

Mediastinoscopy is usually performed in a hospital under **general anesthesia**. Before the general anesthesia is administered, **local anesthesia** is applied to the throat while an endotracheal tube is inserted. Once the patient is under general anesthesia, a small incision is made, usually just below the neck or at the notch at the top of the sternum. The surgeon may clear a path and feel the person's lymph nodes first to evaluate any abnormalities within the nodes. Next, the physician inserts the mediastinoscope through the incision. The scope is a narrow, hollow tube with an attached light that allows the surgeon to see inside the area. The surgeon can insert tools through the hollow tube to help perform biopsies. A tissue sample from the lymph nodes or a mass can be removed and sent for study under a microscope, or to a laboratory for further testing.

In some cases, tissue sample analysis that shows malignancy will suggest the need for immediate surgery while the person is already prepared and under anesthesia. In other cases, the surgeon will complete the visual study and tissue removal, and stitch the small incision closed. The person will remain in the surgical recovery area until the effects of anesthesia have lessened and it is safe to leave the area. The entire procedure should require about an hour, not counting preparation and recovery time. Studies have shown that mediastinoscopy is a safe, thorough, and cost-effective diagnostic tool with less risk than some other procedures.

## Diagnosis/Preparation

Because mediastinoscopy is a surgical procedure, it should only be performed when the benefits of the exam's findings outweigh the risks of surgery and anesthesia. Individuals who previously had mediastinoscopy should not receive it again if there is scarring from the first exam.

Several other medical conditions, such as impaired cerebral circulation, obstruction or distortion of the upper airway, or thoracic aortic aneurysm (abnormal dilation of the thoracic aorta) may also preclude mediastinoscopy. Certain structures in a person's anatomy that can be compressed by the mediastinoscope may complicate these pre-existing medical conditions.

Patients are asked to sign a consent form after reviewing the risks of mediastinoscopy and known risks and reactions to anesthesia. The physician will normally instruct the patient to fast from midnight before the test until after the procedure is completed. A physician may also prescribe a sedative the night before the exam and again before the procedure. Often a local anesthetic will be applied to the throat to prevent discomfort during placement of the endotracheal tube.

## Aftercare

Following mediastinoscopy, patients will be carefully monitored and watched for changes in **vital signs**, or symptoms of complications from the procedure or anesthesia. The patient may have a sore throat from the endotracheal tube, experience temporary chest pain, and have soreness or tenderness at the incision site.

## Risks

Complications from the actual mediastinoscopy procedure are relatively rare. The overall complication rates in various studies have been reported in the range of 1.3–3%. However, the following complications, in decreasing order of frequency, have been reported:

- hemorrhage
- pneumothorax (air in the pleural space)
- recurrent laryngeal nerve injury, causing hoarseness
- infection
- tumor implantation in the wound
- phrenic nerve injury (injury to a thoracic nerve)
- esophageal injury
- chylothorax (chyle is milky lymphatic fluid in the pleural space)
- air embolism (air bubble)
- transient hemiparesis (paralysis on one side of the body)

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A mediastinoscopy procedure is usually performed by a thoracic or general surgeon in a hospital setting.

The usual risks associated with general anesthesia also apply to this procedure.

## Normal results

In the majority of procedures performed to diagnose cancer, a normal result indicates the presence of small, smooth lymph nodes with no abnormal tissue, growths, or signs of infection. In the case of lung cancer staging, results are related to the severity and progression of the cancer.

Abnormal findings may indicate lung cancer, tuberculosis, the spread of disease from one body part to another, sarcoidosis (a disease that causes nodules, usually affecting the lungs), lymphoma (abnormalities in the lymph tissues), and Hodgkin's disease.

## Morbidity and mortality rates

Complications of mediastinoscopy include bleeding, pain, and post-procedure infection. These are relatively uncommon. Mortality is extremely rare.

## Alternatives

A less invasive technique is **ultrasound**. However, it is not as specific as mediastinoscopy, and the information obtained is not as useful in making a diagnosis.

Although still performed, there is a decline in the use of mediastinoscopy as a result of advancements in computed tomography (CT), **magnetic resonance imaging** (MRI), and ultrasonography techniques. In addition, improved fine-needle aspiration (withdrawing fluid using suction) results of and core-needle biopsy (using a needle to obtain a small tissue sample) investigations, along with new techniques in thoracoscopy (examination of the thoracic cavity with a lighted instrument called a thoracoscope) offer additional options in examining masses in the mediastinum. Mediastinoscopy may be required when other methods cannot be used or when they provide inconclusive results.



## QUESTIONS TO ASK THE DOCTOR

- Why is this test needed?
- Is the test dangerous?
- What test preparation is required?
- How long will the test take?
- When will the results be available?
- What form of anesthesia will be used?
- Is the surgeon board certified?
- How many mediastinoscopy procedures has the surgeon performed?
- What is the surgeon's complication rate?

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- American Cancer Society. 1599 Clifton Rd. NE, Atlanta, GA 30329. (800) 227 2345. <http://www.cancer.org>.
- American College of Surgeons. 633 North St. Clair Street, Chicago, IL 60611 32311. (312) 202 5000. Fax: (312) 202 5001. [postmaster@facs.org](mailto:postmaster@facs.org). <http://www.facs.org>.
- American Lung Association. 1740 Broadway, New York, NY 10019 4374. (800) 586 4872. <http://www.lungusa.org>.
- American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464 5000. <http://www.ama-assn.org>.
- Society of Thoracic Surgeons. 633 N. Saint Clair St., Suite 2320, Chicago, IL 60611 3658. (312) 202 5800. Fax: (312) 202 5801. [sts@sts.org](mailto:sts@sts.org). <http://www.sts.org>.

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## Medicaid

### Definition

Medicaid is a federal-state entitlement program for low-income citizens of the United States. The Medicaid program is part of Title XIX of the Social Security Act Amendment that became law in 1965. Medicaid offers federal matching funds to states for costs incurred in paying health care providers for serving covered individuals. State participation is voluntary, but since 1982, all 50 states have chosen to participate in Medicaid.

### Description

#### Medicaid benefits

Medicaid benefits cover basic health care and long-term care services for eligible persons. About 58% of Medicaid spending covers hospital and other acute care services. The remaining 42% pays for nursing home and long-term care.

States that choose to participate in Medicaid must offer the following basic services:

## KEY TERMS

**Categorically needy**—A term that describes certain groups of Medicaid recipients who qualify for the basic mandatory package of Medicaid benefits. There are categorically needy groups that states participating in Medicaid are required to cover, and other groups that the states have the option to cover.

**Department of Health and Human Service (DHHS)**—It is a federal agency that houses the Centers for Medicare and Medicaid Services, and distributes funds for Medicaid.

**Entitlement**—A program that creates a legal obligation by the federal government to any person, business, or government entity that meets the legally defined criteria. Medicaid is an entitlement both for eligible individuals and for the states that decide to participate in it.

**Federal poverty level (FPL)**—The definition of poverty provided by the federal government, used as the

reference point to determine Medicaid eligibility for certain groups of beneficiaries. The FPL is adjusted every year to allow for inflation.

**Health Care Financing Administration (HCFA)**—A federal agency that provides guidelines for the Medicaid program.

**Medically needy**—A term that describes a group whose coverage is optional with the states because of high medical expenses. These persons meet category requirements of Medicaid (they are children or parents or elderly or disabled) but their income is too high to qualify them for coverage as categorically needy.

**Supplemental Security Income (SSI)**—A federal entitlement program that provides cash assistance to low-income blind, disabled, and elderly people. In most states, people receiving SSI benefits are eligible for Medicaid.

- hospital care, both inpatient and outpatient
- nursing home care
- physician services
- laboratory and diagnostic x-ray services
- immunizations and other screening, diagnostic, and treatment services for children
- family planning
- health center and rural health clinic services
- nurse midwife and nurse practitioner services
- physician assistant services

Participating states may offer the following optional services and receive federal matching funds for them:

- prescription medications
- institutional care for the mentally retarded
- home- or community-based care for the elderly, including case management
- personal care for the disabled
- dental and vision care for eligible adults

Because participating states are allowed to design their own benefits packages as long as they meet federal minimum requirements, Medicaid benefits vary considerably from state to state. About half of all Medicaid spending covers groups of people and services above the federal minimum.

### *Eligibility for Medicaid*

Medicaid covers three major groups of low-income Americans:

- All recipients. In 2006, Medicaid covered an estimated 46.5 million low-income persons in the United States.
- Parents and children. In 2005, Medicaid covered approximately 25.2 million low-income children, approximately one-fifth of all children in the United States. It provided coverage to an estimated 10.2 million low-income adults in families with children; most of these low-income adults were women.
- The elderly. In 2006, Medicaid covered an estimated 5.8 million adults over the age of 65. Medicaid is the largest single purchaser of long-term and nursing home care in the United States.
- The disabled. About 17% of Medicaid recipients are blind or disabled. Most of these persons are eligible for Medicaid because they receive assistance through the Supplemental Security Income (SSI) program.

All Medicaid recipients must have incomes and resources below specified eligibility levels. These levels vary from state to state depending on the local cost of living and other factors. For example, in 2006, the federal poverty level (FPL) was determined to be \$16,600 for a family of three on the mainland of the United States, but \$24,900 in Hawaii and \$29,050 in Alaska.

In most cases, persons must be citizens of the United States to be eligible for Medicaid, although legal immigrants may qualify in some circumstances depending on their date of entry. Illegal aliens are not eligible for Medicaid, except for emergency care.

Persons must fit into an eligibility category to receive Medicaid, even if their income is low. Childless couples and single childless adults who are not disabled or elderly are not eligible for Medicaid.

### *Medicaid costs*

Medicaid is by far the government's most expensive general welfare program. In 1966, Medicaid accounted for 1.4% of the federal budget, but by 2006, its share had risen to nearly 9.1%. Combined federal and state spending for Medicaid takes approximately 21 cents of every tax dollar. The federal government covers about 56% of costs associated with Medicaid. The states pay for the remaining 44%.

As of 2006, costs for Medicaid continued to rise at an average annual rate of approximately 8%. The states spent \$303 billion in FY 2006 to cover Medicaid costs. These costs are projected to continue to increase.

Although more than half (54%) of all Medicaid beneficiaries are children, most of the money (more than 70%) goes for services for the elderly and disabled. The single largest portion of Medicaid money pays for long-term care for the elderly. Only 18% of Medicaid funds are spent on services for children.

There are several factors involved in the steep rise of Medicaid costs:

- The rise in the number of eligible individuals. As the lifespan of most Americans continues to increase, the number of elderly individuals eligible for Medicaid also rises. The fastest-growing age group in the United States is people over 85.
- The price of medical and long-term care. Advances in medical technology, including expensive diagnostic imaging tests, cause these costs to rise.
- The increased use of services covered by Medicaid.
- The expansion of state coverage from the minimum benefits package to include optional groups and optional services.

### **Normal results**

The need to contain Medicaid costs is considered one of the most problematic policy issues facing legislators. In addition, the complexity of the Medicaid system, its vulnerability to billing fraud and other abuses, the confusing variety of the benefits packages

available in different states, and the time-consuming paperwork are other problems that disturb both taxpayers and legislators.

Medicaid has increased the demand for health care services in the United States without greatly impacting or improving the quality of health care for low-income Americans. Medicaid is the largest health insurer in the United States. As such, it affects the employment of several hundred thousand health care workers, including health care providers, administrators, and support staff. Participation in Medicaid is optional for physicians and **nursing homes**. Many do not participate in the program because the reimbursement rates are low. As a result, many low-income people who are dependent on Medicaid must go to overcrowded facilities where they often receive substandard health care.

### **Resources**

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Kaiser Family Foundation. 2400 Sand Hill Road, Menlo Park, CA 94025, Phone: (650) 854 9400, Fax: (650) 854 4800 <http://www.kff.org/>.

National Center for Policy Analysis. 12770 Coit Rd., Suite 800, Dallas, TX 75251 1339, Phone: (972) 386 6272, Fax: (972) 386 0924. <http://www.ncpa.org>.

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## Medical charts

### Definition

A medical chart is a confidential document that contains detailed and comprehensive information on an individual and the care experience related to that person. It is commonly called a medical record.

### Purpose

The purpose of a medical chart is to serve as both a medical and legal record of an individual's clinical status, care, history, and caregiver involvement. The specific information contained in the chart is intended to provide a record of a person's clinical condition by detailing diagnoses, treatments, tests and responses to treatment, as well as any other factors that may affect the person's health or clinical state.

### Demographics

Every person who has a professional relationship with a health-care provider has a medical record. Because most people have such relationships with

more than one health professional or caregiver, most people actually have more than one medical chart.

### Description

The terms medical chart or medical record are a general description of a collection of information on a person. However, different clinical settings and systems utilize different forms of documentation to achieve this purpose. As technology progresses, more institutions are adopting computerized systems that aid in clearer documentation, enhanced access and searching, and more efficient storage and retrieval of individual records.

New uses of technology have also raised concerns about confidentiality. Confidentiality, or personal privacy, is an important principle related to the chart. Whatever system may be in place, it is essential that the health-care provider protect an individual's privacy by limiting access only to authorized individuals. Generally, physicians and nurses write most frequently in the chart. Documentation by the clinician who is leading treatment decisions (usually a physician) often focuses on diagnosis and prognosis, while the documentation by members of the nursing team generally focuses on individual responses to treatment and details of day-to-day progress. In many institutions, the medical and nursing staff may complete separate forms or areas of the chart specific to their disciplines.

Other health-care professionals that have access to the chart include physician assistants; social workers; psychologists; nutritionists; physical, occupational, speech, or respiratory therapists; and consultants. It is important that the various disciplines view the notes written by other specialties in order to form a complete picture of a person and provide continuity of care. Quality assurance and regulatory organizations, legal bodies, and insurance companies may also have access to the chart for specific purposes such as documentation, institutional audits, legal proceedings, or verification of information for care reimbursement. It is important to know about institutional policies regarding chart access in order to ensure the privacy of personal records.

The medical record should be stored in a pre-designated, secure area and discussed only in appropriate and private clinical areas. All individuals have a right to view and obtain copies of their own records. Special state statutes may cover especially sensitive information such as psychiatric, communicable disease



## KEY TERMS

**Consultation**—Evaluation by an outside expert or specialist, someone other than the primary care provider.

**Continuity**—Consistency or coordination of details.

**Discipline**—In health care, a specific area of preparation or training such as social work, nursing, or nutrition.

**Documentation**—The process of recording information in the medical chart, or the materials contained in a medical chart.

**Interdisciplinary**—Consisting of several interacting disciplines that work together to care for an individual.

**Objective**—Not biased by personal opinion; repeatable.

**Prognosis**—Expected resolution or outcome of an illness or injury.

**Regulatory organization**—Organization designed to maintain or control quality in health care.

**Subjective**—Influenced by personal opinion, bias, or experience; not reliably repeatable.

(i.e., HIV), or substance abuse records. Institutional and government policies govern what is contained in the chart, how it is documented, who has access, and policies for regulating access to the chart and protecting its integrity and confidentiality. In those cases in which individuals outside of the immediate care system must access chart contents, an individual or personal representative is asked to provide permission before records can be released. Individuals are often asked to sign these releases so that caregivers in new clinical settings may review their charts.

## Diagnosis/Preparation

### Training

Thorough training is essential prior to independent use of the medical chart. Whenever possible, a new clinician should spend time reviewing the chart to get a sense of organization and documentation format and style. Training programs for health-care professionals often include practice in writing notes or flow charts in mock medical records. Notes by trainees are often initially cosigned by supervisors to ensure accurate and relevant documentation and document-appropriate supervision.

### Operation

Documentation in the medical record begins when an individual enters the care system, which may be a specific place such as a hospital or professional office, or a program such as a home health-care service. Frequently, a facility will request permission to obtain copies of previous records so that they have complete information on the person. Although chart systems vary from institution to institution, there are many aspects of the chart that are universal. Frequently used chart sections include the following:

- Admission paperwork. Includes legal paperwork such as a living will or health care proxy, consents for admission to the facility or program, demographics, and contact information.
- History and physical. Contains comprehensive review of an individual's medical history and physical examinations.
- Orders. Contains medication and treatment orders by the doctor, nurse practitioner, physician assistant, or other qualified health-care team members.
- Medication record. Documents all medications administered.
- Treatment record. Documents all treatments received such as dressing changes or respiratory therapy.
- Procedures. Summarizes diagnostic or therapeutic procedures, i.e., colonoscopy or open-heart surgery.
- Tests. Provides reports and results of diagnostic evaluations, such as laboratory tests and electrocardiography tracings or radiography images or summaries of test results.
- Progress notes. Includes regular notes on the individual's status by members of the interdisciplinary care team.
- Consultations. Contains notes from specialized diagnosticians or external care providers.
- Consents. Includes permissions signed by the individual for procedures, tests, or access to chart. May also contain releases such as the release signed by any person when leaving the facility against medical advice (AMA).
- Flow records. Tracks specific aspects of professional care that occur on a routine basis, using tables or in a chart format.
- Care plans. Documents treatment goals and plans for future care within a facility or following discharge.
- Discharge. Contains final instructions for the person and reports by the care team before the chart is closed and stored following discharge.
- Insurance information. Lists health care benefit coverage and insurance provider contact information.

These general categories may be further divided by individual facilities for their own purposes. For example, a psychiatric facility may use a special section for psychometric testing, or a hospital may provide sections specifically for operations, x-ray reports, or electrocardiograms. In addition, certain details such as allergies or do not resuscitate orders may be displayed prominently (for instance, with large colored stickers or special chart sections) on the chart in order to communicate uniquely important information. It is important for health-care providers to become familiar with the charting systems in place at their specific facilities or programs.

It is important that the information in the chart be clear and concise, so that those utilizing the record can easily access accurate information. The medical chart can also aid in clinical problem solving by tracking an individual's baseline, or status on admission or entry into an office or health care system; orders and treatments provided in response to specific problems; and individual responses. Another reason for the standard of clear documentation is the possibility that the record may be used in legal proceedings, when documentation serves as evidence in exploring and evaluating a person's care experience. When medical care is being referred to or questioned by the legal system, chart contents are frequently cited in court. For all of these purposes, certain practices that protect the integrity of the chart and provide essential information are recommended for adding information and maintaining the chart. These practices include the following:

- Date and time should be included on all entries.
- A person's full name and other identifiers (i.e., medical record number, date of birth) on all records.
- Continued records should be marked clearly (i.e., if a note is continued on the reverse side of a page).
- Each page of documentation should be signed.
- Blue or black non-erasable ink should be used on handwritten records.
- Records should be maintained in chronological order.
- Disposal or obliteration of any records or portions of records should be prevented.
- Documentation errors and corrections should be noted clearly, i.e., by drawing one line through the error and noting the presence of an error, and then initialing the area.
- Excess empty space should be avoided on the page. A line should be drawn through any unused space, the initial, time, and date included.
- Only universally accepted abbreviations should be used.

- Unclear documentation such as illegible penmanship should be avoided.
- Contradictory information should be avoided. For example, if a nurse documents that a person has complained of abdominal pain throughout a shift, while a physician documents that the person is free of pain, these discrepancies should be discussed and clarified. The resolution should be entered into the chart and signed by all parties involved in the disagreement.
- Objective rather than subjective information should be included. For example, personality conflicts between staff should not enter into the notes. All events involving an individual should be described as objectively as possible, i.e., describe a hostile person by simply stating the facts such as what the person said or did and surrounding circumstances or response of staff, without using derogatory or judgmental language.
- Any occurrence that might affect the person should be documented. Documented information is considered credible in court. Undocumented information is considered questionable since there is no written record of its occurrence.
- Current date and time should be used in documentation. For example, a note is added after the fact, it should be labeled as an addendum and inserted in correct chronological order, rather than trying to insert the information on the date of the actual occurrence.
- Actual statements of people should be recorded in quotes.
- The chart should never be left in an unprotected environment where unauthorized individuals may read or alter the contents.

Several methods of documentation have arisen in response to the need to accurately summarize a person's experience. In the critical care setting, flow records are often used to track frequent personal evaluations, checks of equipment, and changes of equipment settings that are required. Flow records also offer the advantages of displaying a large amount of information in a relatively small space and allowing for quick comparisons. Flow records can also save time for a busy clinician by allowing for the completion of checklists versus requiring written narrative notes.

Narrative progress notes, while more time consuming, are often the best way to capture specific information about an individual. Some institutions require only charting by exception (CBE), which requires notes only for significant or unusual findings. While this method may decrease repetition and lower

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

All members of a health-care team or individuals who render professional health-care services usually make entries into medical records. Health-care records are maintained in hospitals or other clinical settings and professional offices. Insurance companies and corporations may maintain limited health-care records or obtain copies of records created by other health-care providers.

required documentation time, most institutions that use CBE notes also require a separate flow record that documents regular contact with a person. Many facilities or programs require notes at regular intervals even when there is no significant occurrence, i.e., every nursing shift. Frequently used formats in individual notes include SOAP (subjective, objective, assessment, plan) notes. SOAP notes use an individual's subjective statement to capture an important aspect of care, follow with a key objective statement regarding the person's status, a description of the clinical assessment, and a plan for how to address individual problems or concerns. Focus charting and PIE (problem-intervention-evaluation) charting use similar systems of notes that begin with a particular focus such as a nursing diagnosis or an individual concern. Nursing diagnoses are often used as guides to nursing care by focusing on individual care-recipient needs and responses to treatment. An example of a nursing diagnosis is fluid volume for someone who is dehydrated. The notes would then focus on assessment for dehydration, interventions to address the problem, and a plan for continued care such as measurement of input and output and intravenous therapy.

### Aftercare

Current medical charts are maintained by members of the health-care team and usually require clerical assistance such as a unit clerk in the hospital setting or records clerk in a professional office. No alterations should be made to the record unless they are required to clarify or correct information and are clearly marked as such. After discharge, the medical records department of a facility checks for completeness and retains the record. Similar checks may be made in professional office settings. Sometimes, the record will be made available in another format, i.e., recording paper charts on microfilm or computer

## QUESTIONS TO ASK THE DOCTOR

- In a particular setting, who has the authority to make entries in a medical chart?
- Who has access to the chart?
- How is security maintained for medical records?

imaging. Institutional policies and state laws govern storage of charts on- and off-site and length of storage time required.

### Risks

A major potential risk associated with medical charts is breach of confidentiality. This must be safeguarded at all times. Other risks include loss of materials in a chart or incorrectly filing a chart so that subsequent retrieval is impeded or impossible.

### Normal results

All members of a health-care team require thorough understanding of the medical chart and documentation guidelines in order to provide competent care and maintain a clear, concise, and pertinent record. Health care systems often employ methods to guarantee thorough and continuous use and review of charts across disciplines. For example, nursing staff may be required to sign below every new physician order to indicate that this information has been communicated, or internal quality assurance teams may study groups of charts to determine trends in missing or unclear documentation. In legal settings, health-care team members may be called upon to interpret or explain chart notations as they relate to a specific legal case.

### Morbidity and mortality rates

Medical charts are made of paper or other materials. They are subject to deterioration or loss. Transporting them may cause lifting injuries, but not lead to disease or **death**.

### Alternatives

There are no alternatives for medical charts. Alternative mediums exist for paper records. These include fixing images on plastic media (photographs or x rays) or electronic storage. The latter can include magnetic tape or computer disks.

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- American Academy of Pediatrics. 141 Northwest Point Boulevard, Elk Grove Village, IL 60007 1098. (847) 434 4000. Fax: (847) 434 8000. [kidsdoc@aap.org](mailto:kidsdoc@aap.org). <http://www.aap.org/default.htm>.
- American College of Physicians. 190 N Independence Mall West, Philadelphia, PA 19106 1572. (800) 523 1546, x2600, or (215) 351 2600. <http://www.acponline.org>.
- American Hospital Association. One North Franklin, Chicago, IL 60606 3421. (312) 422 3000. [http://www.aha.org/aha\\_app/index.jsp](http://www.aha.org/aha_app/index.jsp).
- American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464 5000. <http://www.ama-assn.org>.
- American Medical Informatics Association. 4915 St. Elmo Avenue, Suite 401, Bethesda, MD 20814. (301) 657 1291. Fax: (301) 657 1296. <http://www.amia.org>.

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## Medical co-morbidities

### Definition

Morbidity is the presence of a disease state or disorder within a patient. Co-morbidity is the presence of more than one individual disease or disorder within the same patient. It is a state of having multiple distinct medical conditions at the same time.



(Medical-on-Line / Alamy)



## Demographic

Co-morbidities may be present in anyone regardless of age, but certain populations are more prone to having co-morbidities. Patients that are an advanced age are more vulnerable to medical problems than a younger patient demographic. Certain medical conditions are also prone to association with co-morbidities. For example, diabetes, psychiatric diseases, and cancer (especially in the elderly) are very frequently associated with co-morbid health conditions.

## Description

Co-existing or co-morbid conditions are sometimes commonly associated with a particular disease. For example, cancer patients may frequently have co-existing major depression. Diabetes patients may frequently have co-morbidities involving the cardiovascular system, kidney, and the eye. Chronic diseases are often co-morbid with depression.

Having co-morbidities also increases the risks associated with some surgical procedures. Co-morbidities may complicate the diagnosis of a new disease, especially if there are overlapping symptoms between the two. Co-morbidities have an impact on the type of treatment chosen for a patient, as well as the patient's prognosis. A patient's disease burden may have a health impact that is greater than the sum of the impact of the individual diseases. The medical outcome of co-morbid conditions may be very severe.

## The Charlson Co-morbidity Index

There are many systems that endeavor to standardize the "weight" of the medical impact of different co-morbidities. The end result is to predict the medical outcome or mortality that may result from the presence of specific co-morbidities. There are no systems that have currently been developed that accurately and completely assess this issue and are considered a true medical standard. However, one commonly used system is the Charlson Index, which has been validated and is the most widely accepted of the assessments.

The Charlson Co-morbidity Index attempts to predict the one-year mortality for patients with more than one medical disease or disorder. Each medical condition is categorized according to a set of codes known as the International Statistical Classification of Diseases and Related Health Problems, or ICD Codes. Each ICD Code represents a medical condition and is assigned a specific number that represents the medical weight of the disease. The score assigned to each disease is based on the risk of fatality within one

year associated with the disease. Additional points may be added for age, with each decade over forty being one point. The sum of the scores for each co-morbidity gives a total score that represents the risk of **dying**. The higher the score, the greater the risk of dying. This score assists physicians in determining how to treat patients with multiple co-morbidities. For example, if one patient has cancer, but also very severe co-morbidities, it may not be appropriate to subject the patient to difficult treatments because of the reduced likelihood of survival associated with the co-morbidity.

## Co-morbidity of Psychiatry

In psychiatry, a co-morbidity is defined as a diagnosis that exists simultaneously with another diagnosis. However, psychiatric co-morbidities may not represent the presence of multiple disorders. Rather they represent the number of diagnoses necessary to accurately describe the full range of the patient's symptoms. The severity of a patient's mental illness has a strong association with the number of co-morbid disorders present. Treatment of psychiatric diseases and disorders are impacted by co-morbidity, as the co-morbidity may render the normal treatment of an illness inappropriate. For example, some pharmaceutical treatments may cause symptoms of anxiety as a side effect. In a patient with an anxiety disorder as a co-morbidity, using this treatment for their primary illness would be inappropriate. Pharmaceutical treatments that have addictive potential are not appropriate for treatment of a primary illness in a patient with drug abuse as a co-morbidity. Drug abuse is often co-morbid with psychiatric disorders, and may be a consequence of the initial illness. Studies have shown that proper treatment of some psychiatric disorders may prevent the development of drug abuse problems.

Providing treatment for patients with co-morbidities that address and do not aggravate all the aspects of their various disorders can be challenging for health care providers. Co-morbidities in psychiatry can be controversial to diagnose as distinct disorders. For example, does a patient with drug abuse problems as well as bulimia (binging on food and then purging through vomiting) have two separate illnesses, or do they have a single disorder involving impulse control? Whether some co-morbidities are truly separate diagnoses or all part of one disorder can be difficult to judge.

## Co-morbidity of Diabetes

Diabetes is associated with many different co-morbidities. The increased blood glucose that is part

## QUESTIONS TO ASK YOUR DOCTOR

- Do I have co-morbid health conditions?
- Are my co-morbidities truly distinct from each other, or could they be related?
- What can I do to address health concerns regarding my co-morbid conditions?
- Do any of my treatments for primary illness have an adverse impact on one of my co-morbid health conditions?
- Do any of my co-morbidities have an adverse impact on treatment for my primary illness?

of the disease process can be very damaging to the blood vessels and the organ systems. Some of the co-morbidities associated with diabetes were previously believed to be separate from the course of the diabetes disease. It is controversial whether the co-morbidities associated with diabetes are distinct diseases or are a result of the diabetes itself, which is increasingly referred to as “metabolic syndrome”. Regardless of their source, the co-morbidities associated with diabetes have a significant impact on the overall health profile of the patient.

Patients with diabetes often develop vascular complications, which are medical problems of the blood vessels. Damaged blood vessels are a serious complication, as they affect all the organ systems. Excess blood glucose can also directly damage organs. In diabetics, there are often medical complications seen with the kidneys, the retina of the eye, the peripheral nervous system, heart disease, and stroke or peripheral artery disease. Tight control of blood glucose levels may help to prevent the development of complications and these co-morbidities of diabetes.

### Co-morbidity of Cancer in Elderly Patients

Patients above 65 years of age statistically bear a large proportion of cancer cases seen in the United States. In addition to cancer, the elderly are vulnerable to many different health conditions such as pulmonary disease, heart disease, and hypertension. Having co-morbidities with cancer has a great impact on decisions made by the patient and the physician regarding treatment choices. When an elderly person is newly diagnosed with cancer and has other existing medical conditions, each health problem needs to be evaluated in the context of its predicted impact on the course of the cancer. Awareness and evaluation of co-

## KEY TERMS

**Bulimia**—Psychiatric disorder involving eating large amounts of food in a short time period and then vomiting to purge the contents of the stomach.

**Cardiovascular System**—The physiological system including the heart and the blood vessels.

**Metabolic Syndrome**—A combination of medical disorders including diabetes, high blood pressure, and heart disease.

**Pulmonary Disease**—Disease involving the lungs.

morbidities is crucial to optimize care of a cancer patient, and may alter the appropriateness of treatment options. Quality of life, limiting the potential complications seen with treatment, and preventing recurrence of cancer are all impacted by how the co-morbidities are managed.

The existence of co-morbidities with cancer also affects the patient’s prognosis for survival. Because of this, physicians must often make treatment choices in the context of the likelihood of survival. For example a physician and patient may need to decide whether it is worth putting the patient through the rigors of chemotherapy, when congestive heart failure may already be severely limiting the patient’s life span in the short term. In some cases, the cancer treatment may cause mortality because of the co-morbidities. The co-morbidity may increase and amplify the adverse effects normally seen with some types of cancer treatment. This may limit the amount of medical assistance available to a cancer patient. Depending on their nature and severity, co-morbidities in cancer may create a far more severe overall health profile and prognosis for a patient.

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Maria Basile, PhD

## Medical errors

### Introduction and definitions

The subject of medical errors is not a new one. However, it did not come to widespread attention in the United States until the 1990s, when government-sponsored research about the problem was undertaken by two physicians, Lucian Leape and David Bates. In 1999, a report compiled by the Committee on Quality of Health Care in America and published by the Institute of Medicine (IOM) made headlines with its findings. As a result of the IOM report, President Clinton asked the Quality Interagency Coordination Task Force (QuIC) to analyze the problem of medical errors and patient safety, and make recommendations for improvement. The Report to the President on Medical Errors was published in February 2000.

It is important to understand the terms used by the government and health care professionals in describing medical errors in order to distinguish between injury or **death** resulting from mistakes made by people on the one hand, and unfortunate results of treatment on the other. Some allergic reactions to medications or failures to respond to cancer treatment, for example, result from physical differences among patients or the known side effects of certain treatments, and not from prescribing the wrong drug or therapy for the patient's condition. This type of negative outcome is called an adverse event in official documents. Adverse events can be defined as undesirable and unintentional, though not necessarily unexpected, results of medical treatment. An example of an adverse event is discomfort in an artificial joint that continues after the expected recovery period, or a chronic headache following a spinal tap.

A medical error, on the other hand, is an adverse event that could be prevented given the current state of medical knowledge. The QuIC task force expanded the IOM's working definition of a medical error to cover as many types of mistakes as possible. Their definition of a medical error is as follows: "The failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim. Errors can include problems in practice, products, procedures, and systems." The National Patient Safety Foundation (NPSF) prefers the term "healthcare error" to "medical error," and defines such errors as follows: "An unintended healthcare outcome caused by a defect in the delivery of care to a patient. Healthcare errors may be errors of commission (doing the wrong thing), omission (not doing the right thing), or execution (doing the right thing incorrectly)." A useful brief definition of a medical error is that it is a preventable adverse event.

### Statistics

The statistics contained in the IOM report were startling. The authors of the report stated that between 45,000 and 98,000 Americans die each year as the result of medical errors. If the lower figure is used as an estimate, deaths in hospitals resulting from medical errors are the eighth leading cause of mortality in the United States, surpassing deaths attributable to motor vehicle accidents (43,458), breast cancer (42,297), and AIDS (16,516). Moreover, these figures refer only to hospitalized patients; they do not include people treated in outpatient clinics, **ambulatory surgery centers**, doctors' or dentists' offices, college or military health services, or **nursing homes**. Medical errors certainly occur outside hospitals; in 1999, the Massachusetts State Board of Registration in Pharmacy estimated that 2.4 million prescriptions are filled incorrectly each year in that state—which is only one of 50 states.

In terms of health-care costs, the IOM report estimated that medical errors cost the United States about \$37.6 billion each year; about half this sum pays for direct health care.

Medical errors also carry a high psychological cost; according to a poll conducted by the National Patient Safety Foundation, 42% of the respondents had been affected personally by a medical error or had a friend or family member affected by one. The respondents rated the American health care system overall as only moderately safe, giving it a score of 4.9 on a 1–7 point scale, in which 7 was defined as very safe and 1 as very unsafe.

## KEY TERMS

**Adverse event**—An undesirable and unintended result of a medical treatment or intervention.

**Medical error**—A preventable adverse event.

**Systems analysis**—An approach to medical errors and other management issues that looks for problems in the work process rather than singling out individuals as bad or incompetent.

The United States is not unique in having a high rate of medical errors. The United Kingdom, Australia, and Sweden are presently undertaking studies of their respective health-care systems. British experts estimate that 40,000 patients die each year in the United Kingdom as the result of medical errors. Australia has been testing a new system for reporting errors since 1995.

### Description

There is no single universally accepted method of classifying medical errors in order to describe them more fully. The 2000 QuIC report lists five different classification schemes that have been used:

- type of health care given (medication, surgery, diagnostic imaging, etc.)
- severity of the injury (minor discomfort, serious injury, death, etc.)
- legal definitions (negligence, malpractice, etc.)
- setting (hospital, emergency room, intensive care unit, nursing home, etc.)
- persons involved (physician, nurse, pharmacist, patient, etc.)

The importance of these different ways to classify medical errors is their indication that different types of errors require different approaches to prevention and problem solving. For example, medication errors are often related to such communication problems as misspelled words or illegible handwriting, whereas surgical errors are often related to unclear or misinterpreted diagnostic images.

### Causes of medical errors

The causes of medical errors are complex and not yet completely understood. Some causes that have been identified include the following:

- Communication errors. One widely publicized case from 1994 involved the death of a Boston newspaper columnist from an overdose of chemotherapy for

breast cancer due to misinterpretation of the doctor's prescription; the patient was given four times the correct daily dose, when the doctor intended the dosage to be administered instead over a four-day period. Other cases involve medication mix-ups due to drugs with very similar names. The Food and Drug Administration (FDA) has identified no fewer than 600 pairs of look-alike or sound-alike drug names since 1992.

- The increasing specialization and fragmentation of health care. The more people involved in a patient's treatment, the greater the possibility that important information will be missing along the chain.
- Human errors resulting from overwork and burn-out. For some years, hospital interns, residents, and nurses have attributed many of the errors made in patient care to the long hours they are expected to work, many times with inadequate sleep. With the coming of managed care, many hospitals have cut the size of their nursing staff and require those that remain to work mandatory overtime shifts. A study published in the *Journal of the American Medical Association* in October 2002 found a clear correlation between higher-than-average rates of patient mortality and higher-than-average ratios of patients to nurses.
- Manufacturing errors. Instances have been reported of blood products being mislabeled during the production process, resulting in patients being given transfusions of an incompatible blood type.
- Equipment failure. A typical example of equipment failure might be intravenous pump with a malfunctioning valve, which would allow too much of the patient's medication to be delivered over too short a time period.
- Diagnostic errors. A misdiagnosed illness can lead the doctor to prescribe an inappropriate type of treatment. Errors in interpreting diagnostic imaging have resulted in surgeons operating on the wrong side of the patient's body. Another common form of diagnostic error is failure to act on abnormal test results. As of 2006, studies of autopsies in the United States indicated that doctors misdiagnosed fatal illnesses about 20% of the time.
- Poorly designed buildings and facilities. Hallways that end in sharp right angles, for example, increase the likelihood of falls or collisions between people on foot and patients being wheeled to an operating room.

### Ways of thinking about medical errors

One subject that has been emphasized in recent reports on medical errors is the need to move away



from a search for individual culprits to blame for medical errors. This judgmental approach has sometimes been called the “name, shame, and blame game.” It is characterized by the belief that medical errors result from inadequate training or from a few “bad apples” in the system. It is then assumed that medical errors can be reduced or eliminated by identifying the individuals at fault, and firing or disciplining them. The major drawback of this judgmental attitude is that it makes health-care workers hesitate to report errors for fear of losing their own jobs or fear of some other form of reprisal. As a result of underreporting, hospital managers and others concerned with patient safety often do not have an accurate picture of the frequency of occurrence of some types of medical errors.

Both the IOM report and the QuIC report urge the adoption of a model borrowed from industry that incorporates systems analysis. This model emphasizes making an entire system safer rather than punishing individuals; it assumes that most errors result from problems with procedures and work processes rather than bad or incompetent people; and it analyzes all parts of the system in order to improve them. The industrial model is sometimes referred to as the continuous quality improvement model (CQI). Hospitals that are implementing error-reduction programs based on the CQI model have found that a non-punitive procedure for reporting medical errors has improved morale among the staff as well as significantly reduced the number of medical errors. At Columbia-Presbyterian Hospital, for example, patients as well as staff can report medical errors via the Internet, a telephone hotline, or paper forms.

### Proposals for improvement

Current proposals for reducing the rate of medical errors in the American health-care system include the following:

- Adopt stricter standards of acceptable error rates. One reason that industrial manufacturers have made great strides in product safety and error reduction is their commitment to improving the quality of the work process itself.
- Standardize medical equipment and build in mechanical safeguards against human error. Anesthesiology is the outstanding example of a medical specialty that has cut its error rate dramatically by asking medical equipment manufacturers to design ventilators with standardized controls and valves to prevent the oxygen content from falling below that of room air. These changes were the result of studies that showed that many medical errors resulted from doctors having to

use unfamiliar ventilators and accidentally turning off the oxygen flow to the patient.

- Improve the working conditions for nurses and other hospital staff. Recommendations in this area include redesigning hospital facilities to improve efficiency and minimize falls and other accidents, as well as reducing the length of nursing shifts below 12.5 hours. Since 2003, residency programs for physicians have been redesigned to lower the risk of medical errors caused by human fatigue. These changes resulted from rules imposed in July 2003 by the Accreditation Council for Graduate Medical Education (ACGME). The rules limit residents to an 80-hour work week and 24 continuous hours on call, and guarantee one day off each week.
- Make use of new technology to improve accuracy in medication dosages and recording patients' vital signs. Innovations in this field include giving nurses and residents handheld computers for recording patient data so that they do not have to rely on human memory for so many details. Another innovation that helped Veterans Administration (VA) hospitals cut the rate of medication errors was the introduction of a handheld wireless bar-coding system. After the system went into operation at the end of 1998, the number of medication errors in VA hospitals dropped by 70%.
- Develop a nationwide database for error reporting and analysis. At present, there is no unified system for tracking different types of medical errors. An error in liver transplantation in August 2002 that cost the life of a baby led several researchers to recognize that there is still no national registry recording transplant mismatches. As a result, no one knows how many cases occur each year, let alone find ways to improve the present system.
- Encourage patients to become more active participants in their own health care. This recommendation includes asking more questions and requesting adequate explanations from health-care professionals, as well as reporting medical errors.
- Address the fact that both patients and physicians have emotional as well as knowledge-related needs around the issue of medical errors. A report published in the *Journal of the American Medical Association* in February 2003 stated that patients clearly want emotional support from their doctors following an error, including an apology. The researchers also found, however, that doctors are as upset when an error occurs and, additionally, are unsure where to turn for emotional support.
- Adopt a teamwork rather than an individualistic approach to medical care. According to an article

published in 2005 in the *Annals of Internal Medicine*, health care teams make fewer mistakes than individuals.

### What patients can do

Patients are an important resource in lowering the rate of medical errors. The QuIC task force has put together some fact sheets to help patients improve the safety of their health care. One of these fact sheets, entitled “Five Steps to Safer Health Care,” gives the following tips:

- Do not hesitate to ask questions of your health-care provider, and ask him or her for explanations that you can understand.
- Keep lists of all medications, including over-the-counter items as well as prescribed drugs.
- Ask for the results of all tests and procedures, and find out what the results mean for you.
- Find out what choices are available to you if your doctor recommends hospital care.
- If your doctor suggests surgery, ask for information about the procedure itself, the reasons for it, and exactly what will happen during the operation.

This fact sheet, as well as a longer and more detailed patient fact sheet on medical errors, is available for free download from the Agency for Health Research and Quality (AHRQ) Website, or by telephone order from the AHRQ Publications Clearinghouse at (800) 358-9295. In addition, the AHRQ has set up a patient safety network website at <<http://www.psnet.ahrq.gov/index.aspx>>. The website has an extensive list of resources ranging from online articles and fact sheets to links to audiovisual materials, journal articles, government reports, and other online materials. The site is produced and maintained by a team of editors at the University of California, San Francisco.

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Rebecca Frey, PhD

Medical history see **Health history**

## Medicare

### Definition

Medicare is a national health insurance program created and administered by the federal government in the United States to address the medical needs of older American citizens. Medicare is available to U.S. citizens 65 years of age and older and some people with disabilities under age 65.

### Description

Medicare is the largest health insurance program in the United States. The program was created as part of the Social Security Act Amendment in 1965 and was put into effect in 1966. At the end of 1966, Medicare served approximately 3.9 million individuals. As of 2003, it serves about 41 million people. There are 5.6 million Medicare beneficiaries enrolled in managed care programs.

In 1973, the Medicare program was expanded to include people who have permanent kidney failure and need dialysis or transplants and people under the age of 65 who have specific types of disabilities. Medicare was originally administered by the Social Security Administration, but in 1977, the program was transferred to

## KEY TERMS

**DHHS**—The Department of Health and Human Service. This federal agency houses the Centers for Medicare and Medicaid Services and distributes funds for Medicaid.

**Entitlement**—A program that creates a legal obligation by the federal government to any person, business, or government entity that meets the legally defined criteria. Medicare is an entitlement for eligible individuals.

**HCFA**—Health Care Financing Administration. A federal agency that provides guidelines for the Medicaid program.

**Medicare Part A**—Hospital insurance provided by Medicare, provided free to persons aged 65 and older.

**Medicare Part B**—Medical insurance provided by Medicare that requires recipients to pay a monthly premium. Part B pays for some medical services Part A does not.

the Health Care Financing Administration (HCFA), which is part of the United States Department of Health and Human Services (DHHS). The Centers for Medicare and **Medicaid** Services, an agency of the DHHS, is the administrative agency. This agency also administers Medicaid programs.

Medicare is an entitlement program similar to Social Security and is not based on financial need. Medicare benefits are available to all American citizens over the age of 65 because they or their spouses have paid Social Security taxes through their working years. Since Medicare is a federal program, the rules for eligibility remain constant throughout the nation and coverage remains constant regardless of where an individual receives treatment in the United States.

Medicare benefits are divided into two different categories referred to as Part A and Part B. Medicare Part A is hospital insurance that provides basic coverage for hospital stays and post-hospital nursing facilities, home health care, and **hospice** care for terminally ill patients. Most people automatically receive Part A when they turn 65 and do not have to pay a premium because they or their spouse paid Medicare taxes while they were working.

Medicare Part B is medical insurance. It covers most fees associated with basic doctor visits and laboratory testing. It also pays for some outpatient medical

services such as medical equipment, supplies, and home health care and physical therapy. However, these services and supplies are only covered by Part B when medically necessary and prescribed by a doctor. Enrollment in Part B is optional and the Medicare recipient pays a premium of approximately \$65 per month for these added benefits. The amount of the premium is periodically adjusted. Not every person who receives Medicare Part A enrolls in Part B.

Although Medicare provides fairly broad coverage of medical treatment, neither Part A nor B pays for the cost of prescription drugs or other medications.

Medicare is funded solely by the federal government. States do not make matching contributions to the Medicare fund. Social Security contributions, monthly premiums paid by program participants, and general government revenues generate the money used to support the Medicare program. Insurance coverage provided by Medicare is similar to that provided by private health insurance carriers. Medicare usually pays 50–80% of the medical bill, while the recipient pays the remaining balance for services provided.

### Normal results

As the population of the United States ages, concerns about health care and the financing of quality health care for all members of the elderly population grow. One concern is that health insurance provided by the Medicare program will become obsolete or will be cut from the federal budget in an attempt to save money. Another concern is that money provided by the Social Security Administration for Medicare will be depleted before the aging population of the United States can actually benefit from the taxes they are now paying. A third concern is coverage for prescription medications.

During the Clinton administration, several initiatives were started that saved funds for Medicare. The DHHS also supports several initiatives to save and improve the program. However, continuance of the federal health insurance program is still a problem that American citizens expect legislators to resolve.

During the George W. Bush administration, there has been debate concerning coverage for prescription drugs. Health-care reformers suggest that prescription drugs be made available through the Medicare program due to the high cost of such medications. This debate has not been resolved as of early 2003, and legislation has not been enacted.

Some of the successful initiatives undertaken since 1992 include:

- Fighting fraud and abuse. Much attention has focused on Medicare abuse, fraud, and waste. As a result, overpayments were stopped, fraud was decreased, and abuse was investigated. This has saved the Medicare program approximately \$500 million per year.
- Preserving the Medicare benefit. Due to aggressive action by the federal government, it is estimated that funds have been appropriated to keep Medicare viable through 2026.
- Supporting Preventive Medicine and the Healthy Aging Project. Medicare programs are supporting preventive medicine and diagnostic treatments in anticipation that preventive measures will improve the health of older Americans and thereby reduce health-care costs.

Medicare benefits and health care financing are major issues in the United States. Legislators and federal agencies continue to work on initiatives that will keep health-care programs in place and working for the good of American citizens.

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## Medication Monitoring

### Definition

Medication monitoring is the process of monitoring prescription medications to check that blood levels are within the expected and desired range, or the process of measuring the effects of a prescription medication in the blood.

### Description

Medication monitoring is done by measuring blood levels of a drug or some aspect of a drug's effects. Some prescription drugs are very beneficial for health and may even be life saving, yet are very dangerous if even a small overdose is given. Because of this danger, drugs that are associated with severe or life threatening medical effects after a small overdose would not be available for use in medicine without a method by which to monitor their blood levels or their effects. Medication monitoring is a critical tool in the administration of these medications.

### Therapeutic Index of Medications

All drugs may be dangerous if taken in great enough quantity. However for some drugs, the difference between a therapeutic dose and a dangerous or poisonous dose is smaller than others. The figurative "distance" between a medically effective and safe dose of a medication and its toxic dose is known as the therapeutic index or therapeutic window. Drugs with

wide therapeutic windows require a greatly increased dose before they are toxic and are therefore safer to use than drugs with narrow therapeutic windows. Drugs with narrow therapeutic windows have a smaller difference in dose amount between their beneficial and harmful effects. If the therapeutic index of a drug is small enough, that drug may require medication monitoring techniques to be added as part of the treatment regimen to ensure that it is used safely.

### Monitoring the Effects of Anticoagulants

**Anticoagulant drugs** are administered to inhibit the ability of the blood to form a blood clot, a process known as blood coagulation. Anticoagulants are not administered to dissolve existing blood clots, but rather to prevent the clotting process from forming a new blood clot or increasing an existing one. The most common health condition that may require anticoagulation drug therapy is a cardiac arrhythmia (abnormal heart rhythm) called atrial fibrillation. Atrial fibrillation is a rapid arrhythmia in a portion of the heart known as the atria, that may lead to a stroke. A stroke is a condition involving the inability of blood vessels in the brain to provide oxygen to brain tissue. A stroke may be caused by a blood clot blocking the blood vessel that supplies a part of the brain, thereby depriving the brain of oxygen and causing **death** of brain tissue. In atrial fibrillation, blood clots are sometimes knocked off of the heart tissue and travel through the blood to the brain, causing a stroke. Anticoagulant therapy may prevent a stroke by preventing the formation of blood clots. It may also prevent blood clots that could damage heart tissue or lead to a heart attack. The anticoagulant drug warfarin (coumadin) is most commonly used for this purpose.

While anticoagulant drugs have great benefit for prevention of stroke in atrial fibrillation, they can also be very dangerous. If the blood is kept too "thin" (via a decreased ability to clot), small wounds or a bump on the head may cause life threatening internal bleeding. Under normal conditions, these minor injuries would not cause excessive bleeding because the blood would clot and close the wound. With too great a dose of warfarin, minor injuries may become catastrophes. Even without injury, dangerous internal bleeding such as gastrointestinal bleeding or brain hemorrhages may occur. For this reason, the amount of warfarin given must only be the minimum necessary for treatment.

There is no one dose of warfarin that is safe and standardized for all patients. It must be individually determined, and the amount that is necessary may change frequently even within an individual. The effects of warfarin must be monitored at least weekly

## QUESTIONS TO ASK YOUR DOCTOR

- Which of my medications needs to be routinely monitored?
- Why does this medication require monitoring?
- Why is this medication the best treatment option for my health condition?
- What are the effects of too much of this medication?
- How often do I need to come have my blood levels checked?
- Is the drug being measured in my blood, or an effect of the drug?

to ensure that too much has not been given (avoiding dangerous blood conditions) or that too little has been given to provide the therapeutic effect. Warfarin is not directly measured from blood samples, but rather the blood is examined for the degree of change in its blood clotting mechanisms. By measuring the effect of warfarin on the blood, doses can be tailored up or down to maintain a therapeutic but safe level. There is a very narrow window in which warfarin's effects are desirable, and it is very close to dangerous doses. Without medication monitoring techniques, warfarin could not be used to save lives in patients with heart conditions.

### Monitoring Anticonvulsant Drugs

Anticonvulsant drugs are used to treat epilepsy, a type of neurological seizure disorder. The goal of anticonvulsant therapy is to provide seizure prevention without causing too many adverse side effects of drug treatment. Anticonvulsants such as phenytoin (dilantin) are beneficial for seizure patients, but also have a relatively narrow therapeutic index. Additionally, there is great variability in the way different patients metabolize the drug. Studies have shown that different patients taking the same dose of phenytoin may have up to a 50-fold difference in blood levels. There is also variability in the amount of drug needed to control seizure disorders in different patients within a safe range of doses. For all these reasons, there is no one dose that is standardized for all patients. Rather, the dose used for each patient varies widely, and needs to be individually tailored and monitored. The level of phenytoin may be directly measured in blood serum to make sure that blood levels are within the therapeutic range, and that they are not toxic levels. If blood levels of phenytoin are below what is considered a therapeutic range, doses

## KEY TERMS

**Atria**—Plural for atrium.

**Atrial Fibrillation**—A dangerous heart condition involving a rapid, irregular heartbeat.

**Atrium**—Chamber of the heart that contains specialized heart cells that set the heartbeat.

**Blood Serum**—The fluid portion of the blood.

**Cardiac Arrhythmia**—An irregular heartbeat.

**Coagulation**—Blood clotting.

**Epilepsy**—A neurological disorder that involves uncontrolled seizures.

**Gastrointestinal Tract**—The path in the body from the mouth, through the stomach, intestines, rectum, and the anus.

**Phlebitis**—Inflammation of a vein.

**Stroke**—An event causing impairment of blood circulation to the brain, causing death of brain tissue and potentially drastically affecting mental functioning.

are usually increased within safe limits even if the patient has not been experiencing seizures since initiating therapy.

Anticonvulsant drugs may be monitored when a patient first starts the drug to make sure they reach therapeutic levels, after a patient has been on the drug to make sure they are maintaining therapeutic and not toxic levels, or to explore symptoms of toxicity that may potentially be caused by the drug. Anticonvulsant drugs may also be monitored when the patient is experiencing seizures despite drug therapy. If levels of the current anticonvulsant are within the established therapeutic range of doses, then there may be need to assess whether to add other medications to the treatment regimen or switch to another medication entirely.

### Risks of Medication Monitoring

There is very little risk associated with having blood drawn for medication monitoring. Most people have no side effects or a small bruise. However, with any blood draw there is a small chance that the area around the punctured vein may develop phlebitis, the inflammation of a vein. Phlebitis may also involve a bacterial infection if the site of the blood draw was not appropriately cleaned before the needle was inserted. Phlebitis can be locally painful but usually resolves in a short period of time.

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## Meningocele repair

### Definition

A meningocele repair is a surgical procedure performed to repair an abnormal opening in the spinal column (called spina bifida) by draining excess fluid and closing the opening.

### Purpose

The surgery is necessary to close this abnormal opening in order to decrease the risk of infection and protect the integrity of the spinal column and the tissue inside.

### Demographics

According to the Spina Bifida Association of America, spina bifida is both the most common neural tube defect and the most common birth defect resulting in permanent disability. It is estimated that about 40% of Americans have spina bifida occulta. However, some people who have it may have no symptoms and may therefore be unaware of their condition, so the percentage is an approximation. Meningocele and myelomeningocele are noticeable at birth and are paired together as spina bifida manifesta. Spina bifida manifesta occurs in about one in 1,000 births, with 4–5% occurring as meningocele and 95–96% occurring as myelomeningocele.

## KEY TERMS

**Folic acid**—A water-soluble vitamin belonging to the B-complex group of vitamins.

**Meninges**—The membrane covering neural tissue.

**Shunt**—A shunt is a tube that is used to drain excess fluid. It is surgically implanted. The shunt drains the fluid from around the brain and sends it into the abdomen.

### Description

The term meningocele may be used to refer to more than one condition. Spina bifida is a neural tube birth defect involving an abnormal opening in the spine. It occurs when the fetus's spine does not close properly during the first month of fetal development. In spina bifida occulta an opening in the spinal bones exists, but the neural tissue and membrane covering the spine (the meninges) are not exposed. Because there is no opening, the defect may appear as a dimple, or depression, at the base of the spine (the sacrum). Another sign of spina bifida occulta is the presence of tufts of hair at the sacrum. It is possible that while there is no opening, vertebrae are missing and there is damage to nerve tissue.

A meningocele is a sac protruding from the spinal column, which contains some of the spinal fluid and meninges. The sac may be covered with skin or with the meninges, and does not contain neural tissue. It may be located near the brain or along the spinal column. Hydrocephalus is rarely present, and the neurological examination may be normal. Because the neural tissue remains intact, it can be repaired by the experienced neurosurgeon, with excellent results.

A myelomeningocele is the most severe type of spina bifida because the spinal cord has herniated into the protruding sac. Neural tissue and nerves may be exposed. About 80% of myelomeningoceles occur at the lower back, where the lumbar and sacral regions join. Some people refer to myelomeningocele as spina bifida. Because of the exposed neural tissue, significant symptoms may be present. These symptoms may include:

- muscle weakness or paralysis in the hips and lower limbs
- no sensation in the part of the body below the defect
- lack of bowel and bladder function
- fluid build-up in the brain, known as hydrocephalus

Because of the risk of neural tissue damage, swelling, and infection into the spinal fluid and brain with an opening in the spinal column, surgery to repair the meningocele or myelomeningocele is usually done within 24 hours of birth. However, although the opening is closed, whatever damage has already been done to the neural tissue is permanent. If hydrocephalus is developing, the meningocele repair may be done first. Then, a few days later, a shunt can be inserted to resolve the hydrocephalus. If the hydrocephalus is present at birth, the two surgeries may be done at the same time to decrease the risks associated with increasing pressure on the brain. To prevent drying of the sac, it may be kept moist with sterile **dressings** until surgery is begun. Once the anesthesia has put the baby to sleep and the surgery is pain-free, a surgical incision is made into the sac. Excess fluid is drained, and the meninges is wrapped around the spine to protect it. The opening is then closed with sutures.

### Diagnosis/Preparation

If an individual has spina bifida occulta, with no outward signs of a neural tube defect and no symptoms, the condition may go undetected. The protruding sacs associated with meningocele and myelomeningocele are quite noticeable at birth. To understand the extent of the defect x rays, **ultrasound**, computed tomography (CT) scans, or **magnetic resonance imaging** (MRI) of the spine may be taken.

Spina bifida may be diagnosed while the mother is still pregnant, through prenatal screening. If spina bifida is indicated, a blood test will show an elevated alpha fetoprotein. However, elevated levels can be present without spina bifida, so further testing should be done if the test is positive. There is an elevated alpha fetoprotein level in about 85% of women with a fetus with spina bifida. An ultrasound can reliably reveal the spinal structure of the fetus. An **amniocentesis** may be done to check for chromosomal abnormalities. In amniocentesis, a long syringe is used to draw amniotic fluid out from the uterus through the mother's abdomen. Because the protruding sac of the meningocele and myelomeningocele can look the same on the outside, it is important to have a clear diagnosis, as the anticipated outcome of the two conditions is very different.

### Aftercare

The infant will first spend some time in the **recovery room**, and then be transferred to an **intensive care unit**. The infant will be monitored for signs of excess bleeding and infection. Temperature will be closely monitored. **Antibiotics** will be given to decrease the

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Surgery on the spine is a very delicate procedure and needs to be done by a surgeon specializing in pediatric neurosurgery. It is best performed in a hospital with a pediatric intensive care unit available to closely monitor the infant after the surgery.

risk of infection, and the infant will be positioned to lie flat on the stomach to avoid pressure on the surgical wound. Extreme care is taken to keep the wound clean of urine and stool.

### Risks

Surgical risks include infection and bleeding. Anesthesia risks include a reaction to the medications used, including difficulty breathing. During meningocele and myelomeningocele repair, there are additional risks of damage to the spinal column and infection of the spinal fluid surrounding the spine and brain. Damage to the neural tissue could result in paralysis, or loss of nerve function (for example, loss of bowel and bladder control). There may also be an increased risk of an urinary tract infection. An infection of the meninges is called meningitis. However, further damage would be expected if surgery were not done, and serious infection would be likely. As in all surgery, one must weigh the potential risks against the expected benefits.

### Normal results

Results depend greatly on the extent of involvement of exposed neural tissue and the condition of the infant prior to surgery. A meningocele repair can have excellent results, as neural tissue does not extend into the protruding sac. In myelomeningocele, the amount of exposed neural tissue will determine the extent of lower limb weakness, or paralysis. The infant will usually spend a few weeks in the hospital after surgery before being able to be discharged home. As the child grows, it may be necessary to use braces, crutches, or a wheelchair for mobility. If surgery for hydrocephalus is successful, the prognosis is better. Children with a repaired myelomeningocele may be able to go to school, but will benefit from special education and associated services. There may be varying degrees of learning problems, and difficulties with the child's attention span. An effective bowel and bladder-training program can help make attending school easier. Because of muscle



## QUESTIONS TO ASK THE DOCTOR

- What is the extent of the neurological damage?
- Is my child likely to walk?
- What experience do you have with this procedure?
- What complications have your patients experienced with this procedure?
- How long is my child likely to stay in the hospital?

weakness or paralysis, a child with spina bifida will need physical therapy and may require future surgeries.

### Morbidity and mortality rates

With current medical and surgical treatments, about 85% of infants survive, and about 50% will be able to walk. Bowel and bladder disorders contribute significantly to morbidity and mortality in those with spina bifida who survive past the age of two years.

### Alternatives

There is no alternative to surgical repair. Risk of infection and damage to the spine and brain is high with an opening to the spine, so surgery is necessary to close the opening and drain the excess fluid that could put pressure on the brain. The Spina Bifida Association of America recommends that all women of child-bearing age take 0.4 mg of folic acid daily, as this amount has been shown to decrease the likelihood of neural tube defects. Once a woman is aware of being pregnant, the critical first month of neural tube development has already past, and folic acid cannot cure any damage that has been done.

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National Library of Medicine. <http://www.nlm.nih.gov>.

Spina Bifida Association of America. 4590 MacArthur Boulevard, NW, Suite 250; Washington, DC 20007 4226. Telephone (800) 621 3141, (202)944 3285. [sbaa@sbaa.org](mailto:sbaa@sbaa.org). <http://www.sbaa.org>.

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## Mental health assessment

### Definition

A mental health assessment is an examination used to ascertain whether or not a patient is functioning on a healthy psychological, social, or developmental level. A mental health assessment can also be used to aid diagnosis of some neurological disorders, specific diseases, or possible drug abuse.

### Purpose

Mental health assessments are performed to screen for mental health disorders such as depression or anxiety, or as part of their continuing evaluation. They can also be used to help diagnose neurological pathology, such as Alzheimer's disease. A mental health assessment may be indicated if a person is having difficulty at work, school, or in social situations. For example, a diagnosis of Attention Deficit Hyperactivity Disorder (ADHD) or a personality disorder may begin with a mental health assessment as part of their discovery. Mental health assessments may also be done if substance abuse is suspected.

### Demographics

A mental health assessment can be done for patients of any age or gender. The mental health assessment of a child or adolescent is based on developmental stage as appropriate for age. An adult mental health assessment may be done to screen for new diagnoses, assess patients with an existing diagnosis for changes in severity, or to assess the need to modify current a treatment plan.



(Mikael Karlsson / Alamy)

## WHO PERFORMS THE PROCEDURE?

A general practitioner may perform a brief mental health assessment during a routine examination. However, if there are symptoms of a mental disorder present, the patient may be referred to a specialist for a more thorough mental health assessment. A specialist for a mental health assessment may be a psychologist or a psychiatrist.

A psychologist is a health care professional who is not a medical doctor. A psychologist may have a degree called a PsyD (doctor of psychology), or a PhD (doctor of philosophy) in psychology. Psychologists can evaluate and counsel patients, and need to be licensed to practice. However in most states, psychologists cannot prescribe medication.

A psychiatrist is a medical doctor who specializes in the diagnosis and treatment of mental health problems. Psychiatrists can evaluate, counsel, and prescribe medications to treat mental health problems. Some psychiatrists further specialize in specific areas of mental health, such as psychiatry for adolescents. Psychiatrists need to be licensed to practice. They should be board-certified through the Board of Psychiatry and Neurology, a board that is validated by the American Board of Medical Specialties.

## Description

### *Patient History*

History taking is an important component of the mental health assessment. The **health history** of a patient includes their medical health history, family health history, medications they are currently on, and social history. Social history is a critical component, including history of drug use, physical or emotional abuse, and exposure to traumatic situations. It also covers the “chief complaint,” or description of the patient’s current issue in the context of the patient’s life, both past and present. Health care professionals who perform a mental health assessment need to obtain a thorough health history from the patient, because it places the current situation into the context of the patient’s overall health. For the current chief complaint, the health care provider will ask questions to form an overall picture of how the patient is feeling and any distressing emotions the patient is experiencing. A pertinent health history also includes information on

## QUESTIONS TO ASK YOUR DOCTOR

- Why do I need a mental health assessment?
- Who will perform the assessment?
- How will the assessment be performed?
- How long is the assessment expected to take?
- What tests are involved in my mental health assessment?
- Are there any specific preparations I need to make before or after the assessment?
- What will the results of the assessment specifically indicate?
- When will the results be available?
- What are the risks of the assessment?
- Who else has access to the results of the assessment?
- Do any of my prescription medications, non-prescription medications, nutritional, or herbal supplements potentially affect the results of my mental health assessment?

any previous psychiatric illness, for both the patient and the patient’s family. It is important that the health care provider be made aware of not only current prescription medications, but also non-prescription medications, nutritional supplements, and herbal supplements or teas the patient is currently taking, as they may affect the patient’s mental status. History of suicide attempts or thoughts may be initially discussed during the history portion of the assessment.

### *Mental Status Examination*

The mental status examination explores multiple aspects of the patient’s ability to function in a healthy, normal manner. The health care provider will assess the multiple components of the patient’s mental status through both direct questioning and objective observation.

**GENERAL APPEARANCE.** General appearance is assessed by observation on the part of the health care provider. Patient hygiene, grooming, excessive nervousness or physical activity, and apparent nutritional state are all pertinent to the mental status examination. General alertness, facial expressions, and eye contact are noted. The patient’s attitude toward the health care provider is also an important component, including whether the patient seems hostile, guarded, friendly, or cooperative.

## KEY TERMS

**Affect**—The external manifestation of a mood or state of mind. Affect is usually observed in facial expression or other body language.

**Attention Deficit Hyperactivity Disorder (ADHD)**—A disorder involving a developmentally inappropriate degree of inattention and impulsivity. Hyperactivity may or may not be a component. This disorder usually appears in childhood and manifests itself as difficulty at home or school. It sometimes persists into adulthood where it may affect work, relationships, and other social situations.

**Alzheimer's Disease**—A disease of the elderly involving progressive mental deterioration including loss of memory, judgment, and intellect; disorientation; confusion; general inability to mentally function in social situations. The disease may begin as early as late mid-life and results in eventual death. It is associated with specific physical changes to the brain that can be visualized using medical imaging techniques.

**Autism**—A childhood disorder that manifests as an inability to communicate with or relate to others, or interact in social situations in a healthy, normal manner. Autism may range from mild to severe and includes repetitive behaviors, the inability to cope with changes from routine activities, and obsessions with specific objects. Autism is sometimes associated with below-normal intelligence or anxiety.

**Brain Lesion**—Physical damage done to a specific part or location of the brain, that may result in

specific symptoms or behaviors associated with that brain lesion.

**Chemical Toxicity**—State of physical illness induced by poisoning with toxic chemicals. Chemical toxicities may affect a person's behavior or mental function.

**Cognition**—The mental activity of thinking, learning, and memory.

**Compulsion**—The uncontrollable impulse to perform specific acts. In mental health disorders, compulsions are often repetitive and carried out by the person in order to avoid feelings of anxiety.

**Computed Tomography (CT scan)**—A computer uses x-rays across many different directions on a given cross section of the body, and combines all the cross sections to create one image. CT scans can be used to visualize bodily organs including the brain, blood vessels, bones, and the spinal cord. Contrast dye is sometimes administered to the patient to help visualize structures.

**Delusion**—Conviction of a false belief or wrong judgment despite obvious evidence to the contrary.

**Dementia**—The progressive loss of cognitive and intellectual function of the brain including impaired memory, judgment, and disorientation, without the impairment of perception or consciousness. It is usually associated with a structural brain disease such as Alzheimer's disease.

**Developmental Disorder**—A disorder or disability that occurs because of prenatal or early childhood

**MOOD AND AFFECT.** Mood is the internal set of sustained emotions that the patient experiences, while affect is the external manifestation of mood as body language and facial expression. Patients are questioned as to what moods they have experienced for lengths of time, such as depression, tiredness, or anxiety. Affect may be described as normal; blunted or flat where the patient has little expression; expansive and inappropriate where the patient seems to be experiencing extremes of emotion that may not be appropriate to the setting.

**SPEECH AND THOUGHT PROCESSES.** Speech is examined for clarity, general coherence, appropriate inflection (not monotone), quantity that is unusually large or small, a rate that is unusually fast or slow, and appropriate volume. While asking questions during the examination, the health care provider will also monitor

the responses given by the patient for specific thought processes or patterns of speech. The following examples may be observed by the health care provider or described by the patient: flight of ideas where the patient randomly changes from one topic to another; looseness of association where the patient makes irrelevant connections between seemingly unrelated topics; racing thoughts; excessively trailing off onto tangents; nonsensical speech; rhyming or creation of new words; halting speech; paucity of speech; or speaking in riddles.

**THOUGHT CONTENT.** Thought content may be evaluated through both direct questioning and observation of topics brought up by the patient. There are many types of thought content that may be pertinent to this section of the mental health assessment. Thought aspects of mental disorders may include the following: hallucinations that may be auditory, visual,

events that affect cognition, language, motor, or social skills.

**Flight of Ideas**—A psychiatric term describing a thought disorder where streams of unrelated words or ideas enter a patient's mind too quickly to be properly vocalized despite the rushed and rapid rate of the patient's speech.

**Hallucination**—The perception of a person, object, event, or sensory stimulus that is not truly there. Hallucinations can be visual (seen), auditory (heard), olfactory (smelled), tactile (felt), gustatory (tasted), or a combination thereof.

**Looseness of Association**—A psychiatric term describing a thought disorder where a patient makes irrelevant connections between seemingly unrelated topics. In a mental health assessment the patient's responses may not seem to correspond to the question asked by the health care provider.

**Magnetic Resonance Imaging (MRI)**—A diagnostic test where a magnetic field is applied to atoms within a patient's body, aligns the atoms, and reads the energy pulses given off by the atoms in a manner that creates a three-dimensional picture of the patient's internal structures. There is no exposure to radiation. An MRI is especially useful for visualizing soft tissue and for neurological imaging.

**Metabolic Disturbance**—A disturbance in the general function of the body's basic life processes such as energy production. The body's ability to provide

the brain with appropriate nourishment can affect the mental status of the individual.

**Obsession**—A recurrent and persistent idea, thought, or impulse that the individual cannot repress.

**Parkinson's Disease**—A neurological disease resulting from a deficiency of the neurotransmitter dopamine that is associated with specific recognizable movements, affects, and behavior patterns.

**Personality Disorder**—Group of behavioral disorders characterized by maladaptive patterns of behavior, social interactions, or lifestyles that deviate from the healthy normal. Personality disorders are distinct from psychotic disorders.

**Phobia**—An irrational and unfounded fear of a situation, place, or object that causes a state of panic.

**Psychiatrist**—A medical doctor (MD) who specializes in the treatment of mental health problems and can prescribe medication.

**Psychologist**—A health care professional (PsyD or PhD) who is not a medical doctor but can evaluate or provide counseling for patients with mental health issues.

**Thyroid Dysfunction**—A physical state that involves the failure of the thyroid gland to function properly. Thyroid dysfunction not only affects a person's physical state, but may have secondary effects on their mental state as well.

tactile, or olfactory; auditory hallucinations involving commands for the patient to carry out specific actions; delusions of having special powers, status, or persecution by others; paranoid thinking; obsessions, compulsions, and ritualistic behaviors; phobias; thoughts of self-harm or suicide; homicidal thoughts.

**COGNITION.** An important aspect of the mental status examination is assessment of the patient's cognitive state. Elements of this section include the following: assessment of general awareness and level of consciousness; orientation to person, current location, current date and time, and situation; ability to pay attention and concentrate; general memory tests; ability to follow directions; language comprehension and appropriate usage of language; ability to perform abstract reasoning by interpreting proverbs supplied by the health care provider.

### *Written and Verbal Tests*

Written or verbal tests are used as part of a mental health assessment when there is a reason to apply the test to explore a specific potential diagnosis. There are standardized tests for many different mental disorders and disturbances. For example, depression is sometimes assessed using a specific set of standards or measurements called a rating scale. Other tests may evaluate intelligence levels, and aid in the diagnosis of dementia or developmental disorders such as learning disabilities or autism. These types of tests are controversial and do not stand alone to make a diagnosis, but rather may be used in addition to the other components of the mental health assessment. Each test may take from thirty minutes to several hours to complete, and be may administered over multiple days.



### Adjunctive Tests

**PHYSICAL EXAMINATION.** Mental health assessments are sometimes helpful in diagnosing certain neurological disorders, and may be performed in the larger context of a neurological examination. The neurological examination includes a mental status exam, as well as assessing motor function, reflexes, sensory perception, posture, and gait. Diseases such as Parkinson's disease or Alzheimer's disease may initially be suspected as a result of the mental health assessment.

**CLINICAL TESTS.** Clinical tests may be necessary as an adjunct to the mental health assessment, to aid in diagnosis of specific neurological or neuropsychiatric disorders. For example, a patient with Alzheimer's disease may require **Magnetic Resonance Imaging (MRI)** as an adjunct to the mental health assessment for a successful diagnosis. Clinical tests may also be used rule out non-mental health related illnesses. Some drugs of abuse, thyroid dysfunction, hormonal imbalances, prescription medications, chemical toxicities, metabolic disturbances, selective brain lesions, or types of tumors may all manifest in ways that affect the mental status assessment. Blood laboratory testing, Computed Tomography (CT scan), or an MRI may help to assess the presence or absence of these physical states.

### Follow-up after the Assessment

Whether or not a patient requires further inpatient care, outpatient care, or medication is dependent upon the final diagnosis. Inpatient care is always indicated if the patients are unable to suitably care for themselves, suicidal, or homicidal.

### Risks

The mental health assessment is a valuable tool in the diagnosis of mental health problems. However, some mental health problems are very difficult to diagnose. Mental health assessments may need to be performed multiple times before any medical conclusion is reached. Even with multiple mental health assessments and adjunctive tests, there is risk that an accurate diagnosis may still be missed.

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American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, Virginia, 22209 3901, 703 907 7300, [apa@psych.org](mailto:apa@psych.org), <http://www.psych.org/>.

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## Mentoplasty

### Definition

Mentoplasty is a term that refers to **plastic surgery** procedures for the chin. It comes from the Latin word *mentum*, which means chin, and the Greek verb *plassein*, which means "to form" or "to shape." Mentoplasty is also known as genioplasty or chinplasty.

### Purpose

Mentoplasty may be done for several reasons:

- To correct malformations of the chin resulting from developmental abnormalities of the bones in the jaw. Sometimes the jawbones continue to grow on one side of the face but not the other, leading to facial asymmetry. In other instances a part of the jawbone is missing; this condition is known as congenital agenesis of the jaw.
- To reshape a chin that is out of proportion to other facial features.
- As part of gender reassignment surgery. The size and shape of the chin and lower jawline are somewhat different in men and women. Some people choose to have mentoplasty as part of their gender transition.
- As part of craniofacial reconstruction following trauma or cancer surgery.
- As part of orthognathic surgery. Orthognathic surgery involves repositioning the facial bones in order to correct deformities that affect the patient's ability to speak or chew normally.

## KEY TERMS

**Aesthetic**—Pertaining to beauty. Plastic surgery done to improve the patient's appearance is sometimes called aesthetic surgery.

**Agensis**—The absence of an organ or body part due to developmental failure.

**Alloplast**—An implant made of an inert foreign material such as silicone or hydroxyapatite.

**Congenital**—Present at the time of birth.

**Extrusion**—Pushing out or expulsion. Extrusion of a chin implant is one possible complication of mentoplasty.

**Genioplasty**—Another word for mentoplasty. It comes from the Greek word for "chin."

**Hematoma**—A localized collection of blood in an organ or tissue due to broken blood vessels.

**Intraoral**—Inside the mouth.

**Malocclusion**—Malpositioning and defective contact between opposing teeth in the upper and lower jaws.

**Microgenia**—An extremely small chin. It is the most common deformity of the chin.

**Orthognathic surgery**—Surgery that corrects deformities or malpositioning of the bones in the jaw. The term comes from two Greek words meaning straight and jaw.

**Sliding genioplasty**—A complex plastic surgery procedure in which the patient's jawbone is cut, moved forward or backward, and repositioned with metal plates and screws.

**Submental**—Underneath the chin.

Insurance coverage for mentoplasty depends on its purpose. Chin reshaping that is done to improve personal appearance is not usually covered by insurance. Mentoplasty that is performed as a reconstructive procedure after trauma, genetic deformity, or orthognathic surgery may be covered by insurance.

The cost of mentoplasty varies considerably according to the complexity of the procedure. The average surgeon's fee for a chin implant was \$1,612 in 2002. The average fee for a sliding genioplasty, however, was \$4,000–\$6,000.

## Demographics

In spite of the fact that chin deformities are the most common facial abnormality, mentoplasty is not

one of the more frequently performed procedures in plastic surgery. In 2002, there were 18,352 mentoplasties performed in the United States, compared to 117,831 face lifts and 282,876 liposuctions. Most mentoplasties are done in combination with rhinoplasties.

Mentoplasty is primarily performed in adult patients; it is not usually done in children until all permanent teeth have come in and the jaw is close to its adult size. According to the American Society of Plastic Surgeons, 7% of patients who had mentoplasties in the United States in 2002 were 18 or younger; 35% were between the ages of 19 and 34; 40% were between the ages of 35 and 50, while another 15% were between 51 and 64. Only 3% were over 65.

With respect to sex, women account for 69% of mentoplasty patients; only 31% are men.

## Description

Mentoplasties fall into two large categories: procedures that augment (increase) small or receding chins; and those that reduce large or protruding chins. Chin augmentation is done more frequently than chin reduction, reflecting the fact that microgenia (small chin) is the most common abnormality of the chin.

### Chin augmentation

Chin augmentation can be performed by inserting an implant under the skin of the chin or by performing a sliding genioplasty. Insertion of an implant takes 30–60 minutes, while a sliding genioplasty takes slightly longer, 45–90 minutes. If the mentoplasty is done together with orthognathic surgery, the operation may take as long as three hours.

Chin implants are used in patients with mild or moderate microgenia. At one time they were made of cartilage taken from donors or from other sites on the patient's body, but as of 2003 alloplastic implants (made from inert foreign materials) are used more often because they reduce the risk of infection. To insert the implant, the surgeon can choose to make the incision under the chin (submental) or inside the mouth (intraoral). In either case, the surgeon cuts through several layers of tissue, taking care to avoid damaging the major nerve in the chin. The surgeon makes a pocket in the connective tissue inside the chin and washes it out with an antiseptic solution. The sterile implant is then inserted in the pocket and positioned properly. The incision is closed and the wound covered with Steri-Strips.

A sliding genioplasty may be performed if the patient's chin is too small for augmentation with an

implant, or if the deformity is more complex. In this procedure, the surgeon cuts through the jawbone with an oscillating saw and removes part of the bone. He or she then moves the bone segment forward, holding it in place with metal plates and screws. After the bone segment has been fixed in place, the incision is closed and the patient's head is wrapped with a pressure dressing.

### *Chin reduction*

Reduction of an overly large or protruding chin may be done either by direct reduction or a sliding genioplasty. In a direct reduction, the surgeon makes either a submental or an intraoral incision and removes excess bone from the chin with a burr. A sliding genioplasty reduction is similar to a genioplasty to augment the chin, except that the bone segment is moved backward rather than forward.

## Diagnosis/Preparation

### *Diagnosis*

Diagnostic evaluation consists of a facial analysis as well as a complete dental and medical history. The chin is one of the three most significant parts of the face from an aesthetic standpoint, the others being the forehead and the nose. Many patients who are concerned about the size of their nose, for example, can be helped by having a too-small chin augmented as well as having the nose reshaped. In the facial analysis, the face is divided into thirds, with the mouth and chin in the lowest third. The surgeon compares the proportions of the features in each third in order to determine the most suitable procedure for restoring balance. The patient will be photographed from several angles to document the condition of the chin before surgery.

The dental history and x-ray studies of the head and jaw are necessary in order to determine whether the facial disproportion can be corrected by an implant or simple reduction, or whether orthognathic surgery is required. Patients who have severe malocclusion (irregular contact between the teeth in the upper and lower jaws) or deformities of the facial bones are usually referred to a maxillofacial specialist for **reconstructive surgery**.

Lastly, the surgeon will evaluate the patient for any signs of psychological instability, including unrealistic expectations of the results of surgery.

### *Preparation*

Patients should stop smoking and discontinue all medications containing **aspirin** or NSAIDs for two

weeks prior to mentoplasty. If the surgeon is planning to make a submental incision, the patient should use an antibacterial facial cleanser for two days before surgery. Patients scheduled for an intraoral approach should rinse the mouth with mouthwash three times a day for two days before surgery. They should not eat or drink anything for eight hours prior to the procedure.

## Aftercare

Patients should have someone drive them home after the procedure. They are given medication for discomfort and a one-week course of antibiotic medication to reduce the risk of infection. Most patients can return to work in seven to 10 days.

Other aspects of aftercare include the following:

- a soft or liquid diet for four to five days
- raising the head of the bed or using two to three pillows
- rinsing the mouth with a solution of hydrogen peroxide and warm water two to three times daily
- avoiding sleeping on the face and unnecessary touching of the chin area
- avoiding vigorous physical exercise for about two weeks

## Risks

In addition to infection, bleeding, and an allergic reaction to the anesthetic, the risks of insertion of a chin implant include:

- deformity of the chin following an infection
- injury to the major nerve in the chin, leading to loss of feeling or paralysis of the chin muscles
- erosion of the bone beneath the implant
- moving around or dislocation of the implant
- extrusion (pushing out) of the implant

Specific risks associated with sliding genioplasties include:

- under- or overcorrection of the defect
- injury to the major nerve in the chin
- failure of the bone segment to reunite properly with the other parts of the jaw
- damage to the roots of the teeth
- hematoma (a collection of blood within a body organ or tissue caused by leakage from broken blood vessels; it can damage the results of a mentoplasty by causing pressure that distorts the final shape of the chin)

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Mentoplasties may be performed by plastic surgeons, oral surgeons, or maxillofacial surgeons. Fat injections and facial liposuction are usually performed by plastic surgeons.

Chin implant insertions or direct reductions are usually performed as outpatient procedures in the surgeon's office or an ambulatory surgery center. The patient may be given either general or local anesthesia. Sliding genioplasties can be done as outpatient procedures; however, they are usually performed in hospitals under general anesthesia, particularly if the patient is having orthognathic surgery at the same time.

### Normal results

Normal results of either augmentation or reduction mentoplasty include correction of facial asymmetry and disproportion. The functioning of the jaw is also often improved. Patients who have had a mentoplasty are usually very satisfied with the results.

### Morbidity and mortality rates

The rate of complications with chin implants as well as sliding genioplasties is about 5%.

### Alternatives

#### *Fat injections*

In some cases, fat may be injected into the area below the chin to plump up the skin and minimize the apparent size of the chin. This technique, however, is limited to minor disproportions of chin size. In addition, fat injections must be repeated periodically as the fat is gradually absorbed by the body.

#### *Liposuction*

Facial **liposuction** can be used together with or instead of mentoplasty to improve the patient's profile. In particular, removal of fatty tissue below the chin can make a receding chin look larger or more prominent.

## QUESTIONS TO ASK THE DOCTOR

- Would you recommend a chin implant or a sliding genioplasty in my case?
- Would you use a submental or an intraoral approach to a chin augmentation?
- How many mentoplasties have you performed?
- Should I consider a mentoplasty in combination with another facial procedure?

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Rebecca Frey, Ph.D.

Microalbumin test see **Urinalysis**

## Microsurgery

### Definition

Microsurgery is surgery that is performed on very small structures, such as blood vessels and nerves, with specialized instruments under a microscope.

### Purpose

Microsurgical procedures are performed on parts of the body that are best visualized under a microscope. Examples of such structures are small blood vessels, nerves, and tubes. Microsurgery uses techniques that have been performed by surgeons since the early twentieth century, such as blood vessel repair and organ transplantation, but under conditions that make traditional **vascular surgery** difficult or impossible.

The first microvascular surgery, using a microscope to aid in the repair of blood vessels, was described by Jules Jacobson of the University of Vermont in 1960. The first successful replantation (reattachment of an

## KEY TERMS

**Capillaries**—Tiny blood vessels that deliver oxygen to tissues.

**Peripheral nerves**—The nerves outside of the brain and spinal cord.

**Vascular surgery**—A branch of medicine that deals with the surgical repair of disorders of or injuries to the blood vessels.

**Venous valves**—Folds on the inner lining of the veins that prevent the backflow of blood.

amputated body part) was reported in 1964 by Harry Bunke. This replantation of a rabbit's ear was significant because blood vessels smaller than 0.04 inch (1 mm)—similar in size to the blood vessels found in a human hand—were successfully attached. Two years later, the successful replantation of a toe to the hand of a monkey was made possible using microsurgical techniques. Soon thereafter, microsurgery began being used in a number of clinical settings.

Numerous surgical specialties utilize the techniques of microsurgery. Otolaryngologists (ear, nose, and throat doctors) perform microsurgery on the small, delicate structures of the inner ear or the vocal cords. Cataracts are removed by ophthalmologists (eye doctors), who also perform corneal transplants and treat eye conditions like glaucoma. Urologists can reverse vasectomies (male sterilization), and gynecologists can reverse tubal ligations (female sterilization), giving people new choices about having children. Microsurgical techniques are used by plastic surgeons to reconstruct damaged or disfigured skin, muscles, or other tissues, or to transplant tissues from other parts of the body. And, importantly, a number of specialties can collaborate to treat patients who have limbs or other body parts; under certain circumstances, amputated parts can be reattached, or another body part can be replanted in the place of one lost (for example, a great toe replacing a lost or damaged thumb).

Today, microsurgery can be lifesaving. Neurosurgeons can treat vascular abnormalities found in the brain, and cancerous tumors can be removed.

### Description

#### Equipment

Microsurgical equipment magnifies the operating field, provide instrumentation precise enough to

maneuver under high magnification, and allow the surgeon to operate on structures barely visible to the human eye. The most important tools used by the microsurgeon are the microscope, microsurgical instruments, and microsuture materials.

**MICROSCOPE.** While operating microscopes may differ according to their specific use, certain features are standard. The microscope may be floor- or ceiling-mounted, with a moveable arm that allows the surgeon to manipulate the microscope's position. A view of the surgical site is afforded by a set of lenses and a high-intensity light source. This lighting is enhanced by maintaining a low level of light in the rest of the **operating room**. Two or more sets of lenses allow a surgeon and an assistant to view the operating field and focus and zoom independently. A video camera allows the rest of the **surgical team** to view the operating field on a display screen. Features that come on some microscopes include foot and/or mouth switch controls and motorized zoom and focus.

A magnification of five to forty times (5–40x) is generally required for microsurgery. A lower magnification may be used to identify and expose structures, while a higher magnification is most often used for microsurgical repair. Alternatively, surgical loupes (magnifying lenses mounted on a pair of eyeglasses) may be used for lower magnifications (2–6x).

**INSTRUMENTS.** Microsurgical instruments differ from conventional instruments in a number of ways. They must be capable of delicately manipulating structures barely visible to the naked eye, but with handles large enough to hold comfortably and securely. They must also take into account the tremor of the surgeon's hand, greatly amplified under magnification.

Some of the various instruments that are used in microsurgery include:

- forceps
- needle holders (for suturing)
- scissors
- vascular clamps (for controlling bleeding) and clamp applicators
- irrigators (for washing structures in the surgical field)
- vessel dilators (for opening up the cut end of a blood vessel)
- various standard surgical tools

**SUTURE MATERIALS.** Suturing, or stitching, is done by means of specialized thread and needles. The diameter (gauge) of suture thread ranges in size and depends on the procedure and tissue to be sutured. Conventional suturing usually requires gauges of 2-0 (0.3 mm) to 6-0 (0.07 mm). Conversely, gauges of 9-0

(0.03 mm) to 12-0 (0.001 mm) are generally used for microsurgery. Suture thread may be absorbable (able to be broken down in the body after a definite amount of time) or non-absorbable (retaining its strength indefinitely), natural (made of silk, gut, linen, or other natural material) or synthetic (made of nylon, polyester, wire, or other man-made material). The type of suture thread used depends on the procedure and tissue to be sutured.

The suture needle comes in various sizes (diameters and length) and shapes (straight or curved), and also with different point types (rounded, cutting, or blunt). It comes with suture thread preattached to one end; this is called the swage. As in the case of suture thread, the type of needle used depends on the procedure and tissue to be sutured; generally, needles with a diameter of less than 0.15 mm are used for microsurgery.

### Training

For a surgeon to perform microsurgery in a clinical setting, extensive training and practice are required. A basic knowledge of anatomy and surgical techniques is essential. After a thorough introduction to the operating microscope and other microsurgical equipment, basic techniques are introduced using small animals as the experimental model. Specifically, surgeons must be taught how to maintain correct posture and to maintain constant visual contact with the microscope during surgery, how to properly hold and use the instruments, how to minimize the amount of hand tremor, and how to perform basic techniques, such as suturing. After becoming proficient at these skills, more advanced techniques can be taught, including procedures regarding how to treat specific conditions.

Extensive and ongoing practice is necessary for a surgeon to maintain adequate proficiency at microsurgical techniques. For this reason, a microsurgical laboratory is made available to surgeons for training and practice.

### Techniques

Most microsurgical procedures utilize a set of basic techniques that must be mastered by the surgeon. These include blood vessel repair, vein grafting, and nerve repair and grafting.

**BLOOD VESSEL REPAIR.** Blood vessel, or vascular anastomosis, is the connection of two cut or separate blood vessels to form a continuous channel. Anastomoses may be end-to-end (between two cut ends of a blood vessel) or end-to-side (a connection of one cut end of a blood vessel to the wall of another vessel).

The first step of creating an anastomosis is to identify and expose the blood vessel by isolating it from surrounding tissues. Each end of the vessel is irrigated (washed) and secured with clamps for the duration of the procedure. A piece of contrast material is placed behind the surgical site so that the tiny vessel can be more easily visualized. The magnification is then increased for the next segment of surgery. The first suture is placed through the full thickness of the vessel wall; the second and third sutures are then placed at 120° from the first. Subsequent sutures are placed evenly in the remaining spaces. Arteries 1 millimeter in diameter generally require between five and eight **stitches** around the perimeter, and veins of the same size between seven and 10. Once the last suture has been placed, the clamps are released and blood is allowed to flow through the anastomosis. If excessive bleeding occurs between the stitches, the vessel is reclamped and additional sutures are placed.

The procedure for an end-to-side anastomosis is similar, except that an oval-shaped hole is cut in the wall of the recipient vessel. Sutures are first placed at each of the oval to connect the attaching vessel to the recipient vessel, and then placed evenly to fill in the remaining spaces.

**VEIN GRAFTING.** Vein grafting is an alternative procedure to end-to-end anastomosis and may be pursued if cut ends of a blood vessel cannot be attached without tension. Nonessential veins similar in diameter to the recipient blood vessel can be removed from the hand, arm, or foot. If the graft is to be used to reconstruct an artery, its direction is reversed so that the venous valves do not interfere with blood flow. End-to-end anastomosis is then performed on each end of the graft, using the suture techniques described above.

**NERVE REPAIR.** The process of connecting two cut ends of a nerve is called neurorrhaphy, or nerve anastomosis. Peripheral nerves are composed of bunches of nerve fibers called fascicles that are enclosed by a layer called the perineurium; the epineurium is the outer layer of the nerve that encases the fascicles. Nerve repair may involve suturing of the epineurium only, the perineurium only, or through both layers.

Many of the techniques used for blood vessel anastomoses are also used for nerves. The cut ends of the nerve are exposed, then isolated from surrounding tissues. The ends are trimmed so that healthy nerve tissue is exposed, and a piece of contrast material placed behind the nerve for better visualization. Each nerve end is examined to determine the pattern of fascicles; the nerve ends are then rotated so that the fascicle patterns align. Sutures may be placed around

the circumference of the epineurium; this is called epineurial neurorrhaphy. The perineurium of each cut fascicle end may be stitched with excess epineurium removed (perineurial neurorrhaphy), or both layers may be sutured (epiperineurial neurorrhaphy).

**NERVE GRAFTING.** If there is a large gap between the cut ends of a nerve, neurorrhaphy cannot be performed without creating tension in the nerve, which can interfere with postsurgical function. A piece of nerve from another part of body may be used to create a nerve graft, which is stitched into place using anastomosis techniques. A disadvantage to nerve grafting is that a loss of function or sensation is experienced from the donor nerve site. A common nerve used for grafting is the sural nerve, which innervates parts of the lower leg.

### Diagnosis/Preparation

In an emergency situation, such as an **amputation** or crushing injury, a number of steps must be taken immediately to improve the odds that replantation or reconstruction will be successful. An IV line is placed so that fluids and **antibiotics** can be administered. The injured area is x rayed so that the extent of the injury can be determined, and the amputated body part is wrapped in sterile gauze and placed on ice, so that the tissues are preserved. To prevent freezing, the body part must not be packed below the ice. The patient is transported by ambulance or helicopter to the nearest surgical center capable of microsurgical repair.

In other cases, a patient may suffer from a chronic condition or wound, and microsurgery can be scheduled as an elective procedure. Prior to surgery, the patient will be instructed to refrain from tobacco use because it interferes with healing. In addition, the patient will be told not to eat after midnight the day of surgery. It is important that the patient inform the doctor completely about any prior surgeries, medical conditions, or medications taken on a regular basis, including **nonsteroidal anti-inflammatory drugs** (NSAIDs), such as **aspirin**. Patients taking blood thinners, such as Coumadin or Heparin (generic name: warfarin), should not adjust their medication themselves, but should speak with their prescribing doctors regarding their upcoming surgery). Patients should never adjust dosage without their doctors' approval. This is especially important for elderly patients, asthmatics, those with hypertension, or those who are on ACE inhibitors.

The patient will be placed under **general anesthesia** for the duration of the procedure. The advantages to general anesthesia are that the patient remains

unconscious and completely relaxed during the procedure, imperative because of the precise nature and extended duration of the surgery. The patient must be able to tolerate the long surgery and therefore must be relatively stable condition; complex surgeries may take up to 12 hours or more.

Microsurgery makes possible a number of reconstructive procedures that would be more difficult or impossible with conventional surgery. Some of the more frequently performed microsurgical procedures include:

- **Replantation.** This emergency surgery is performed to reattach an amputated body part such as a finger, arm, or foot. Replantation surgery requires a series of time- and energy-intensive steps to reattach all of the structures while the amputated part is still viable. The cut bone must be shortened slightly so that blood vessels and nerves can be reattached without tension. Anastomoses are created between cut arteries and veins and blood flow is reestablished to the amputated part. Tendons (if present) are then repaired, followed by nerves and soft tissues. Further procedures may be necessary to completely the reconstruction depending on the extent of the injury.
- **Transplantation.** In some cases an amputated part cannot be reattached, or tissue is deformed because of a congenital defect or an injury. Transplantation may then be an option. The great toe or second toe may be removed from a patient's foot and transplanted to the hand to replace a missing finger. A segment of rib along with its blood supply can be used to reconstruct bones in the face and jaw.
- **Free-tissue transfers.** Also called free flaps, free-tissue transfers may be used to reconstruct damaged tissues that cannot be treated with skin grafts, closed by traditional methods such as suturing, or allowed to heal without intervention. This includes tissues that have constricted after a burn, injuries in which there is not sufficient skin to properly close the wound, or tissues that have been removed as a result of treatment for cancer. Examples of tissues that may be transferred with microsurgical techniques are skin, muscle, fat, bone, and intestine.

### Aftercare

Following surgery, the patient is given intravenous fluids and usually progresses to a liquid diet within 12 to 24 hours, and a regular diet soon thereafter. The patient must be kept warm and adequately hydrated, and the surgical site is elevated if possible to help drain excess fluids. Medications are administered to help manage pain. The color, temperature, quality of capillary refill,

and tissue turgor (fullness) of the surgical site are closely monitored. Skin should be pink, warm, and have one- to two-second capillary refill. Conversely, tissue that is pale or blue, cool, with no refill or rapid refill may indicate a problem with blood flow.

Certain tests may be recommended to further evaluate the surgical site. These include:

- **Doppler ultrasound.** This technology uses high-frequency sound waves to evaluate the flow of blood to and from the surgical site.
- **Intravenous fluorescein.** After a chemical dye called fluorescein is administered to the patient, a specialized machine called a fluorimeter is used to determine how much blood is flowing through the surgical site.
- **Pulse oximetry.** A pulse oximeter measures the amount of oxygen in the blood and tracks the patient's pulse.
- **Arteriography.** X rays are taken of the surgical site after a contrast dye has been injected into the bloodstream to determine the condition of vascular anastomoses.

When the patient is discharged from the hospital, he or she will receive instructions for aftercare. Exposure to tobacco must be limited for at least six weeks following the surgery, as nicotine interferes with circulation. The patient must remain warm as **body temperature** also affects circulation. Bed rest may be prescribed for a period of days to weeks after surgery, depending on the procedure. Patients who have had a hand, finger, or multiple fingers replanted must keep the part elevated at heart level to help blood flow and decrease swelling.

Some form of rehabilitation is often recommended after microsurgery. This includes a program of individualized exercises used to restore function to a replanted or transplanted body part. In some cases where problems with circulation occur after surgery, leech therapy may be recommended. Leeches are worms that attach to the skin and draw blood while also injecting substances into the skin that act as a local anesthetic and an anticoagulant (preventing the formation of blood clots). Therapy involves attaching a leech to the replanted part or tissue flap and allow it to feed for 15 to 30 minutes, several times a day, until blood flow is established.

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Stephanie Dionne Sherk

## Minimally invasive heart surgery

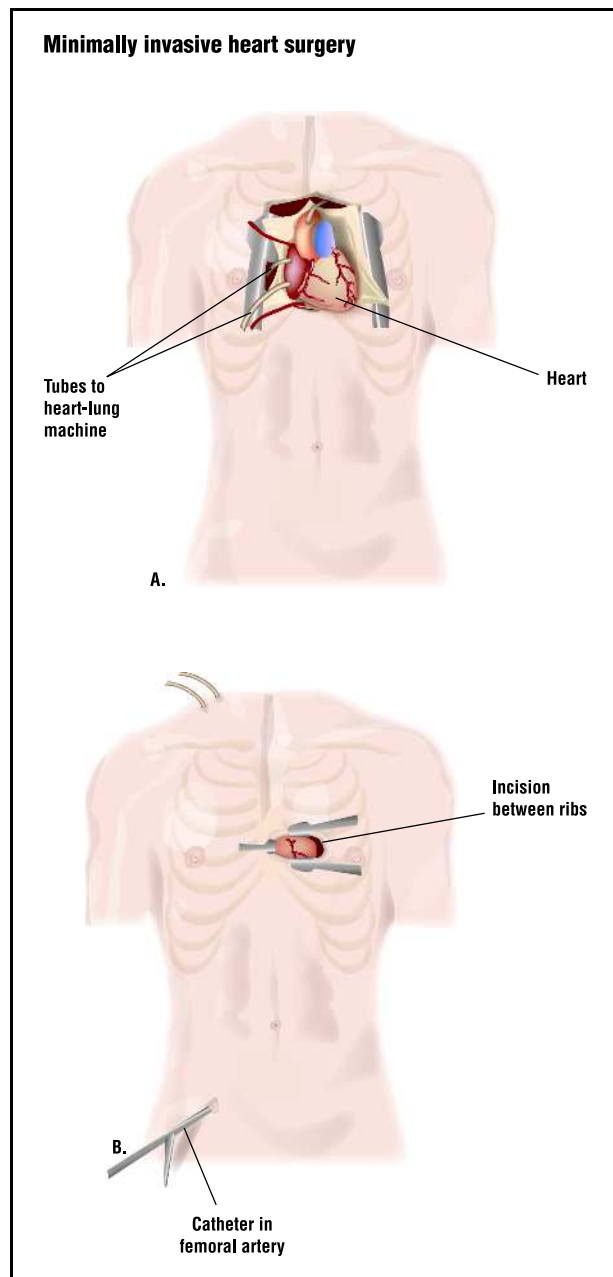
### Definition

Minimally invasive heart surgery refers to surgery performed on the beating heart to provide coronary artery bypass grafting. This technique is often referred to as MIDCAB, minimally invasive direct coronary artery bypass; or OPCAB, off-pump CABG.

### Purpose

Minimally invasive heart surgery is performed on the diseased heart to reroute blood around clogged arteries and improve the blood and oxygen supply to the heart. This approach provides patients some benefit in that cardiopulmonary bypass (use of a heart-lung machine) may be avoided. In addition, smaller incisions can be used instead of the standard sternotomy (incision through the sternum, or breastbone) approach. Faster recovery time, decreased procedure costs, and reduced morbidity and mortality are the goals of this technique.

Minimally invasive technique is not new to the field of cardiac surgery. It was performed as early as the 1950s, although the technology associated with



**In traditional open heart surgery, a large incision is made in the chest, and the sternum must be broken (A). Minimally invasive surgery uses a much smaller incision between the ribs to access the heart (B).** (Illustration by GGS Information Services. Cengage Learning, Gale.)

stabilizing the cardiac structure during the procedure has become more sophisticated. Also, the anesthesiologist and perfusionist (person monitoring blood flow) have developed better techniques to preserve cardiac function during the procedure to help the surgeon achieve the desired outcome. During the 1990s these new techniques were named: off-pump CABG

## KEY TERMS

**Anastomosis**—Connection of the bypassing blood vessel to the blocked blood vessel by surgical suture. The stitches may be made in continuous manner or individual, with continuous being more common. The disadvantage of continuous suture can be purse-stringing or cinching of the graft opening during knotting of the suture.

**Angiography**—Injecting dye into blood vessels so they can be seen on an x ray.

**Arrhythmia**—Cardiac electrical signaling that generates an ECG rhythm other than normal sinus rhythm.

**Balloon angioplasty**—A procedure used to open an obstructed blood vessel. A small, balloon-tipped catheter is inserted into the vessel and the balloon is inflated to widen the vessel and push the obstructing material against the vessel's walls. The result is improved blood flow through the vessel.

**Cannula**—A small, flexible tube.

**Cardioplegic arrest**—Halting the electrical activity of the heart by delivery of a high potassium solution to the coronary arteries. The arrested heart provides a superior surgical field for operation.

**Cardiopulmonary bypass**—Use of the heart-lung machine to provide systemic circulation cardiac output and ventilation of the blood.

**Coronary occlusion**—Obstruction of an artery that supplies the heart. When the artery is completely blocked, a myocardial infarction (heart attack) results; an incomplete blockage may result in angina.

**Coronary stent**—An artificial support device used to keep a coronary vessel open.

**Electrocardiography**—A testing technique used to measure electrical impulses from the heart in order to gain information about its structure or function.

**Myocardial infarction**—Heart attack.

**Stabilizer**—A device used to depress the movement of the area around the coronary artery where the anastomosis is made. The stabilizer is used to provide a still, motionless field for suturing.

**Sternotomy**—A surgical opening into the thoracic cavity through the sternum (breastbone).

**Thoracotomy**—A surgical opening into the thoracic cavity.

(OPCAB) and minimally invasive direct coronary artery bypass (MIDCAB). The MIDCAB procedure includes procedures done both with and without cardiopulmonary bypass, the later being referred to as off-pump MIDCAB. Unless otherwise specified, MIDCAB refers to both types of procedures.

Minimally invasive valve surgery has been an outgrowth of the success with minimally invasive coronary artery bypass grafting. Incisions other than the traditional sternotomy allow access to the heart. Minimally invasive valve surgery still requires cardiopulmonary bypass, since this is a true open-heart procedure (i.e. this is not surgery that is done while the heart is beating). New tools in managing cardioplegic cardiac arrest allow for the smaller incision unobstructed by the required instrumentation. Cannulation of the femoral vessels instead of the larger vessels of the heart also improves visualization.

### Demographics

Patients under the age of 70, but not limited by age, with a history of coronary artery disease can be evaluated for this procedure. High risk patients with advanced age, at risk for stroke, or suffering peripheral

vascular disease, renal disease, or with poor lung function may benefit from OPCAB and MIDCAB.

Typically, disease of the left anterior descending coronary artery is treated with the technique called off-pump MIDCAB. With sternotomy, disease of the right and left coronary arteries can also be addressed by OPCAB. The significance and location of the coronary artery lesions may limit the success of the MIDCAB or OPCAB procedure. Most practices have at least one surgeon skilled in performing revascularizations without cardiopulmonary bypass. Of all coronary artery bypass grafting procedures, approximately 10–20% are performed in this manner.

### Description

The patient receives cardiac monitoring during **general anesthesia**. Systemic anticoagulation is given to avoid clot formation from foreign surfaces and any periods of artery blockage (occlusion).

### MIDCAB

If cardiopulmonary bypass is not employed, the procedure is called an off-pump MIDCAB. The surgeon performs an alternative incision (rather than a

midline sternotomy), typically a left anterior **thoracotomy**. The left internal mammary artery is dissected from the left chest wall. A stabilizer device is placed on the heart to provide support of the left anterior descending artery as the heart continues to beat. This device applies gentle pressure or suction, mildly limiting cardiac function. The left internal mammary artery is sutured to the left anterior descending artery to bypass the blockage (anastomosis).

If cardiopulmonary bypass is indicated, the surgeon inserts cannulae (small, flexible tubes) into the femoral vessels. Aortic occlusion and cardioplegia are administered through a catheter advanced through the contralateral femoral artery into the aortic root (ascending aorta). This catheter has a balloon tip that stops blood flow to the coronary arteries when inflated, but allows selective administration of cardioplegia (a solution that stops the heart) to the coronary arteries. **Angiography** is performed to provide visualization of catheter placement.

The surgeon performs an alternative incision (rather than a midline sternotomy), typically a left anterior thoracotomy. The left internal mammary artery is dissected from the left chest wall. Cardiopulmonary bypass can be instituted with or without cardioplegic arrest. Cardioplegic arrest requires cardiopulmonary bypass. The use of cardioplegic arrest makes this a non-beating heart procedure, but it is still considered MIDCAB. Cardioplegic arrest of the heart occurs as the balloon tip of the catheter is inflated. The left internal mammary artery is sutured to the left anterior descending artery to bypass the blockage (anastomosis). Once the anastomosis is complete the balloon is deflated, allowing the heart to begin to beat. Cardiopulmonary bypass is discontinued once cardiac function is stabilized. The cannulae and catheter are removed, and the groin wounds are closed with sutures.

### **OPCAB**

The OPCAB procedure does not use cardiopulmonary bypass. The incision of choice can be a midline sternotomy or a left anterior thoracotomy (incision in the side). The midline sternotomy allows access to both the right and left internal mammary arteries. Additional vascular bypass conduits may be acquired by harvesting the saphenous vein (in the leg), gastroepiploic artery (near the stomach), or radial artery (in the arm). A stabilizing device is used to secure the coronary artery of choice. This device applies gentle pressure or suction, mildly limiting cardiac function, but providing better access to posterior and inferior vessels of the heart. The surgeon makes the necessary anastomosis to the targeted coronary arteries. If

conduits other than the mammary arteries are used they are connected to the ascending aorta to provide systemic blood flow.

If an anticoagulant was administered, drugs are given to reverse the anticoagulant. Upon completion of the off-pump MIDCAB, MIDCAB, or OPCAB procedure, the chest is closed. If a midline sternotomy was performed, stainless steel wires are implanted to hold the sternal bone together. Sutures are used to close the skin wound, and sterile **bandages** are applied as a wound dressing.

### **Diagnosis/Preparation**

An **electrocardiogram** detects the presence of acute coronary blockage (occlusion). A history of myocardial infarction can also be detected by electrocardiogram. Patients with a history of angina also are evaluated for coronary artery disease. Coronary angiography provides the best diagnostic information about the extent and location of the coronary artery disease.

### **Aftercare**

The patient receives continued cardiac monitoring in the **intensive care unit**. Once the patient is able to breathe on his/her own, the breathing tube is removed (extubation), if it is not removed immediately post-operatively. Any medications to treat poor cardiac function or manage blood pressure are discontinued as cardiac function improves and blood pressure stabilizes. Blood drainage tubes protruding from the chest cavity are removed once internal bleeding decreases. The patient also may be equipped with external cardiac pacing to maintain heart rate. The pacing is terminated once the heart is beating at an adequate rate free of arrhythmia. A warming blanket may be used to warm the patient's core temperature that was decreased by the surgical exposure.

The duration of the post-operative hospital stay is reduced by one to two days in these procedures. Pain also should be reduced. **Home care** for the wound is described prior to discharge, and instructions for responding to adverse events after discharge also are given. Patients who have undergone these procedures should expect to return to normal activities sooner than those who have undergone traditional coronary artery bypass grafting.

### **Risks**

MIDCAB can result in a higher rate of restenosis (recurrence of narrowing of the arteries) than traditional coronary artery bypass grafting, but these numbers continue to decrease as experience with the

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Medical centers performing cardiac surgical procedures are equipped to perform this procedure. A cardiothoracic, cardiovascular, or cardiac surgeon receives additional training to successfully complete this procedure. Special technology in stabilizer design is purchased by the institution and made available for the surgeon to master. Within most clinical practices one surgeon becomes skilled in the technique. This one surgeon completes most procedures off-pump with MIDCAB or OPCAB techniques as necessary to revascularize the patient.

procedure improves. Some patients may have to have the procedure converted to a standard sternotomy with cardiopulmonary bypass, if the anastomosis can not be completed from the MIDCAB approach. Rib fracture is the most common adverse event. Pericarditis also is a possible complication. Supraventricular arrhythmias and ST segment elevation also may develop.

In the event of systemic blood pressure abnormalities, arrhythmia, poor surgical anastomosis, or poor exposure of the coronary blood vessels, OPCAB patients may require conversion to cardiopulmonary bypass for completion of the anastomosis. Post-operatively some patients may need additional surgery to control bleeding or to address poor sternal healing. This is related to the increased use of both internal mammary arteries for these procedures. Cerebral complications and atrial fibrillation also may be experienced. These post-operative complications are comparable to those seen in patients who have undergone traditional coronary artery bypass grafting.

### Normal results

Patency (openness) of the grafted vessels is expected to be the same as what is seen in traditional coronary artery bypass grafting. When compared to traditional coronary artery bypass grafting, minimally invasive heart surgery also is expected to result in a shorter hospital stay, less pain, fewer blood transfusions, and quicker return to normal activity.

### Morbidity and mortality rates

#### MIDCAB

Conversion to a full sternotomy or sternotomy with cardiopulmonary bypass is expected in 1–2% of

## QUESTIONS TO ASK THE DOCTOR

- Is there a surgeon associated with this practice skilled with OPCAB or MIDCAB procedures?
- Can the surgeon skilled in these procedures evaluate the patient for an OPCAB or MIDCAB procedure?
- How many procedures has the surgeon performed in the last year? In the last five years?
- What is the surgeon's reoperation rate in regards to length of graft patency?

patients. Redo procedures and **reoperation** can occur in over 5% of patients, which is still lower than the risk of a second procedure associated with balloon **angioplasty** and stent placement. Over 90% of all patients are expected to be free of adverse events. Complications most frequently involve rib fracture (over 10% of patients). Mortality associated with MICAB is low and is not seen during the surgical procedure in most instances, but is associated with post-operative complications.

#### OPCAB

Conversion to cardiopulmonary bypass may be required in patients if anastomosis cannot be completed due to unstable blood pressure, arrhythmia, ischemia, poor anastomosis, or poor surgical access. The same operative mortality is expected when compared to cardiopulmonary bypass patients. The expected decrease in neurological events, renal dysfunction, pulmonary complications, or arrhythmias has not yet been shown to be a consistent benefit, therefore all of these complications can still occur.

### Alternatives

Percutaneous balloon angioplasty and **coronary stenting** of the left anterior descending artery are successful alternative procedures. MIDCAB may be a preferred treatment when compared to balloon angioplasty and stenting because fewer repeat interventions are required. An additional alternative is traditional on-pump, cardiopulmonary bypass; coronary artery bypass grafting is a powerful technique with a long record of safety and effectiveness since the 1960s.



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Allison Joan Spiwak, MSBME

Minor tranquilizers see **Antianxiety drugs**

## Mitral valve repair

### Definition

Mitral valve repair is a surgical procedure used to improve the function of a stenotic (narrowed), prolapsed (slipped from its normal position), or insufficient (weakened) mitral valve of the heart.

### Purpose

The mitral valve controls the blood flow between the left atrium (upper chamber) and left ventricle (lower chamber) of the heart. When the mitral valve functions correctly, blood flows in one direction only—from the atrium to the ventricle. Then the valve becomes diseased or weakened, blood can back-flow from the ventricle to the atrium when the ventricle contracts (systole). The mitral valve also can become narrowed, preventing the flow of blood from the left atrium into the left ventricle during ventricular filling (diastole). In mitral valve prolapse, one or more of the mitral valve's cusps protrude back into the left atrium during ventricular contraction. Mitral valve repair is performed to improve the function of the diseased valve so that it correctly controls the amount and direction of blood flow.

### Demographics

Mitral valve prolapse is the most common heart valve defect. In the United States it is present in about 2–6% of the population. The defect is believed to have an inherited component and is seen twice as often in women as in men. Having this condition does not automatically mean that mitral insufficiency will develop. Patients with a history of rheumatic fever, coronary artery disease, infective endocarditis, or collagen vascular disease also may develop mitral insufficiency.

Mitral valve stenosis almost always is the result of having rheumatic fever in childhood. Rheumatic fever

occurs in some people after a group A streptococcal throat infection (commonly called strep throat). Genetics appears to play a role in determining who develops rheumatic fever after a strep infection, with women more likely than men to progress to the disease. After rheumatic fever subsides, there is usually a latency period of 10–20 years before symptoms of mitral valve stenosis appear. The prevalence of mitral valve stenosis has declined in the United States because there has been a decline in the number of cases of rheumatic fever. In the United States in 2005, about one case of rheumatic fever occurred for every 100,000 people. Rheumatic fever is much more common in developing countries (100–150 cases per 100,000 in India, for example), and thus the rate of mitral valve stenosis is also higher. Mitral valve stenosis may be present at birth (congenital); however, it rarely occurs alone but rather in conjunction with other heart defects.

### Description

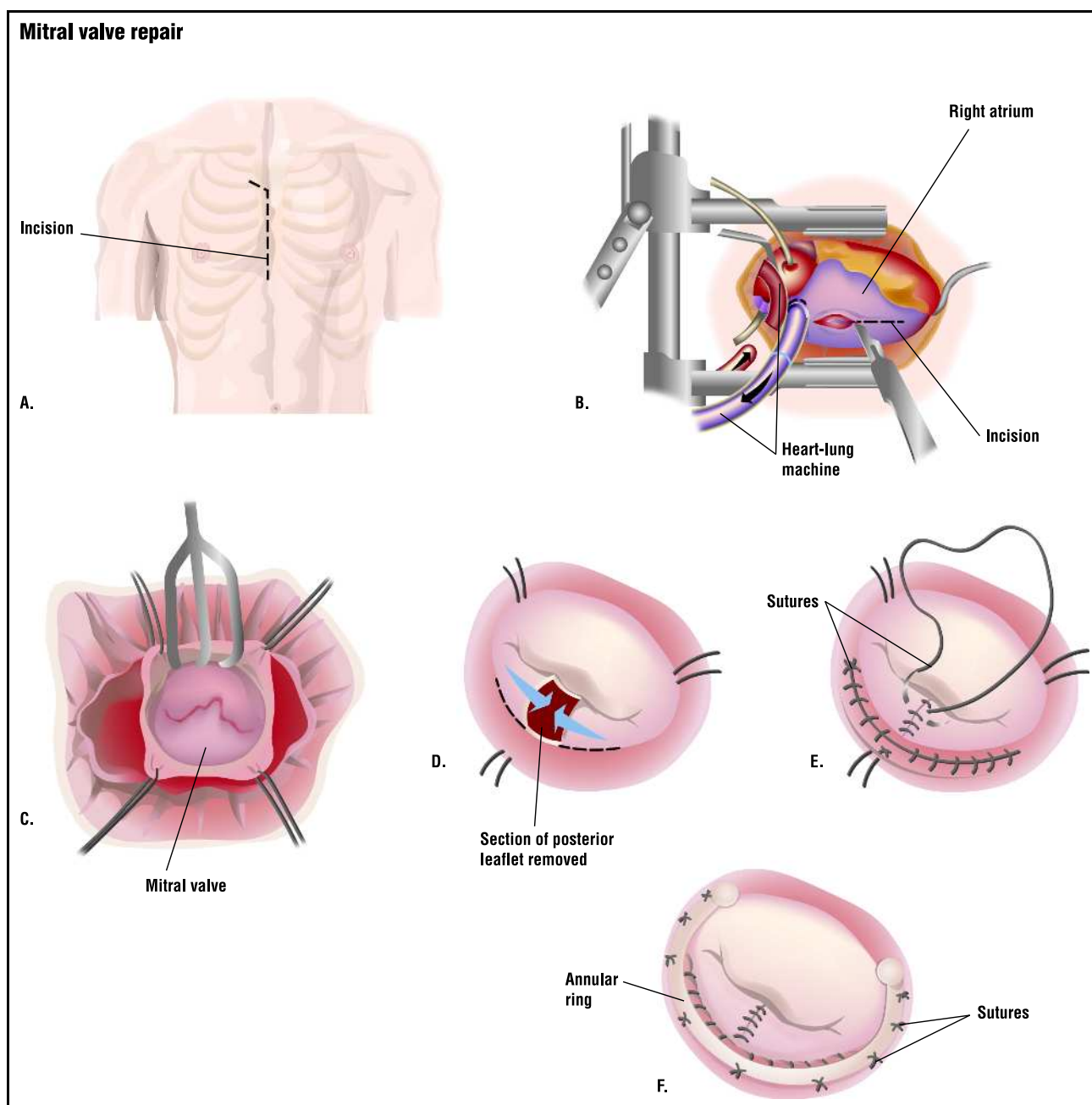
Mitral valve repair is done under **general anesthesia** with continuous cardiac monitoring. Uncomplicated mitral valve surgery normally takes 2–3 hours. In traditional mitral repair, the surgeon uses a sternotomy to access the heart and large blood vessels. Anticoagulation drugs are given as cannulae are inserted into the large veins. Cardiopulmonary bypass (use of a heart-lung machine) is instituted. The heart-beat is stopped as blood vessels are clamped to prevent blood flow through the heart. The surgeon opens the heart to see the mitral valve. He/she may expose the mitral valve by opening the right atrium and then opening the atrial septum (tissue dividing the atria). Another approach requires a large left atrium that can be opened directly, making the mitral valve visible.

### *Mitral commissurotomy*

Mitral commissurotomy is used to repair mitral stenosis associated with rheumatic fever. The commissures—openings between the valve leaflets—are manually separated by the surgeon. Fused chordae tendineae (cords of connective tissue that connect the mitral valve to the papillary muscle of the heart's left ventricle) are separated, along with papillary muscles. Calcium deposits may be removed from the valve leaflets. The left atrial appendage is removed to reduce the risk of future thromboemboli (blood clot) generation.

### *Chordae tendineae repair*

The chordae tendineae can become lengthened or rupture, resulting in mitral valve prolapse (the valve slipping out of place). A skilled surgeon repairs the mitral valve structure by placing sutures in the valve



During a mitral valve repair, the patient's chest is opened along the sternum (A). The heart is connected to a heart-lung machine, and an incision is made into the right atrium, or upper chamber of the heart (B), exposing the mitral valve (C). A section of the valve is removed, and the area is repaired with sutures (D and E). A flexible fabric ring may be stitched to the outside of the valve to strengthen it, in a procedure called an annuloplasty (F). (Illustration by GGS Information Services. Cengage Learning, Gale.)

leaflets to stabilize the valve structure. Typically the posterior leaflet requires this type of repair.

#### ***Annuloplasty***

A flexible fabric ring is sutured to the valve annulus to provide support and reconstruction for the

patient's valve annulus. The size of the ring is selected to match the patient's own valve size. This repair allows the valve to function normally.

The heart is closed with sutures. De-airing of the heart is performed before removal of the clamps. When the clamps are removed, de-airing continues to

## KEY TERMS

**Acute**—Rapid onset.

**Annulus**—A ring-shaped structure.

**Anticoagulants**—Drugs that are given to slow blood clot formation.

**Atrium (plural Atria)**—The right or left upper chamber of the heart.

**Cannula (plural cannulae)**—A small, flexible tube.

**Cardiac catheterization**—A diagnostic procedure (using a catheter inserted through a vein and threaded through the circulatory system to the heart) which does a comprehensive examination of how the heart and its blood vessels function.

**Cardiopulmonary bypass**—Use of the heart-lung machine to provide systemic circulation cardiac output and ventilation of the blood.

**Chordae tendineae**—The strands of connective tissue that connect the mitral valve to the papillary muscle of the heart's left ventricle.

**Chronic**—Long-term.

**Commissures**—The normal separations between the valve leaflets.

**Doppler echocardiography**—A testing technique that uses Doppler ultrasound technology to evaluate the pattern and direction of blood flow in the heart.

**Endocarditis**—Infection of the heart endocardium tissue, the inner most tissue and structures of the heart.

**NYHA heart failure classification**—A classification system for heart failure developed by the New York Heart Association. It includes the following four categories: I, symptoms with more than ordinary activity; II, symptoms with ordinary activity; III, symptoms with minimal activity; IV, symptoms at rest.

**Rheumatic carditis**—Inflammation of the heart muscle associated with acute rheumatic fever.

**Rheumatic fever**—An inflammatory disease that arises as a complication of untreated or inadequately treated strep throat infection. Rheumatic fever can seriously damage the heart valves.

**Sternotomy**—A surgical opening into the thoracic cavity through the sternum (breastbone).

**Systemic circulation**—Circulation supplied by the aorta including all tissue and organ beds, except the alveolar sacs of the lungs used for gas exchange and respiration.

**Thromboemboli**—Blood clots that develop in the circulation and lodge in capillary beds of tissues and organs.

**Transesophageal echocardiography**—A diagnostic test using an ultrasound device that is passed into the esophagus of the patient to create a clear image of the heart muscle and other parts of the heart.

ensure that no air enters the systemic circulation. At this time a transesophageal echocardiogram (TEE) may be used to test that the valve is functioning correctly and that the heart is free of air. If the surgeon is not satisfied with the repair, **mitral valve replacement** is performed. Once the surgeon is satisfied that the valve is working correctly, cardiopulmonary bypass is terminated, anticoagulation is reversed, and the cannulae are removed from the blood vessels. The sternotomy is closed. Permanent stainless steel wires are used to hold the sternum bone together. The skin incision is closed with sutures, and sterile **bandages** are applied to the wound.

#### *Minimally invasive mitral valve repair*

In the mid-2000s, some cardiac surgery centers began performing robot-assisted minimally invasive mitral valve repair. In minimally invasive repair, a 2–3 inch (5–8 cm) opening is made in the side of the chest instead of reaching the heart by breaking the sternum.

Then, with the assistance of a robotic arm, the valve is repaired. Minimally invasive mitral valve repair may not be appropriate for all patients, but when it is, it offers the advantages of less chance of infection and blood loss, a shorter hospital stay, and a faster, less painful recovery.

### Diagnosis/Preparation

Mitral valve stenosis is diagnosed by history, **physical examination**, listening to the sounds of the heart (cardiac auscultation), **chest x ray**, and ECG. Patients may have no symptoms of a valve disorder or may have shortness of breath (dyspnea), fatigue, or pulmonary edema (fluid in the lungs). Other patients present with atrial fibrillation (a cardiac arrhythmia) or an embolic event (result of a blood clot, i.e., heart attack or stroke). Doppler **echocardiography** is the preferred diagnostic tool for evaluation of mitral valve stenosis, and can be performed in conjunction

with non-invasive **exercise** testing by treadmill or bicycle. **Cardiac catheterization** is reserved for patients who demonstrate discrepancies in Doppler testing. Both left- and right-heart catheterization should be performed in the presence of elevated pulmonary artery pressures.

A diagnosis of mitral insufficiency requires a detailed patient history. Listening to the heart (auscultation) reveals the presence of a third heart sound. Chest x ray and ECG provide additional information. Again, Doppler echocardiography provides valuable information. Exercise testing with Doppler echocardiography can show the true severity of the disease.

After initial findings, patients may be followed with repeat visits and testing to monitor disease progress. If the patient has reached NYHA Class III or IV, replacement is considered. Severe pulmonary hypertension with pulmonary artery systolic pressures greater than 60 mm Hg is considered an indication for surgery. Left ventricular ejection fraction less than 60% also is an indication for surgery.

### Aftercare

The patient receives continued cardiac monitoring in the **intensive care unit** and usually remains in intensive care for 24–48 hours after surgery. Ventilation support is discontinued when the patient is able to breathe on his/her own. If mechanical circulatory support and inotropic drugs (substances that stimulate heart muscle contractions, e.g. digitalis) were needed during the surgical procedure, they are discontinued as cardiac function recovers. Tubes draining blood from the chest cavity are removed as bleeding from the surgical procedure decreases. Prophylactic **antibiotics** are given to prevent infective endocarditis and prevent the recurrence of rheumatic carditis.

If the patient recovers normally, **discharge from the hospital** occurs within a week of surgery. At discharge, the patient is given specific instructions about **wound care** and infection recognition, as well as contact information for the physician and guidelines about when a visit to the emergency room is indicated. Within three to four weeks after discharge, the patient is seen for a follow-up office visit with the physician, at which time physical status will have improved for evaluation. Thereafter, asymptomatic, uncomplicated patients are seen at yearly intervals. Few limitations are placed on patient activity once recovery is complete.

### Risks

There are always risks associated with general anesthesia and cardiopulmonary bypass. Risks specifically

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Cardiothoracic and cardiovascular surgeons perform mitral valve repair. Surgeons are trained during their residency to perform these procedures, although a certain level of skill is required for perfection of the technique. Medical centers that perform cardiac surgery are able to provide mitral valve repair.

associated with mitral valve repair include embolism, bleeding, or operative valvular endocarditis. When valve repair does not produce adequate results, then increased operative time is required to replace the mitral valve. If the patient's mitral valve is replaced with a mechanical valve, the patient must take an anticoagulation drug, such as Coumadin, for the rest of his/her life. An inadequately repaired valve, if left untreated, results in continued myocardial dysfunction resulting in pulmonary edema, congestive heart failure, and systemic thromboemboli generation.

### Normal results

Patients treated by mitral valve repair for mitral insufficiency can expect improved myocardial function and relief of symptoms. Oxygen consumption by skeletal muscle continues to improve. Cardiac output improves and pulmonary hypertension resolves over several months after the initial decrease in left atrial pressure, pulmonary artery pressure, and pulmonary arteriolar resistance.

Excellent results in terms of improved cardiac function and symptom relief also are expected for patients that undergo mitral valve repair for mitral stenosis.

### Morbidity and mortality rates

Operative mortality associated with mitral valve repair for stenosis is 1–3%. The prognosis for restenosis (re-narrowing) is 30% at five years and 60% at nine years; additional surgery is required in 4–7% of patients at five years. Eighty to 90% of patients whose mitral valve stenosis was repaired by commissurotomy are complication free at five years after surgery.

Mitral valve repair for mitral insufficiency is the preferred approach because it preserves the valvular apparatus and left ventricular function. It also eliminates the risk of mechanical valve failure and the need for lifelong anticoagulation.



## QUESTIONS TO ASK THE DOCTOR

- Is mitral valve repair the best treatment choice for my condition?
- Am I a candidate for minimally invasive mitral valve repair?
- How many of these procedures has the surgeon performed in the last year? in the last five years?
- What is the surgeon's morbidity and mortality rate with mitral valve repair?
- What will happen if the repair fails?
- What type of follow-up care is required during the first year after surgery and throughout the rest of my life?
- What type of complications can be encountered both acute and chronic?

### Alternatives

The asymptomatic patient with a history of rheumatic fever can be treated with prophylactic antibiotics and followed until symptoms appear. If atrial fibrillation develops antiarrhythmic medications can be used for treatment. Atrial **defibrillation** may relieve atrial fibrillation. Anticoagulants may be prescribed to prevent the occurrence of systemic embolization.

Mitral valve repair for mitral regurgitation is not as successful if the anterior leaflet is involved. Rheumatic, ischemic, or calcific diseases decrease the likelihood of repair in even the most skilled hands. In the absence of mitral valve replacement, mitral valve repair is indicated.

### Resources

#### BOOKS

ICON Health Publications. *The Official Patient's Source book on Mitral Valve Prolapse*. San Diego, CA: ICON Health Publications, 2006.

#### PERIODICALS

Bonow, R., et al. "ACC/AHA 2006 Guidelines for the Management of Patients with Valvular Heart Disease." *Circulation*. 114 (2006) e84 e231. <http://circ.ahajournals.org/cgi/reprint/114/5/e84>.

#### ORGANIZATIONS

American Heart Association. 7272 Greenville Avenue, Dallas, TX 75231. (800) 242 8721. <http://www.americanheart.org>.

Mitral Valve Repair Center at Mount Sinai Hospital. 1190 Fifth Avenue, New York, NY 10029 (212) 659 6820. <http://www.mitralvalverepair.org>.

### OTHER

Gillinov, A, Marc. "Mitral Valve Repair." *Cleveland Clinic Heart and Vascular Institute*. <http://www.clevelandclinic.org/heartcenter/> [accessed May 16, 2008].

"Mitral Valve Repair Using Robotic Surgery." *St. Joseph's Hospital (Atlanta) Center for Robotic Surgery*. [cited February 5, 2008]. <http://www.stjosephsatlanta.org/centerforroboticsurgery/heart/mitralvalverepairroboticsurgery.html>.

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## Mitral valve replacement

### Definition

Mitral valve replacement is surgical procedure in which the diseased mitral valve of the heart is replaced by a mechanical valve or biological tissue valve.

### Purpose

The mitral valve controls the blood flow between the left atrium (upper chamber) and left ventricle (lower chamber) of the heart. When the mitral valve functions correctly, blood flows in one direction only—from the atrium to the ventricle. When the valve becomes diseased or weakened, blood can back-flow from the ventricle to the atrium when the ventricle contracts (systole). The mitral valve also can become narrowed, preventing the flow of blood from the left atrium into the left ventricle during ventricular filling (diastole). In mitral valve prolapse, one or more of the mitral valve's cusps protrude back into the left atrium during ventricular contraction. **Mitral valve repair** is the preferred operation to correct these conditions and improve the function of the diseased valve so that it correctly controls the amount and direction of blood flow. When mitral valve repair is not possible, mitral valve replacement is performed. The defective mitral valve is surgically removed and a new mechanical valve or biological tissue valve (from a pig, cow, or human cadaver) is put into place to correctly control blood flow.

### Demographics

Mitral valve prolapse is the most common heart valve defect. In the United States it is present in about 2–6% of the population. The defect is believed to have an inherited component and is seen twice as often in women as in men. Having this condition does not

## KEY TERMS

**Annulus**—A ring-shaped structure.

**Anticoagulants**—Drugs that are given to slow blood clot formation.

**Biological tissue valve**—An autograft is a valve that comes from the patient, usually the pulmonary valve. An autologous pericardial valve is constructed from the patient's pericardium (the fibrous sac that surrounds the heart and the roots of the great vessels and also forms the outer layer of the heart wall) at the time of surgery. A homograft (or allograft) valve is a valve harvested from a human cadaver. A porcine (pig) or bovine (cow) heterograft is animal tissue valve that is made acceptable to the body by destroying antigenicity so that the body will not reject the foreign tissue.

**Cardiac catheterization**—A diagnostic procedure (using a catheter inserted through a vein and threaded through the circulatory system to the heart) which does a comprehensive examination of how the heart and its blood vessels function.

**Cardiopulmonary bypass**—Use of the heart-lung machine to provide systemic circulation cardiac output and ventilation of the blood.

**Doppler echocardiography**—A testing technique that uses Doppler ultrasound technology to evaluate the pattern and direction of blood flow in the heart.

**Endocarditis**—Infection of the heart endocardium tissue, the inner most tissue and structures of the heart.

**Mechanical valve**—There are three types of mechanical valve: ball valve, disk valve, and bileaflet valve.

**NYHA heart failure classification**—A classification system for heart failure developed by the New York Heart Association. It includes the following four categories: I, symptoms with more than ordinary activity; II, symptoms with ordinary activity; III, symptoms with minimal activity; IV, symptoms at rest.

**Rheumatic carditis**—Inflammation of the heart muscle associated with acute rheumatic fever.

**Rheumatic fever**—An inflammatory disease that arises as a complication of untreated or inadequately treated strep throat infection. Rheumatic fever can seriously damage the heart valves.

**Sternotomy**—A surgical opening into the thoracic cavity through the sternum (breastbone).

**Systemic circulation**—Circulation supplied by the aorta including all tissue and organ beds, except the alveolar sacs of the lungs used for gas exchange and respiration.

**Thromboemboli**—Blood clots that develop in the circulation and lodge in capillary beds of tissues and organs.

**Transesophageal echocardiography**—A diagnostic test using an ultrasound device that is passed into the esophagus of the patient to create a clear image of the heart muscle and other parts of the heart.

automatically mean that mitral insufficiency will develop, and even when it does, mitral valve repair is often preferable to valve replacement. Patients with a history of rheumatic fever, coronary artery disease, infective endocarditis, or collagen vascular disease also may develop mitral insufficiency.

Mitral valve stenosis almost always is the result of having rheumatic fever in childhood. Rheumatic fever occurs in some people after a group A streptococcal throat infection (commonly called strep throat). Genetics appears to play a role in determining who develops rheumatic fever after a strep infection, with women more likely than men to progress to the disease. After rheumatic fever subsides, there is usually a latency period of 10–20 years before symptoms of mitral valve stenosis appear. The prevalence of mitral valve stenosis has declined in the United States because there has been a decline in the number of

cases of rheumatic fever. In the United States in 2005, about one case of rheumatic fever occurred for every 100,000 people. Rheumatic fever is much more common in developing countries (100–150 cases per 100,000 in India, for example), and thus the rate of mitral valve stenosis is also higher. Mitral valve stenosis may be present at birth (congenital); however, it rarely occurs alone but rather in conjunction with other heart defects. Again, repair is preferable to replacement of the mitral valve.

### Description

A heart valve is a structure within the heart that prevents the backflow of blood by opening and closing with each heartbeat. Replacement heart valves are either mechanical or biological tissue valves. For patients under the age of 65, the mechanical valve offers superior longevity, but the use of this type of

valve requires that the patient take an anticoagulation drug for the rest of his/her life. The biological tissue valve does not require anticoagulation therapy, but this type of valve is prone to deterioration leading to re-operation after about 10–15 years. Women who may want to have children after a valve replacement should usually receive a biological tissue valve, because the anticoagulant warfarin (Coumadin) most often prescribed for patients with mechanical valves is associated with fetal birth defects. **Aspirin** can be substituted for warfarin in certain circumstances.

Mitral valve replacement is done under **general anesthesia** with continuous cardiac monitoring. Uncomplicated mitral valve surgery normally takes 2–3 hours. To replace the mitral valve, the surgeon breaks the breastbone (sternum) to gain access to the heart and large blood vessels. Anticoagulation drugs are given as cannulae are inserted into the large veins. Cardiopulmonary bypass (use of a heart-lung machine) is instituted. The heartbeat is stopped as blood vessels are clamped to prevent blood flow through the heart. The surgeon opens the heart to see the mitral valve. He/she may expose the mitral valve by opening the right atrium and then opening the atrial septum (tissue dividing the atria). Another approach requires a large left atrium that can be opened directly, making the mitral valve visible.

Next, the surgeon cuts the diseased valve away from the valve annulus (outer ring). The annulus is sized so that the proper size of valve can be selected for the patient's anatomy. Sutures are applied around the valve annulus, the valve is sutured into place, and tied into position. The atrial septum is closed with suture or left to heal naturally, and the heart is closed with sutures.

De-airing of the heart is performed before removal of the clamps. When the clamps are removed, de-airing continues to ensure that no air enters the systemic circulation. At this time a transesophageal echocardiogram (TEE) may be used to test that the valve is functioning correctly and that the heart is free of air. If the surgeon is not satisfied with the repair, mitral valve replacement is performed. Once the surgeon is satisfied that the valve is working correctly, cardiopulmonary bypass is terminated, anticoagulation is reversed, and the cannulae are removed from the blood vessels. The sternotomy is closed. Permanent stainless steel wires are used to hold the sternum bone together. The skin incision is closed with sutures, and sterile **bandages** are applied to the wound.

### Diagnosis/Preparation

Mitral valve stenosis is diagnosed by history, **physical examination**, listening to the sounds of the

heart (cardiac auscultation), **chest x ray**, and ECG. Patients may have no symptoms of a valve disorder or may have shortness of breath (dyspnea), fatigue, or frank pulmonary edema. Other patients present with atrial fibrillation (a cardiac arrhythmia) or an embolic event. Doppler **echocardiography** is the preferred diagnostic tool for evaluation of mitral valve stenosis, and it can be performed in conjunction with non-invasive **exercise** testing by treadmill or bicycle. **Cardiac catheterization** is reserved for patients who demonstrate discrepancies in Doppler testing. Both left- and right-heart catheterization should be performed in the presence of elevated pulmonary artery pressures.

A diagnosis of mitral insufficiency requires a detailed patient history. Listening to the heart (auscultation) reveals the presence of a third heart sound. Chest x ray and ECG provide additional information. Again, Doppler echocardiography provides valuable information. Exercise testing with Doppler echocardiography can show the true severity of the disease.

After initial findings, patients may be followed with repeat visits and testing to monitor disease progress. If the patient has reached NYHA Class III or IV, replacement is considered. Severe pulmonary hypertension with pulmonary artery systolic pressures greater than 60 mm Hg is considered an indication for surgery. Left ventricular ejection fraction (a measure of blood output with each heartbeat) less than 60% normal also is an indication for surgery.

### Aftercare

The patient receives continued cardiac monitoring in the **intensive care unit** and usually remains in intensive care for 24–48 hours after surgery. Ventilation support is discontinued when the patient is able to breathe on his/her own. If mechanical circulatory support and inotropic agents (a substance that influences the force of muscle contractions, e.g. digitalis) were needed during the surgical procedure, they are discontinued as cardiac function recovers. Tubes draining blood from the chest cavity are removed as bleeding from the surgical procedure decreases. Prophylactic **antibiotics** are given to prevent infective endocarditis and the recurrence of rheumatic carditis.

Both mechanical and biological tissue valves require anticoagulation therapy after surgery, and while patients are hospitalized their anticoagulant status is monitored and dosages are adjusted accordingly. Patients with biological tissue valves can discontinue anticoagulation therapy within three months of valve replacement surgery, but those with mechanical valves must take an anticoagulant (aspirin, warfarin, or a

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Cardiothoracic and cardiovascular surgeons provide surgical treatment. Surgeons are trained during the residency to perform these procedures. Medical centers that perform cardiac surgery are able to provide mitral valve replacement.

combination of the two) for the rest of their lives. These patients are regularly monitored for INR values (a measure of the clotting potential of their blood).

If the patient recovers normally, **discharge from the hospital** occurs within a week of surgery. At discharge, the patient is given specific instructions about **wound care** and infection recognition, as well as contact information for the physician and guidelines about when a visit to the emergency room is indicated. Within three to four weeks after discharge, the patient is seen for follow-up office visit with the physician, at which time physical status will have improved for evaluation. Thereafter, asymptomatic, uncomplicated patients are seen at yearly intervals. Few limitations are placed on patient activity once recovery is complete.

### Risks

There are always risks associated with general anesthesia and cardiopulmonary bypass. Risks specifically associated with mitral valve replacement include embolism, bleeding, and operative valvular endocarditis. Hemolysis (the breakdown of red blood cells) is associated with certain types of mechanical valves, but is not a contraindication for implantation.

### Normal results

Patients treated by mitral valve replacement for mitral insufficiency can expect relief of symptoms. For patients who received mechanical valves, anticoagulation therapy is continued for life. Since thromboembolic complications are associated with initial implant of biological tissue valves, patients who received this type of valve take an anticoagulant for three months after surgery. If non-cardiac surgery or dental care is needed, the anticoagulation therapy is adjusted to prevent bleeding complications.

Patients who undergo mitral valve replacement for mitral stenosis can expect excellent improvement of symptoms. Those patients with symptoms consistent with NYHA class IV before surgery have better

## QUESTIONS TO ASK THE DOCTOR

- Is mitral valve replacement the best treatment option for my condition? Why is it preferable to mitral valve repair?
- How many of these procedures has the surgeon performed in the last year? in the last five years?
- What is the surgeon's morbidity and mortality rate with mitral valve replacement?
- What type of replacement valve, biological tissue or mechanical, is best for me?
- What are the pros and cons of each valve type?
- What type of follow-up care is required during the first year after valve implant and for the rest of my life?
- What types of complications are associated with this surgery?

outcome after mitral valve replacement compared to no treatment.

### Morbidity and mortality rates

Mitral valve replacement carries a 5% risk of **death** in young, healthy patients. With increased age, additional medical problems, or pulmonary hypertension the risk of death increases substantially. Post-replacement the five-year survival is 80%. Patients over the age of 75 have poorer outcomes when mitral valve replacement is used to treat mitral insufficiency.

### Alternatives

Mitral valve replacement is considered only after mitral valve repair has proved inadequate or inappropriate. An asymptomatic patient with a history of rheumatic fever can be treated with prophylactic antibiotics and followed until symptoms appear. If atrial fibrillation develops, drugs may be used to regulate heart rhythm. Anticoagulation therapy is employed to avoid systemic emboli during periods of atrial fibrillation.

### Resources

#### BOOKS

ICON Health Publications. *The Official Patient's Source book on Mitral Valve Prolapse*. San Diego, CA: ICON Health Publications, 2006.



**PERIODICALS**

Bonow, R., et al. "ACC/AHA 2006 Guidelines for the Management of Patients with Valvular Heart Disease." *Circulation*. 114 (2006) e84 e231. <http://circ.ahajournals.org/cgi/reprint/114/5/e84>.

**ORGANIZATIONS**

American Heart Association. 7272 Greenville Avenue, Dallas, TX 75231. (800) 242 8721. <http://www.americanheart.org>.

Mitral Valve Repair Center at Mount Sinai Hospital. 1190 Fifth Avenue, New York, NY 10029 (212) 659 6820. <http://www.mitralvalverepair.org>.

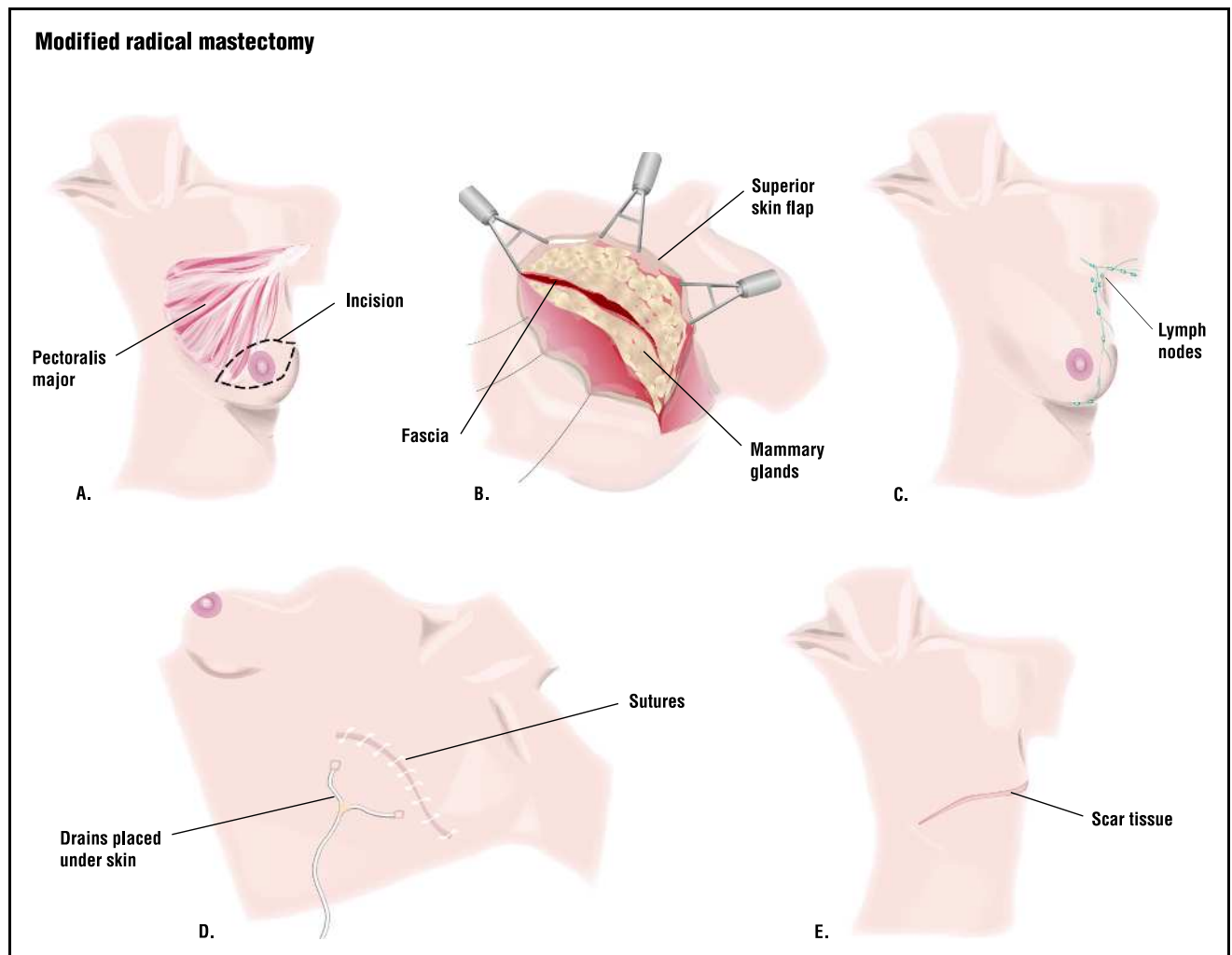
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**Modified radical mastectomy****Definition**

A surgical procedure that removes the breast, surrounding tissue, and nearby lymph nodes that are affected by cancer.

**Purpose**

The purpose for modified radical **mastectomy** is the removal of breast cancer (abnormal cells in the breast that grow rapidly and replace normal healthy tissue). Modified radical mastectomy is the most widely used surgical procedure to treat operable breast



In a modified radical mastectomy, the skin on the breast is cut open (A). The skin is pulled back, and the tumor, lymph nodes, and breast tissue is removed (B and C). The incision is closed (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

cancer. This procedure leaves a chest muscle called the pectoralis major intact. Leaving this muscle in place will provide a soft tissue covering over the chest wall and a normal-appearing junction of the shoulder with the anterior (front) chest wall. This sparing of the pectoralis major muscle will avoid a disfiguring hollow defect below the clavicle. Additionally, the purpose of modified radical mastectomy is to allow for the option of **breast reconstruction**, a procedure that is possible, if desired, due to intact muscles around the shoulder of the affected side. The modified radical mastectomy procedure involves removal of large multiple tumor growths located underneath the nipple and cancer cells on the breast margins.

### Demographics

The highest rates of breast cancer occur in Western countries (more than 100 cases per 100,000 women) and the lowest among Asian countries (10–15 cases per 100,000 women). Men can also have breast cancer, but the incidence is much less when compared to women. There is a strong genetic correlation since breast cancer is more prevalent in females who had a close relative (mother, sister, maternal aunt, or maternal grandmother) with previous breast cancer. Increased susceptibility for development of breast cancer can occur in females who never breastfed a baby, had a child after age 30, started menstrual periods very early, or experienced menopause very late.

The American Cancer Society estimated that in 2007, 240,510 new cases of breast cancer would be diagnosed in the United States and 40,460 women would die as a result of the disease. Approximately one in eight women will develop breast cancer at some point in her life. The risk of developing breast cancer increases with age: women aged 30 to 40 have a one in 252 chance of developing breast cancer; women aged 40 to 50 have a one in 68 chance; women aged 50 to 60 have a one in 35 chance; and women aged 60 to 70 have a one in 27 chance—and these statistics do not even account for genetic and environmental factors.

### Description

The surgeon's goal during this procedure is to minimize any chance of local/regional recurrence; avoid any loss of function; and maximize options for breast reconstruction. Incisions are made to avoid visibility in a low neckline dress or bathing suit. An incision in the shape of an ellipse is made. The surgeon removes the minimum amount of skin and tissue so that remaining healthy tissue can be used for possible reconstruction. Skin flaps are made carefully and as

## KEY TERMS

**Lymphatic system**—A system that filters excess tissue fluids through lymph nodes to return to the bloodstream.

thinly as possible to maximize removal of diseased breast tissues. The skin over a neighboring muscle (pectoralis major fascia) is removed, after which the surgeon focuses in the armpit (axilla, axillary) region. In this region, the surgeon carefully identifies vital anatomical structures such as blood vessels (veins, arteries) and nerves. Accidental injury to specific nerves like the medial pectoral neurovascular bundle will result in destruction of the muscles that this surgery attempts to preserve, such as the pectoralis major muscle. In the armpit region, the surgeon carefully protects the vital structures while removing cancerous tissues. After axillary surgery, breast reconstruction can be performed, if desired by the patient.

### Diagnosis/Preparation

Modified radical mastectomy is a surgical procedure to treat breast cancer. In order for this procedure to be an operable option, a definitive diagnosis of breast cancer must be established. The first clinical sign for approximately 80% of women with breast cancer is a mass (lump) located in the breast. A lump can be discovered by monthly self-examination or by a health professional who can find 10–25% of breast cancers that are missed by yearly mammograms (a low radiation x ray of the breasts). A biopsy can be performed to examine the cells from a lump that is suspicious for cancer. The diagnosis of the extent of cancer and spread to regional lymph nodes determines the treatment course (i.e., whether surgery, chemotherapy, or radiation therapy, either singly or in combinations). Staging the cancer can estimate the amount of tumor, which is important not only for diagnosis but for prognosis (statistical outcome of the disease process). Patients with a type of breast cancer called ductal carcinoma in situ (DCIS), which is a stage 0 cancer, have the best outcome (nearly all these patients are cured of breast cancer). Persons who have cancerous spread to other distant places within the body (metastases) have stage IV cancer and the worst prognosis (potential for survival). Persons affected with stage IV breast cancer have essentially no chance for cure.

Persons affected with breast cancer must undergo the staging of the cancer to determine the extent of

cancerous growth and possible spread (metastasis) to distant organs. Patients with stage 0 disease have non-invasive cancer with a very good outcome. Stages I and II are early breast cancer, without lymph node involvement (stage I) and with node positive results (stage II). Persons with stage III disease have locally advanced disease and about a 50% chance for five-year survival. Stage IV disease is the most severe since the breast cancer cells have spread through lymph nodes to distant areas and/or other organs in the body. It is very unlikely that persons with stage IV metastatic breast cancer survive 10 years after diagnosis.

It is also imperative to assess the degree of cancerous spread to lymph nodes within the armpit region. Of primary importance to stage determination and regional lymph node involvement is identification and analysis of the sentinel lymph node. The sentinel lymph node is the first lymph node to which any cancer would spread. The procedure for sentinel node biopsy involves injecting a radioactively labeled tracer (technetium 99) or a blue dye (isosulphan blue) into the tumor site. The tracer or dye will spread through the lymphatic system to the sentinel node, which should be surgically removed and examined for the presence of cancer cells. If the sentinel node and one or two other neighboring lymph nodes are negative, it is very likely that the remaining lymph nodes will not contain cancerous cells, and further surgery may not be necessary.

Once a breast lump (mass) has been identified by **mammography** or **physical examination**, the patient should undergo further evaluation to histologically (studying the cells) identify or rule out the presence of cancer cells. A procedure called fine-needle aspiration allows the clinician to extract cells directly from the lump for further evaluation. If a diagnosis cannot be established by fine-needle biopsy, the surgeon should perform an open biopsy (surgical removal of the suspicious mass). Preparation for surgery is imperative. The patient should plan for both direct care and recovery time after modified radical mastectomy. Preparation immediately prior to surgery should include no food or drink after midnight before the procedure. Post-surgical preparation should include caregivers to help with daily tasks for several days.

### Aftercare

After breast cancer surgery, women should undergo frequent testing to ensure early detection of cancer recurrence. It is recommended that annual mammograms, physical examination, or additional tests (biopsy) be performed annually. Aftercare can also include psychotherapy since mastectomy is emotionally

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The procedure is typically performed by a surgeon who has received five years of general surgery training and additional training in the specialty of surgical oncology. A surgeon who specializes in the area has expertise in removing cancerous tissues or areas. The procedure is performed in a hospital and requires that the hospital have a surgical care unit. In the surgical care unit, the patient will be treated by a team of professionals that includes, but is not limited to, physicians, nurses, physician assistants, and medical assistants.

traumatic. Affected women may be worried or have concerns about appearance, the relationship with their sexual partner, and possible physical limitations. Community-centered support groups usually made up of former breast cancer surgery patients can be a source of emotional support after surgery. Patients may stay in the hospital for one to two days. For about five to seven days after surgery, there will be one or two drains left inside to remove any extra fluid from the area after surgery. Usually, the surgeon will prescribe medication to prevent pain. Movement restriction should be specifically discussed with the surgeon.

### Risks

There are several risks associated with modified radical mastectomy. The procedure is performed under **general anesthesia**, which itself carries risk. Women may have short-term pain and tenderness. The most frequent risk of breast cancer surgery (with extensive lymph node removal) is edema, or swelling of the arm, which is usually mild, but the presence of fluid can increase the risk of infection. Leaving some lymph nodes intact instead of removing all of them may help lessen the likelihood of swelling. Nerves in the area may be damaged. There may be numbness in the arm or difficulty moving shoulder muscles. There is also the risk of developing a lump scar (keloid) after surgery. Another risk is that surgery did not remove all the cancer cells and that further treatment may be necessary (with chemotherapy and/or radiotherapy). By far, the worst risk is recurrence of cancer. However, immediate signs of risk following surgery include fever, redness in the incision area, unusual drainage from the incision, and

## QUESTIONS TO ASK THE DOCTOR

- What is the prognosis for the stage (0, I, II, III, IV) of my type of cancer?
- Will my movement be restricted after surgery?
- What care will I need on a daily basis following surgery?
- When should we set up a follow-up consultation/examination?
- Will I require other treatment (chemotherapy and/or radiation therapy) following surgery?
- What kind of mental-health treatment should I pursue (psychotherapy, community-centered support groups, etc.) following surgery?
- What options do I have for breast reconstruction? When would that treatment begin?

increasing pain. If any of these signs develop, it is imperative to call the surgeon immediately.

### Normal results

If no complications develop, the surgical area should completely heal within three to four weeks. After mastectomy, some women may undergo breast reconstruction (which can be done during mastectomy). Recent studies have indicated that women who desire cosmetic **reconstructive surgery** have a higher quality of life and better sense of well-being than those who do not utilize this option.

### Morbidity and mortality rates

The outcome of breast cancer is very dependent of the stage at the time of diagnosis. For stage 0 disease, the five-year survival is almost 100%. For stage I (early/lymph node negative), the five-year survival is also almost 100%. For stage II (early/lymph node positive), the five-year survival decreases to 81-92%. For stage III disease (locally advanced), the five-year survival is 54-67%. For women with stage IV (metastatic) breast cancer, the five-year survival is about 20%.

Approximately 17% of patients develop lymphedema after axillary lymph node dissection, while only 3% of patients develop lymphedema after sentinel node biopsy. Five percent of women are unhappy with the cosmetic effects of the surgery.

### Alternatives

There are no real alternatives to mastectomy. Surgical requirement is clear since mastectomy is recommended for tumors with dimensions over 2 in (5 cm). Additional treatment (adjuvant) is typically recommended with chemotherapy and/or radiation therapy to destroy any remaining cancer during surgery. Modified radical mastectomy is one of the standard treatment recommendations for stage III breast cancer.

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- Y ME National Breast Cancer Organization. <http://www.y me.org>.

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## Mohs surgery

### Definition

Mohs surgery, also called Mohs micrographic surgery, is a precise surgical technique that is used to remove all parts of cancerous skin tumors while preserving as much healthy tissue as possible.

### Purpose

Mohs surgery is used to treat cancers of the skin, such as basal cell carcinoma, squamous cell carcinoma, and melanoma.

Malignant skin tumors may occur in strange, asymmetrical shapes. The tumor may have long finger-like projections that extend across the skin (laterally) or down into the skin. Because these extensions may be composed of only a few cells, they cannot be seen or felt. Standard surgical removal (excision) may miss these cancerous cells leading to recurrence of the tumor. To assure removal of all cancerous tissue, a large piece of skin needs to be removed. This causes a cosmetically unacceptable result, especially if the cancer is located on



## KEY TERMS

**Carcinoma**—Cancer that begins in the cells that cover or line an organ.

**Fixative**—A chemical that preserves tissue without destroying or altering the structure of the cells.

**Fixed**—A term used to describe chemically preserved tissue. Fixed tissue is dead so it does not bleed or sense pain.

**Mohs excision**—Referring to the excision of one layer of tissue during Mohs surgery. Also called stage.

the face. Mohs surgery enables the surgeon to precisely excise the entire tumor without removing excessive amounts of the surrounding healthy tissue.

Mohs surgery is performed when:

- The cancer was treated previously and recurred.
- Scar tissue exists in the area of the cancer.
- The cancer is in at least one area where it is important to preserve healthy tissue for maximum functional and cosmetic result, such as on the eyelids, the nose, the ears, and the lips.
- The edges of the cancer cannot be clearly defined.
- The cancer grows rapidly or uncontrollably.

## Demographics

According to the American Cancer Society, about one million people in the United States are diagnosed with non-melanoma skin cancer every year. Another 59,940 people are diagnosed with melanoma. The two most common types of skin cancer are basal cell carcinoma and squamous cell carcinoma, with basal cell carcinoma accounting for more than 90% of all of skin cancers.

Melanoma is the most serious type of skin cancer. Each year in the United States more than 59,940 people are diagnosed with melanoma, and it is becoming more and more common, especially among Western countries. In the United States, the percentage of people who develop melanoma has more than doubled in the past 30 years.

## Description

There are two types of Mohs surgery: fresh-tissue technique and fixed-tissue technique. Of the surgeons who perform Mohs surgery, 72% use only the fresh-tissue technique. The remaining surgeons (18%) use both techniques. However, the fixed-tissue technique is

used in fewer than 5% of patients. The main difference between the two techniques is in the preparatory steps.

### *Fresh-tissue technique*

Fresh-tissue Mohs surgery is performed under **local anesthesia** for tumors of the skin. The area to be excised is cleaned with a disinfectant solution and a sterile drape is placed over the site. The surgeon may outline the tumor using a surgical marking pen, or a dye. A local anesthetic (lidocaine plus epinephrine) is injected into the area. Once the local anesthetic has taken effect, the main portion of the tumor is excised (debulked) using a spoon-shaped tool (curette). To define the area to be excised and to allow for accurate mapping of the tumor, the surgeon makes identifying marks around the lesion. These marks may be made with **stitches, staples**, fine cuts with a scalpel, or temporary tattoos. One layer of tissue is carefully excised (first Mohs excision), cut into smaller sections, and taken to the laboratory for analysis.

If cancerous cells are found in any of the tissue sections, a second layer of tissue is removed (second Mohs excision). Because only the sections that have cancerous cells are removed, healthy tissue can be spared. The entire procedure, including surgical repair of the wound, is performed in one day. Surgical repair may be performed by the Mohs surgeon, a plastic surgeon, or another specialist. In certain cases, wounds may be allowed to heal naturally.

### *Fixed-tissue technique*

With fixed-tissue Mohs surgery, the tumor is debulked, as described previously. Trichloroacetic acid is applied to the wound to control bleeding, followed by a preservative (fixative) called zinc chloride. The wound is dressed and the tissue is allowed to fix for six to 24 hours, depending on the depth of the tissue involved. This period, called the fixation period, can be painful to the patient. The first Mohs excision is performed as described; however, anesthesia is not required because the tissue is dead. If cancerous cells are found, fixative is applied to the affected area for an additional six to 24 hours. Excisions are performed in this sequential process until all cancerous tissue is removed. Surgical repair of the wound may be performed once all fixed tissue has sloughed off—usually a few days after the last excision.

## Diagnosis/Preparation

An oncologist will have diagnosed the skin cancer of the patient using standard cancer diagnostic tools, such as biopsy of the tumor.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Mohs surgery is performed in a hospital setting by highly trained surgeons who are specialists both in dermatology and pathology. With their extensive knowledge of the skin and unique pathologic skills, they are able to remove only diseased tissue, preserving healthy tissue and minimizing the cosmetic impact of the surgery. Only physicians who have also completed a residency in dermatology are qualified for Mohs surgical training. The surgery is very often performed on an outpatient basis, usually in one day.

To prepare for surgery, and under certain conditions (such as the location of the skin tumor or health status of the patient), **antibiotics** may be given to the patient prior to the procedure; this is known as prophylactic antibiotic treatment. Patients are encouraged to eat prior to surgery and also to bring along snacks in case the procedure become lengthy. To reduce the risk of bleeding, the use of **nonsteroidal anti-inflammatory drugs** (NSAIDs), alcohol, vitamin E, and fish oil tablets should be avoided prior to the procedure. The patient who uses over-the-counter **aspirin** or the prescription blood-thinners, brands Coumadin (warfarin, generically) and heparin, should consult with the prescribing physician before adjusting the dosage of any drug.

### Aftercare

Patients should expect to receive specific **wound care** instructions from their physician or surgeon. Generally, however, wounds that have been repaired with absorbable stitches or skin grafts should be kept covered with a bandage for one week. Wounds that have been repaired using nonabsorbable stitches should also be covered with a bandage that should be replaced daily until the stitches are removed one to two weeks later. Signs of infection (e.g., redness, pain, drainage) should be reported to the physician immediately.

### Risks

Using the fresh-tissue technique on a large tumor requires large amounts of local anesthetic that can be toxic. Complications of Mohs surgery include infection, bleeding, scarring, and nerve damage.

Tumors spread in unpredictable patterns. Sometimes a seemingly small tumor is found to be quite

## QUESTIONS TO ASK THE DOCTOR

- How long have you been performing Mohs surgery?
- Will you use the fresh-tissue or fixed-tissue technique?
- Will I have to alter the use of my current medications for this procedure?
- What will you do if you don't find the border of the cancerous lesion?
- How will the wound be repaired?
- Will I need a plastic surgeon to repair the wound?
- What is the cure rate for this type of cancer when treated by Mohs surgery?
- What is the chance that the tumor will recur?
- How often will I have follow-up appointments?

large and widespread, resulting in a much larger excision than was anticipated.

### Normal results

Most skin cancers treated by Mohs surgery are completely removed with minimal loss of normal skin.

### Morbidity and mortality rates

Mohs surgery provides high cure rates for malignant skin tumors. For instance, the five-year recurrence rate for primary basal cell carcinomas treated by Mohs surgery is about 1%. Five-year recurrence rates for other techniques are as follows: surgical excision, 10.1%; curettage and desiccation, 7.7%, radiation therapy, 8.7%, and **cryotherapy**, 7.5%. For squamous cell carcinoma treated by Mohs surgery, the five-year recurrence rate is 3.1% for lesions involving the skin and lip, 5.3% for lesions involving the ear. Other modalities have a 10.9% five-year recurrence rate for lesions involving the skin and lip, and a 18.7% five-year recurrence rate for lesions involving the ear.

### Alternatives

Mohs surgery is a specialized technique that is not indicated for the treatment of every type of skin cancer, and is most appropriately used under specific, well-defined circumstances. The majority of basal cell carcinomas can be treated with very high cure rates by standard methods, including electrodesiccation and curettage (ED&C), local excision, cryosurgery (freezing), and irradiation.

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Mometasone see **Corticosteroids**

MR see **Magnetic resonance imaging**

MRA see **Magnetic resonance angiogram; Magnetic resonance imaging**

MRI see **Magnetic resonance imaging**

MRS see **Magnetic resonance imaging**

MUGA scan see **Multiple-gated acquisition (MUGA) scan**

## Multiple-gated acquisition (MUGA) scan

**Definition**

The multiple-gated acquisition (MUGA) scan, also called a cardiac blood pool study, is a non-invasive nuclear medicine test that enables clinicians to obtain information about heart muscle activity. The scan displays the distribution of a radioactive tracer in the heart. The images of the heart are obtained at intervals

throughout the cardiac cycle, and are used to calculate ejection fraction (an important measure of heart performance) and evaluate regional myocardial wall motion.

**Purpose**

A MUGA scan may be done while the patient is at rest and again with stress. The resting study is usually performed to obtain the ejection fraction of the right and left ventricles, evaluate the left ventricular regional wall motion, assess the effects of cardiotoxic drugs (i.e., chemotherapy), and differentiate the cause of shortness of breath (pulmonary vs. cardiac). Ejection fraction and wall motion are also important measurements made during a stress study, but the stress study is performed primarily to detect coronary artery disease and evaluate angina.

**Description**

The MUGA scan is a series of images that demonstrate the flow of blood through the heart, providing information about heart muscle activity. Before images are taken, a radionuclide is injected into the bloodstream, a process that requires two injections in most health care facilities. The first injection contains a chemical that adheres to red blood cells, and the second contains a radioactive tracer (Tc99m) that attaches to that chemical. Alternatively, the two chemicals can be mixed together first and then injected, but the material tends to accumulate in bone and may obscure the heart.

The pictures are taken via gamma camera driven by a computer program that times the images, processes the information, and performs the mathematical calculations to provide ejection fraction and demonstrate wall motion. Images are obtained at various intervals during the cardiac cycle. Electrodes are placed on the patient so that a time frame can be established, for example, the time period between each "wave" (a part of the cardiac cycle seen on an EKG). The time frame is divided into several intervals, or "multiple gates." The result is a series of pictures showing the left and right ventricles at end-diastole (when the heart is dilated and filled with blood) and end-systole (when the heart is contracted and blood is being pumped out), and a number of stages in between.

A MUGA scan is performed in a hospital nuclear medicine department or in an outpatient facility. It takes approximately 30 minutes to one hour. The patient lies down on a bed alongside the gamma camera, receives the radionuclide injections, and multiple

## KEY TERMS

**Ejection fraction**—The fraction of blood in the ventricle that is ejected during each beat. One of the main advantages of the MUGA scan is its ability to measure ejection fraction, one of the most important measures of the heart's performance.

**Electrocardiogram**—Also known as an EKG, less often as an ECG. A test in which electrodes are placed on the body to record the heart's electrical activities.

**Ischemia**—A decreased supply of oxygenated blood to a body part or organ, often marked by pain and organ dysfunction, as in ischemic heart disease.

**Non-invasive**—A procedure that does not penetrate the body.

images are taken. If a stress study is indicated, the rest study is performed first. In a stress study, the patient usually lies on a special bed fitted with a bicycle apparatus. While an image is being recorded, the patient is asked to cycle for about two minutes, then the resistance of the wheels is increased. After two more minutes of **exercise**, another image is obtained and the resistance is increased again. Blood pressure and ECG are monitored during the procedure. After the stress portion is finished, one more resting, or recovery, study is obtained.

## Preparation

Standard preparation for an ECG is required. Special handling of nuclear materials by a nuclear medicine technologist may be required for the injections.

## Aftercare

The patient may resume normal activities immediately following the test.

## Normal results

A normal MUGA scan should not demonstrate areas of akinesis (lack of movement), or hypokinesis (decreased movement) of the heart muscle walls. Abnormal motion, especially in the left ventricle, is suggestive of an infarct or other myocardial defect. The ejection fraction is a measure of heart function, and should be within the normal limits established by the testing facility.

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## Muscle relaxants

### Definition

Skeletal muscle relaxants are drugs that relax striated muscles (those that control the skeleton). They are a separate class of drugs from the muscle relaxant drugs used during intubations and surgery to reduce the need for anesthesia and facilitate intubation.

### Purpose

Skeletal muscle relaxants may be used for relief of spasticity in neuromuscular diseases such as multiple sclerosis, as well as for spinal cord injury and stroke. They may also be used for pain relief in minor strain injuries and control of the muscle symptoms of tetanus. Dantrolene (Dantrium) has been used to prevent or treat malignant hyperthermia in surgery.



## KEY TERMS

**Central nervous system (CNS)**—The brain and spinal cord.

**Intrathecal**—Introduced into or occurring in the space under the arachnoid membrane that covers the brain and spinal cord.

**Pregnancy category**—A system of classifying drugs according to their established risks for use during pregnancy: category A: controlled human studies have demonstrated no fetal risk; category B: animal studies indicate no fetal risk, and there are no adequate and well-controlled studies in pregnant women; category C: no adequate human or animal studies, or adverse fetal effects in animal studies, but no available human data; category D: evidence of fetal risk, but benefits outweigh risks; category X: evidence of fetal risk, which outweigh any benefits.

**Sedative**—Medicine used to treat nervousness or restlessness.

**Spasm**—Sudden, involuntary tensing of a muscle or a group of muscles.

**Tranquilizer (minor)**—A drug that has a calming effect and is used to treat anxiety and emotional tension.

## Description

The muscle relaxants are divided into two groups: centrally acting and peripherally acting. The centrally acting group appears to act on the central nervous system (CNS), and contains 10 drugs that are chemically different. Only dantrolene has a direct action at the level of the nerve-muscle connection.

Baclofen (Lioresal) may be administered orally or intrathecally (introduced into the space under the arachnoid membrane that covers the brain and spinal cord) for control of spasticity due to neuromuscular disease.

Several drugs, including carisoprodol (Soma), chlorphenesin (Maolate), chlorzoxazone (Paraflex), cyclobenzaprine (Flexeril), diazepam (Valium), metaxalone (Skelaxin), methocarbamol (Robaxin), and orphenadrine (Norflex), are used primarily as an adjunct for rest in management of acute muscle spasms associated with sprains. Muscle relaxation may also be an adjunct to physical therapy in rehabilitation following stroke, spinal cord injury, or other musculoskeletal conditions.

Diazepam and methocarbamol are also used by injection for relief of tetanus.

## Recommended dosage

Dose varies with the drug, route of administration, and purpose. There may be individual variations in absorption that require doses higher than those usually recommended (particularly with methocarbamol). The consumer is advised to consult specific references or ask a doctor for further information.

## Precautions

All drugs in the muscle relaxant class may cause sedation. Baclofen, when administered intrathecally, may cause severe CNS depression with cardiovascular collapse and respiratory failure.

Diazepam may be addictive, and is a controlled substance under federal law.

Dantrolene has a potential for hepatotoxicity. The incidence of symptomatic hepatitis is dose related, but may occur even with a short period of doses at or above 800 mg per day, which greatly increases the risk of serious liver injury. Overt hepatitis has been most frequently observed between the third and twelfth months of therapy. Risk of liver injury appears to be greater in women, in patients over 35 years of age, and in patients taking other medications in addition to dantrolene.

Tizanidine may cause low blood pressure, but this may be controlled by starting with a low dose and increasing it gradually. Rarely, the drug may cause liver damage.

Methocarbamol and chlorzoxazone may cause harmless color changes in urine—orange or reddish purple with chlorzoxazone; and purple, brown, or green with methocarbamol. The urine will return to its normal color when the patient stops taking the medicine.

Most drugs in the muscle relaxant class are well tolerated, but not all of these drugs have been evaluated for safety in pregnancy and breastfeeding.

Baclofen is pregnancy category C. It has caused fetal abnormalities in rats at doses 13 times above the human dose. Baclofen passes into breast milk, so breastfeeding while taking baclofen is not recommended.

Diazepam is category D. All benzodiazepines cross the placenta. Although the drugs appear to be safe for use during the first trimester of pregnancy, use later in pregnancy may be associated with cleft lip and palate. Diazepam should not be taken while breastfeeding. It was found that infants who were breastfed while their mothers took diazepam were excessively sleepy and lethargic.

Dantrolene is category C. In animal studies, it has reduced the rate of survival of the newborn when given in doses seven times the normal human dose. Mothers should not breastfeed while receiving dantrolene.

### Interactions

Skeletal muscle relaxants have many potential drug interactions. It is recommended that individual references be consulted.

Because these drugs cause sedation, they should be used with caution when taken with other drugs that may also cause drowsiness.

The activity of diazepam may be increased by drugs that inhibit its metabolism in the liver. These include cimetidine, oral contraceptives, disulfiram, fluoxetine, isoniazid, ketoconazole, metoprolol, propoxyphene, propranolol, and valproic acid.

Dantrolene may have an interaction with estrogens. Although no interaction has been demonstrated, the rate of liver damage in women over the age of 35 who were taking estrogens is higher than in other groups.

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## Myelography

### Definition

Myelography is an x-ray examination of the spinal canal. A contrast agent is injected through a needle into the space around the spinal cord to display the spinal cord, spinal canal, and nerve roots on an x ray.

### Purpose

The purpose of a myelogram is to evaluate the spinal cord and nerve roots for suspected compression. Pressure on these delicate structures causes pain or other symptoms. A myelogram is performed when precise detail about the spinal cord is needed to make a definitive diagnosis. In most cases, myelography is used after other studies, such as **magnetic resonance imaging** (MRI) or a computed tomography scan (CT), have not provided enough information to be certain of the diagnosis. Sometimes myelography followed by CT scan is an alternative for patients who cannot have an MRI scan, because they have a pacemaker or other implanted metallic device.

A herniated or ruptured intervertebral disc, or related condition such as disc bulge or protrusion, popularly known as a slipped disc, is one of the most common causes for pressure on the spinal cord or nerve roots. The condition is popularly known as a pinched nerve. Discs are pads of fiber and cartilage that contain rubbery tissue. They lie between the vertebrae, or individual bones, which make up the spine.

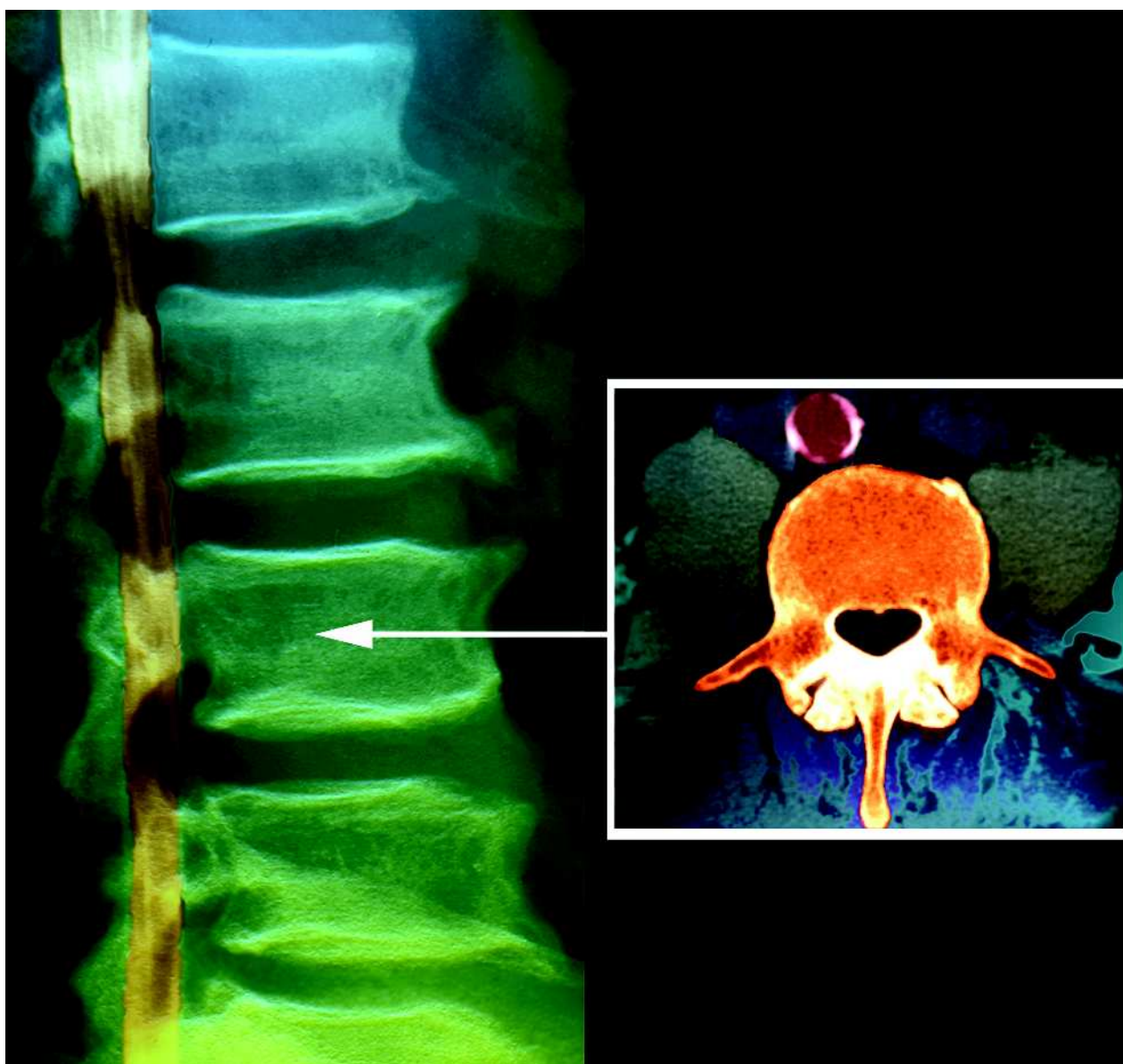
Discs act as cushions, accommodating strains, shocks, and position changes. A disc may rupture suddenly, due to injury or a sudden strain with the spine in an unnatural position. In other cases, the problem may come on gradually as a result of progressive deterioration of the discs with aging. The lower back is the most common area for this problem, but it sometimes occurs in the neck, and rarely in the upper back. A myelogram can help accurately locate the disc or discs involved.

Myelography may be used when a tumor is suspected. Tumors can originate in the spinal cord or in tissues surrounding the cord. Cancers that have started in other parts of the body may spread or metastasize in the spine. It is important to precisely locate the mass causing pressure so effective treatment can be undertaken. Patients with known cancer who develop back pain may require a myelogram for evaluation.

Other conditions that may be diagnosed using myelography include arthritic bony growths (spurs), narrowing of the spinal canal (spinal stenosis), or malformations of the spine.

### Description

Myelograms can be performed in a hospital x-ray department or in an outpatient radiology facility. The patient lies face down on the x-ray table. The radiologist first looks at the spine under fluoroscopy, and the images appear on a monitor screen. This is done to



**Myelogram of the lumbar spine.** (ISM/Phototake. Reproduced by permission.)

find the best location to position the needle. The skin is cleaned, numbed with local anesthetic, and then the needle is inserted. Occasionally, a small amount of cerebrospinal fluid, the clear fluid that surrounds the spinal cord and brain, may be withdrawn through the needle and sent for laboratory studies. Contrast material (dye that shows up on x rays) is then injected.

The x-ray table is tilted slowly, allowing the contrast material to reach different levels in the spinal canal. The flow is observed under fluoroscopy, and x rays are taken with the table tilted at various angles. A footrest and shoulder straps or supports keep the patient from sliding.

In many instances, a CT scan of the spine is performed immediately after a myelogram, while the contrast material is still in the spinal canal. This helps outline internal structures more clearly.

A myelogram takes approximately 30–60 minutes. A CT scan adds about another hour to the examination. If the procedure is done as an outpatient exam, some facilities prefer the patient to stay in a recovery area up to four hours.

Patients who are unable to lie still or cooperate with positioning should not have this examination. Severe congenital spinal abnormalities may make the

## KEY TERMS

**Contrast agent**—Also called a contrast medium, this is usually a barium or iodine dye that is injected into the area under investigation. The dye makes the interior body parts more visible on an x-ray film. For myelograms, an iodine based contrast agent is used.

examination technically difficult to carry out. Patients with a history of severe allergic reaction to contrast material (x-ray dye) should report this to their physician prior to having myelography. Medications to minimize the risk of severe reaction may be recommended before the procedure. Given the invasive nature and risks of myelograms and increased anatomic detail provided by MRI or CT, myelograms are generally not used as the first imaging test.

### Preparation

Patients should be well-hydrated at the time they are undergoing a myelogram. Increasing fluids the day before the study is usually recommended. All food and fluid intake should be stopped approximately four hours before the procedure.

Certain medications may need to be stopped for one to two days before myelography is performed. These include some antipsychotics, antidepressants, blood thinners, and diabetic medications. Patients should discuss this with their physician or the staff at the facility where the study is to be done.

Patients who smoke may be asked to stop the day before the test. This helps decrease the chance of nausea or headaches after the myelogram. Immediately before the examination, patients should empty their bowels and bladder.

### Aftercare

After the examination is complete, the patient usually rests for several hours, with the head elevated. Extra fluids are encouraged, to help eliminate the contrast material and prevent headaches. A regular diet and routine medications may be resumed. Strenuous physical activities, especially those that involve bending over, may be discouraged for one or two days. The physician should be notified if the patient develops a fever, excessive nausea and vomiting, severe headache, or a stiff neck.

### Risks

Headache is a common complication of myelography. It may begin several hours to several days after the examination. The cause is thought to be changes in cerebrospinal fluid pressure, not a reaction to the dye. The headache may be mild and easily alleviated with rest and increased fluids. Sometimes, nonprescription medicines are recommended. In some instances, the headache may be more severe and require stronger medication or other measures for relief. Many factors influence whether the patient develops this problem, including the type of the needle used and his or her age and gender. Patients with a history of chronic or recurrent headaches are more likely to develop a headache after a myelogram.

The chance of a reaction to the contrast material is a very small, but potentially significant risk. It is estimated that only 5–10% of patients experience any effect from contrast exposure. The vast majority of reactions are mild, such as sneezing, nausea, or anxiety. These usually resolve by themselves. A moderate reaction, like wheezing or hives, may be treated with medication, but is not considered life threatening. Severe reactions, such as heart or respiratory failure, occur very infrequently, and require emergency medical treatment.

Rare complications of myelography include injury to the nerve roots from the needle or from bleeding into the spaces around the roots. Inflammation of the delicate covering of the spinal cord, called arachnoiditis, or infections, can also occur. Seizures are another very uncommon complication reported after myelography.

### Normal results

A normal myelogram shows nerves that appear normal, and a spinal canal of normal width, with no areas of constriction or obstruction.

A myelogram may also reveal a herniated disk, tumor, bone spurs, or narrowing of the spinal canal (spinal stenosis).

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**ORGANIZATIONS**

Spine Center. 1911 Arch St., Philadelphia, PA 19103. (215) 665 8300. <http://www.thespinecenter.com>

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## Myocardial resection

### Definition

Myocardial resection is a surgical procedure in which a portion of the heart muscle is removed.

### Purpose

Myocardial resection is done to improve the stability of the heart function or rhythm. Also known as endocardial resection, this open-heart surgery is done to destroy or remove damaged areas. These areas can generate life-threatening heart rhythms. Conditions resulting in abnormal heart rhythms caused by re-entry pathways or aberrant cells are corrected with this treatment.

Areas of the heart involved in a myocardial infarction change in contractility and function, becoming scar tissue that thins and hinders its ability to contract. Removing this diseased area can improve myocardial contractility reversing the severity of chronic heart failure. This procedure has shown promise for patients with chronic heart failure, in order to improve cardiac output and quality of life.

### Demographics

Patients are not limited by age, race or sex when being evaluated for myocardial resection surgery. Patients who experience angina, congestive heart failure, arrhythmias, and pulmonary edema (fluid on the lungs) are candidates for this procedure. Contraindications—conditions in which the surgery is not recommended—include right heart failure, high pressure in the blood coming from left ventricle (lower chamber), and pulmonary hypertension (high blood pressure in the circulation around the lungs).

### Description

After receiving a general anesthetic, an incision will be made in the chest to expose the heart. Cardiopulmonary bypass (to a heart-lung machine) will be instituted since this procedure requires direct visualization of the heart muscle. Since this is a true open

## KEY TERMS

**Arrhythmia**—An abnormal heart rhythm. Examples are a slow, fast, or irregular heart rate.

**Cardiac catheterization**—A diagnostic procedure in which a thin tube is inserted into an artery or vein and guided to the heart using x rays. The function of the heart and blood vessels can be evaluated using this technique.

**Dacron graft**—A synthetic material used in the repair or replacement of blood vessels.

**Ejection fraction**—The amount of blood pumped out at each heartbeat, usually referred to as a percentage.

**Implantable cardioverter-defibrillator**—A device placed in the body to deliver an electrical shock to the heart in response to a serious abnormal rhythm.

**Infarction**—Tissue death resulting from a lack of oxygen to the area.

**Intra-aortic balloon pump**—A temporary device inserted into the femoral artery and guided up to the aorta. The small balloon helps strengthen heart contractions by maintaining improved blood pressure.

**Radiofrequency ablation**—A procedure in which a catheter is guided to an area of heart where abnormal heart rhythms originate. The cells in that area are killed using a mild radiofrequency energy to restore normal heart contractions.

**Wolff-Parkinson-White syndrome**—An abnormal, rapid heart rhythm, due to an extra pathway for the electrical impulses to travel from the atria to the ventricles.

heart procedure, the heart will be unable to pump blood during the surgery.

### *Arrhythmias*

When the exact source of the abnormal rhythm is identified, it is removed. If there are areas around the source that may contribute to the problem, they can be frozen with a special probe. The amount of tissue removed is so small, usually only 2–3 mm, that there is no damage to the structure of the heart.

### *Ventricular reconstruction*

Weakened myocardium (heart muscle) allows the heart to remodel and become less efficient at pumping blood. The goal is to remove the damaged region of the free wall of the left ventricle along with any

involved septum. The heart is then reconstructed to provide a more elliptical structure that pumps blood more efficiently. In some instances a Dacron graft is used to replace the removed myocardium to aid in the reconstruction.

### Diagnosis/Preparation

Diagnosis of arrhythmias begins with a Holter monitor that can identify the type of arrhythmia. This is followed by a **cardiac catheterization** to find the aberrant cells generating the arrhythmia. The patient is then recommended for open-heart surgery to remove the cells generating the arrhythmia.

Diagnosis of chronic heart failure is demonstrated by a cardiac catheterization or nuclear medicine study. During cardiac catheterization, the patient's cardiac function will be measured by cardiac output, ejection fraction and cardiovascular pressures. A nuclear medicine study can demonstrate areas of myocardium that are damaged. Muscle that is akinetic (does not move) will be identified. This information allows the surgeon to identify candidates for myocardial resection.

This is major surgery and should be the treatment of choice only after medications have failed and the use of an **implantable cardioverter-defibrillator** (a device that delivers electrical shock to control heart rhythm) has been ruled out along with medical therapy.

Prior to surgery, the physician will explain the procedure and order blood tests of the formed blood elements and electrolytes.

### Aftercare

Immediately after surgery, the patient will be transferred to the **intensive care unit** for further cardiac monitoring. Any medications to improve cardiac performance will be weaned as necessary to allow the native heart function to return. The patient will be able to leave the hospital within five days, assuming there are no complications. Complications may include the need for intra-aortic balloon pump **ventricular assist device**, surgical bleeding, and infection.

### Risks

The risks of myocardial resection are based in large part on the patient's underlying heart condition and, therefore, vary greatly. The procedure involves opening the heart, so the person is at risk for the complications associated with major heart surgery, such as stroke, shock, infection, and hemorrhage. Since the amount

## WHO PERFORMS THIS PROCEDURE AND WHERE IS IT PERFORMED?

Electrophysiologists, cardiac surgeons and cardiologists, specially trained in cardiac electrical signaling and ventricular reconstruction have undergone specific training in these procedures. The number of patients suitable for these procedures are limited so experienced physicians should be sought to provide medical treatment.

of myocardium to remove is not precise, a patient may demonstrate little benefit in cardiac performance. If not enough or too much tissue is removed, the patient will continue to have heart problems.

General anesthetic with inhalation gases should be avoided as they can promote arrhythmias. Therefore, anesthesia should be limited to intravenous medications.

### Normal results

Postoperative treatment for arrhythmias demonstrates 90% of patients are arrhythmia-free at the end of one year. A study of 245 patients published in 2001, demonstrated a 98% event free survival rate for patients after one year. After five years, 80% of patients had remained event free.

### Morbidity and mortality rates

Cardiopulmonary bypass has an associated risk of complications separate from myocardial resection, with age greater than 70 years of age being a predictor for increased morbidity and mortality. In 1999, over 350,000 total procedures were performed using cardiopulmonary bypass.

In the study of 245 patients, ventricular reconstruction by myocardial resection was found to have an associated in-hospital mortality rate of 78.1%.

### Alternatives

If myocardial resection is being performed to prevent arrhythmia generation, new techniques allow for minimally invasive procedures to be performed, including radiofrequency ablation performed in an electrophysiology laboratory with mild sedation, instead of general anesthetic.

If ventricular restoration is contraindicated, medical treatment will be continued. Mechanical

## QUESTIONS TO ASK THE DOCTOR

- In the past year, how many of these procedures have been performed by the physician?
- What is the standard of care for a patient with arrhythmias/congestive heart failure/angina/pulmonary edema?
- What alternative therapies can be suggested, and what is the difference in survival outcomes at one and five years?
- Where can additional information be found about this procedure?
- What new technologies are available to assist in completing the procedure successfully?
- What are the risks associated with cardiopulmonary bypass?
- What type of post-operative course can be expected?
- How long will it be before normal activities can be reinstituted, such as driving, exercise and returning to work?

circulatory assist with a ventricular assist device may be a suitable option. Heart transplant and total artificial heart should also be explored as alternative therapies.

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#### ORGANIZATIONS

American Heart Association. 7320 Greenville Avenue, Dallas, TX 75231. (800) 242-8721 or (888) 478-7653. <http://www.americanheart.org>.

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Myoglobin test see **Cardiac marker tests**

## Myomectomy

### Definition

Myomectomy is the removal of fibroids (non-cancerous tumors) from the wall of the uterus. Myomectomy is the preferred treatment for symptomatic fibroids in women who want to keep their uterus. Larger fibroids must be removed with an abdominal incision, but small fibroids can be taken out by **laparoscopy** or **hysteroscopy**.

### Purpose

A myomectomy can remove uterine fibroids that are causing symptoms such as abnormal bleeding or pain. It is an alternative to surgical removal of the whole uterus (**hysterectomy**). The procedure can relieve fibroid-induced menstrual symptoms that have not responded to medication. Myomectomy also may be an effective treatment for infertility caused by the presence of fibroids.

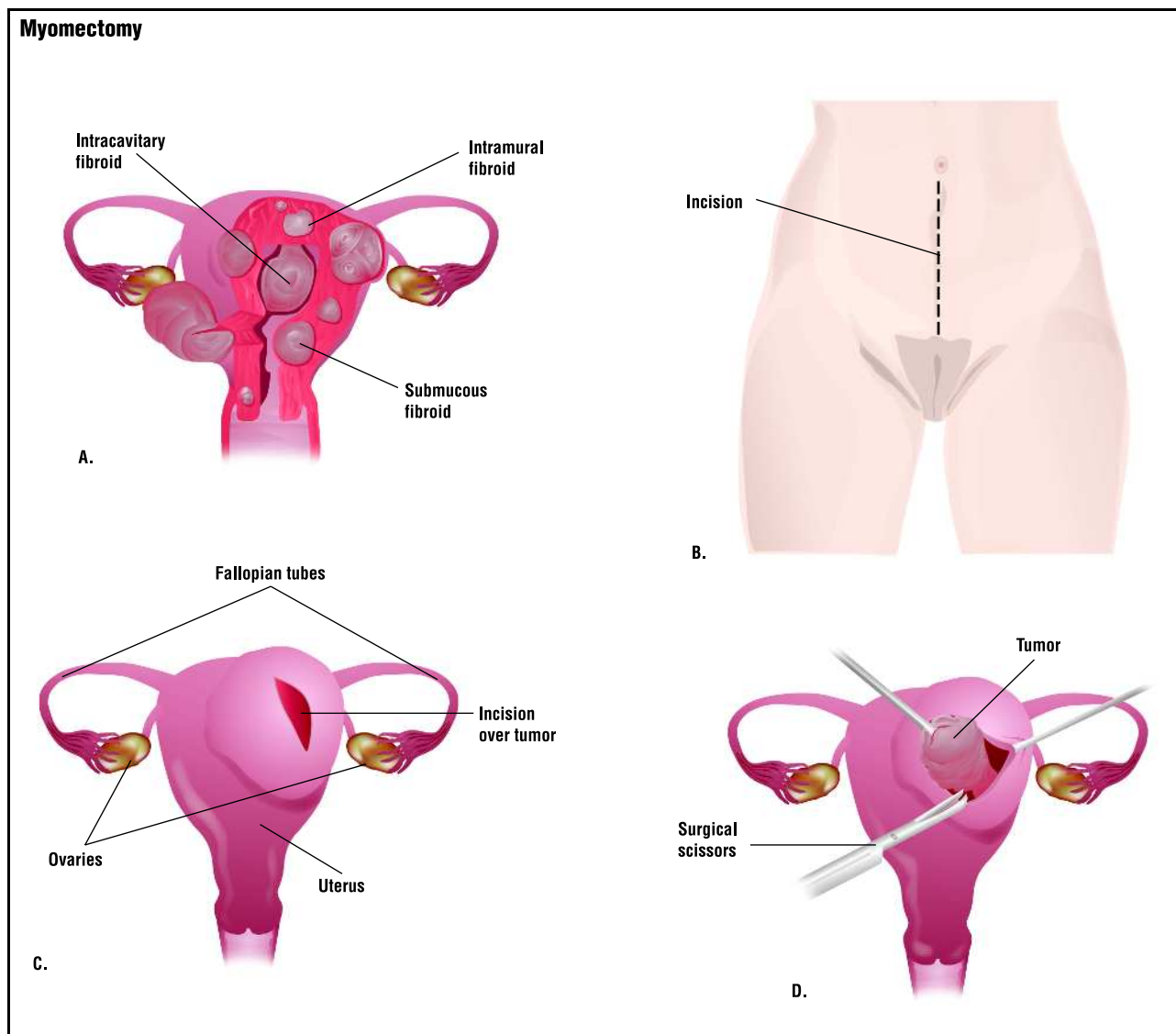
### Demographics

Uterine fibroids are more common among African-American women than among women of other ethnicities. Fibroids affect 20–40% of all women over the age of 35, and 50% of African-American women. A 2001 study by the National Institute of Environmental Health Sciences found that the incidence of fibroids among African-American women in their late 40s was as high as 80%, while approximately 70% of white women of that age were diagnosed as having fibroids. Women who are obese, are older, or started menstruating at an early age are also at an increased risk of developing uterine fibroids. Another study published in 2003 indicated that women with less education were more likely to have a hysterectomy performed to treat fibroids, instead of a less-invasive procedure such as myomectomy.

### Description

Usually, fibroids are buried in the outer wall of the uterus, and abdominal surgery is required. If they are on the inner wall of the uterus, uterine fibroids can be removed using hysteroscopy. If they are on a stalk (pedunculated) on the outer surface of the uterus, laparoscopy can be performed.

Removing fibroids through abdominal surgery is a more difficult and slightly more risky operation than a hysterectomy. This is because the uterus bleeds from the sites where the fibroids were removed, and it may be difficult or impossible to stop the bleeding. This



Uterine fibroids can occur within the uterine cavity, in the mucous layer, or in the muscle (A). To remove them by myomectomy, an incision is made into the woman's lower abdomen (B). An incision is made in the uterus over the tumor (C), and it is removed (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

surgery is usually performed under **general anesthesia**, although some patients may be given a spinal or epidural anesthesia.

The incision may be horizontal (the "bikini" incision) or a vertical incision from the navel downward. After separating the muscle layers underneath the skin, the surgeon makes an opening in the abdominal wall. Next, the surgeon makes an incision over each fibroid, grasping and pulling out each growth.

Every opening in the uterine wall is then stitched with sutures. The uterus must be meticulously repaired in order to eliminate potential sites of bleeding or

infection. The surgeon then sutures the abdominal wall and muscle layers above it with absorbable **stitches**, and closes the skin with clips or non-absorbable stitches.

When appropriate, a laparoscopic myomectomy may be performed. In this procedure, the surgeon removes fibroids with the help of a viewing tube (laparoscope) inserted into the pelvic cavity through an incision in the navel. The fibroids are removed through a tiny incision under the navel that is much smaller than the 4–5 in (10–13 cm) opening required for a standard myomectomy.



## KEY TERMS

**Adhesions**—Bands of scar tissue between organs that can form after surgery or trauma.

**Cesarean section**—A surgical procedure in which incisions are made through a woman's abdomen and uterus to deliver her baby.

**Epidural anesthesia**—A method of pain relief for surgery in which local anesthetic is injected into the epidural space in the middle and lower back.

If the fibroids are small and located on the inner surface of the uterus, they can be removed with a thin, telescope-like device called a hysteroscope. The hysteroscope is inserted into the vagina through the cervix and into the uterus. This procedure does not require any abdominal incision, so hospitalization is shorter.

## Diagnosis/Preparation

Surgeons often recommend hormone treatment with a drug called leuprolide (Lupron) two to six months before surgery in order to shrink the fibroids. This makes the fibroids easier to remove. In addition, Lupron stops menstruation, so women who are anemic have an opportunity to build up their blood count. While the drug treatment may reduce the risk of excess blood loss during surgery, there is a small risk that smaller fibroids might be missed during myomectomy, only to enlarge later after the surgery is completed.

## Aftercare

Patients may need four to six weeks of recovery following a standard myomectomy before they can return to normal activities. Women who have had laparoscopic or hysteroscopic myomectomies, however, can usually recover completely within one to three weeks.

## Risks

The risks of a myomectomy performed by a skilled surgeon are about the same as hysterectomy (one of the most common and safest surgeries). Removing multiple fibroids is more difficult and slightly more risky. Possible complications include:

- infection
- blood loss
- weakening of the uterine wall to the degree that future deliveries need to be performed via cesarean section

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Myomectomies are usually performed in a hospital operating room or an outpatient setting by a gynecologist, a medical doctor who has specialized in the areas of women's general health, pregnancy, labor and childbirth, prenatal testing, and genetics.

- adverse reactions to anesthesia
- internal scarring (and possible infertility)
- reappearance of new fibroids

There is a risk that removal of the fibroids may lead to such severe bleeding that the uterus itself will have to be removed. Because of the risk of blood loss during a myomectomy, patients may want to consider banking their own blood before surgery (**autologous blood donation**).

## Normal results

Removal of uterine fibroids will usually improve any side effects that the patient may have been suffering from, including abnormal bleeding and pain. Under normal circumstances, a woman who has had a myomectomy will be able to become pregnant, although she may have to deliver via **cesarean section** if the uterine wall has been weakened.

## Morbidity and mortality rates

Depending on the surgical approach, the rate of complications for myomectomy is about the same as those for hysterectomy (anywhere between 3% and 9%). The rate of fibroid reoccurrence is approximately 15%. Adhesions (bands of scar tissue between organs that can form after surgery or trauma) occur in 15–53% of women postoperatively.

## Alternatives

Hysterectomy (partial or full removal of the uterus) is a common alternative to myomectomy. The most frequent reason for hysterectomy in the United States is to remove fibroid tumors, accounting for 30% of all hysterectomies. A subtotal (or partial) hysterectomy is the preferable procedure because it removes the least amount of tissue (i.e., the opening to the cervix is left in place).

## QUESTIONS TO ASK THE DOCTOR

- Why is a myomectomy being recommended?
- How many myomectomies do you perform a year?
- What type of myomectomy will be performed?
- What are the risks if I decide against the myomectomy?
- What alternatives to myomectomy are available to me?

Fibroid embolization is a relatively new, less-invasive procedure in which blood vessels that feed the fibroids are blocked, causing the growths to shrink. The blood vessels are accessed via a catheter inserted into the femoral artery (in the upper thigh) and injected with tiny particles that block the flow of blood. The fibroids subsequently decrease in size and the patient's symptoms improve.

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#### ORGANIZATIONS

- American College of Obstetricians and Gynecologists. 409 12th St., SW, P.O. Box 96920, Washington, DC 20090 6920. <http://www.acog.org>.
- Center for Uterine Fibroids, Brigham and Women's Hospital. 623 Thorn Building, 20 Shattuck Street, Boston, MA 02115. (800) 722 5520. <http://www.fibroids.net>.

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## Myringotomy and ear tubes

### Definition

Myringotomy is a surgical procedure in which a small incision is made in the eardrum (the tympanic membrane), usually in both ears. The English word is derived from *myringa*, modern Latin for drum membrane, and *tomē*, Greek for cutting. It is also called myringocentesis, tympanotomy, tympanostomy, or **paracentesis** of the tympanic membrane. Fluid in the middle ear can be drawn out through the incision.

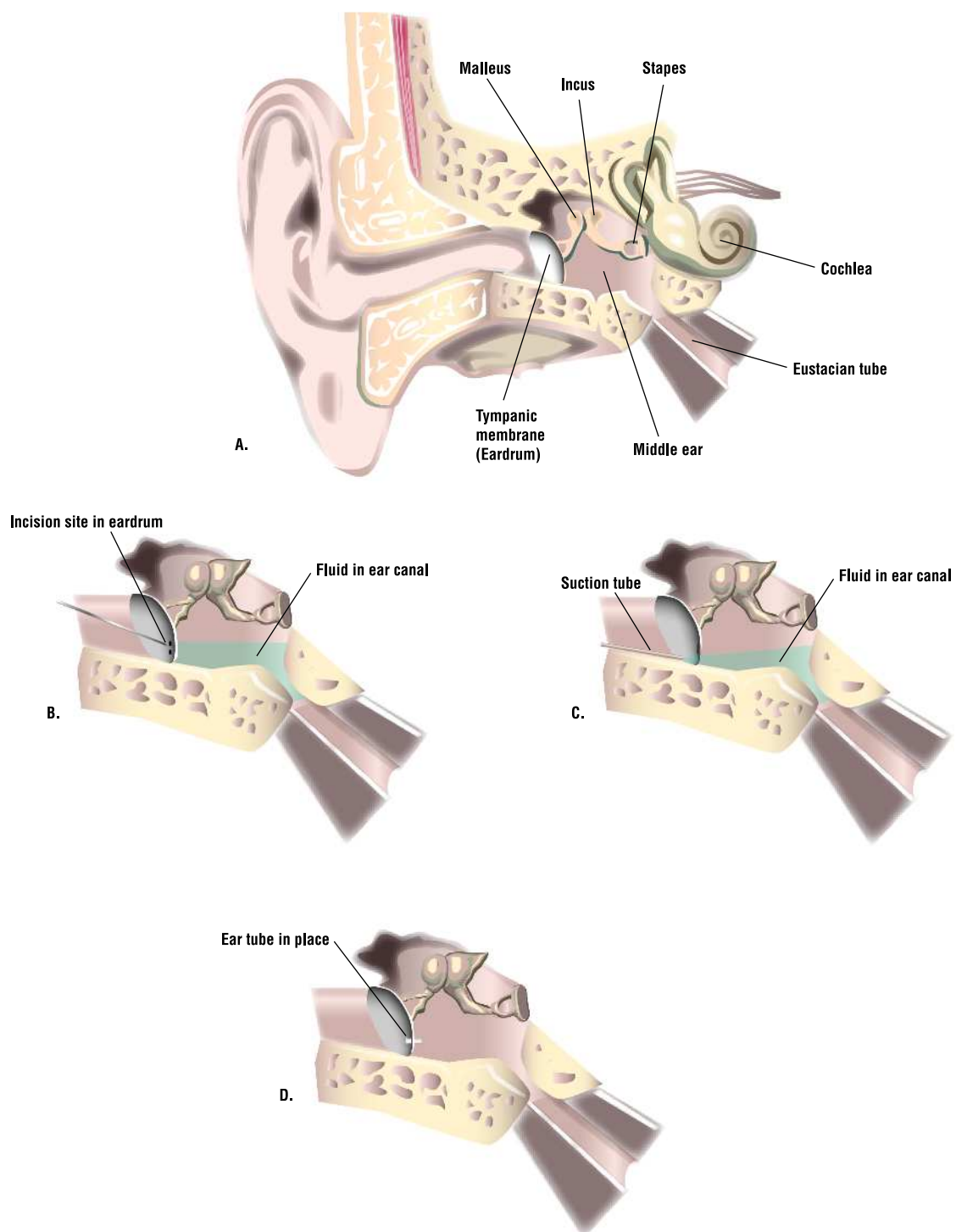
Ear tubes, or tympanostomy tubes, are small tubes open at both ends that are inserted into the incisions in the eardrums during myringotomy. They come in various shapes and sizes and are made of plastic, metal, or both. They are left in place until they fall out by themselves or until they are removed by a doctor.

### Purpose

Myringotomy with the insertion of ear tubes is an optional treatment for inflammation of the middle ear with fluid collection (effusion) that lasts longer than three months (chronic otitis media with effusion) and does not respond to drug treatment. This condition is also called **glue ear**. Myringotomy is the recommended treatment if the condition lasts four to six months. Effusion refers to the collection of fluid that escapes from blood vessels or the lymphatic system. In this case, the effusion collects in the middle ear.

Initially, acute inflammation of the middle ear with effusion is treated with one or two courses of **antibiotics**. Antihistamines and decongestants have been used, but they have not been proven effective unless there is also hay fever or some other allergic inflammation that contributes to the problem. Myringotomy with or without the insertion of ear tubes is *not* recommended for initial treatment of otherwise healthy children with middle ear inflammation with effusion.

## Myringotomy and ear tubes



During a myringotomy, an incision is made into the ear drum, or tympanic membrane (B). The fluid in the ear canal is suctioned out (C), and a small tube is put in place to allow future drainage in the event of an infection (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Acute otitis media**—Inflammation of the middle ear with signs of infection lasting less than three months.

**Adenoids**—Clusters of lymphoid tissue located in the upper throat above the roof of the mouth. Some doctors think that removal of the adenoids may lower the rate of recurrent otitis media in high-risk children.

**Barotrauma**—Ear pain caused by unequal air pressure on the inside and outside of the ear drum. Barotrauma, which is also called pressure-related ear pain or barotitis media, is the most common reason for myringotomies in adults.

**Chronic otitis media**—Inflammation of the middle ear with signs of infection lasting three months or longer.

**Effusion**—The escape of fluid from blood vessels or the lymphatic system and its collection in a cavity, in this case, the middle ear.

**Eustachian tube**—A canal that extends from the middle ear to the pharynx.

**Insufflation**—Blowing air into the ear as a test for the presence of fluid in the middle ear.

**Middle ear**—The cavity or space between the eardrum and the inner ear. It includes the eardrum, the three little bones (hammer, anvil, and stirrup) that transmit sound to the inner ear, and the Eustachian tube, which connects the inner ear to the nasopharynx (the back of the nose).

**Otolaryngologist**—A surgeon who specializes in treating disorders of the ears, nose, and throat.

**Tympanic membrane**—The eardrum. A thin disc of tissue that separates the outer ear from the middle ear.

**Tympanostomy tube**—Ear tube. A small tube made of metal or plastic that is inserted during myringotomy to ventilate the middle ear.

In about 10% of children, the effusion lasts for three months or longer, when the disease is considered chronic. In children with chronic disease, systemic steroids may help, but the evidence is not clear, and there are risks.

When medical treatment doesn't stop the effusion after three months in a child who is one to three years old, is otherwise healthy, and has hearing loss in

both ears, myringotomy with insertion of ear tubes becomes an option. If the effusion lasts for four to six months, myringotomy with insertion of ear tubes is recommended.

The purpose of myringotomy is to relieve symptoms, to restore hearing, to take a sample of the fluid to examine in the laboratory in order to identify any microorganisms present, or to insert ear tubes.

Ear tubes can be inserted into the incision during myringotomy and left there. The eardrum heals around them, securing them in place. They usually fall out on their own in six to 12 months or are removed by a doctor.

While the tubes are in place, they keep the incision from closing, keeping a channel open between the middle ear and the outer ear. This allows fresh air to reach the middle ear, allowing fluid to drain out, and preventing pressure from building up in the middle ear. The patient's hearing returns to normal immediately and the risk of recurrence diminishes.

## Demographics

In the United States, myringotomy and tube placement have become a mainstay of treatment for recurrent otitis media in children. More than 500,000 procedures are performed annually, making myringotomy the most common pediatric, ambulatory operation performed in the U.S.

Myringotomy in adults is a less common procedure than in children, primarily because adults benefit from certain changes in the anatomy of the middle ear that occur after childhood. In particular, the adult ear is less likely to accumulate fluid because the Eustachian tube, which connects the middle ear to the throat area, lies at about a 45-degree angle from the horizontal. This relatively steep angle means that the force of gravity helps to keep fluids from the throat containing disease organisms out of the middle ear. In children, however, the Eustachian tube is only about 10 degrees above the horizontal, which makes it relatively easy for disease organisms to migrate from the nose and throat into the inner ear. Myringotomies in adults are usually performed as a result of barotrauma, which is also known as pressure-related ear pain or barotitis media. Barotrauma refers to earache caused by unequal air pressure on the inside and outside of the eardrum. Adults with very narrow Eustachian tubes may experience barotrauma in relation to scuba diving, using elevators, or frequent flying. A myringotomy with tube insertion may be performed if the condition is not helped by decongestants or antibiotics.



Most myringotomies in children are performed in children between one to two years of age. One Canadian study found that the number of myringotomies performed was 12.8 per thousand for children 11 months old or younger; 54.2 per thousand for children between 12 and 23 months old; and 11.1 per thousand for children between three and 15 years old. Sex and race do not appear to affect the number of myringotomies in any age group, although boys are reported to have a slightly higher rate of ear infections than girls.

## Description

When a conventional myringotomy is performed, the ear is washed, a small incision made in the eardrum, the fluid sucked out, a tube inserted, and the ear packed with cotton to control bleeding.

Recent developments include the use of medical acupuncture to control pain during the procedure, and the use of carbon dioxide lasers to perform the myringotomy itself. Laser-assisted myringotomy can be performed in a doctor's office with only a local anesthetic. It has several advantages over the older technique: it is less painful; less frightening to children; and minimizes the need for tube insertion because the hole in the eardrum produced by the laser remains open longer than an incision done with a scalpel.

Another technique to keep the incision in the eardrum open without the need for tube insertion is application of a medication called mitomycin C, which was originally developed to treat bladder cancer. The mitomycin prevents the incision from sealing over. As of 2007, however, this approach is still being studied.

There has also been an effort to design ear tubes that are easier to insert or to remove, and to design tubes that stay in place longer. As of 2003, ear tubes come in various shapes and sizes.

## Diagnosis/Preparation

The diagnosis of otitis media is based on the doctor's visual examination of the patient's ear and the patient's symptoms. Patients with otitis media complain of earache and usually have a fever, sometimes as high as 105°F (40.5°C). There may or may not be loss of hearing. Small children may have nausea and vomiting. When the doctor looks in the ear with an otoscope, the patient's eardrum will look swollen and may bulge outward. The doctor can evaluate the presence of fluid in the middle ear either by blowing air into the ear, known as insufflation, or by tympanometry, which is an indirect measurement of the mobility of the eardrum. If the eardrum has already ruptured,

there may be a watery, bloody, or pus-streaked discharge.

Fluid removed from the ear can be taken to a laboratory for culture. The most common bacteria that cause otitis media are *Pneumococcus*, *Haemophilus influenzae*, and *Moraxella catarrhalis*. Some cases are caused by viruses, particularly respiratory syncytial virus (RSV).

A child scheduled for a myringotomy should not have food or water for four to six hours before anesthesia. Antibiotics are usually not needed.

If **local anesthesia** is used, a cream containing lidocaine and prilocaine is applied to the ear canal about 30 minutes before the myringotomy. If medical acupuncture is used for pain control, the acupuncture begins about 40 minutes before surgery and is continued during the procedure.

## Aftercare

The use of antimicrobial drops is controversial. Water should be kept out of the ear canal until the eardrum is intact. A doctor should be notified if the tubes fall out.

## Risks

The risks include:

- cutting the outer ear
- formation at the myringotomy site of granular nodes due to inflammation
- formation of a mass of skin cells and cholesterol in the middle ear that can grow and damage surrounding bone (cholesteatoma)
- permanent perforation of the eardrum

It is also possible that the incision won't heal properly, leaving a permanent hole in the eardrum. This result can cause some hearing loss and increases the risk of infection.

The ear tube may move inward and get trapped in the middle ear, rather than move out into the external ear, where it either falls out on its own or can be retrieved by a doctor. The exact incidence of tubes moving inward is not known, but it could increase the risk of further episodes of middle-ear inflammation, inflammation of the eardrum or the part of the skull directly behind the ear, formation of a mass in the middle ear, or infection due to the presence of a foreign body.

The surgery may not be a permanent cure. As many as 30% of children undergoing myringotomy

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Myringotomies are performed by family practitioners, pediatricians, and otolaryngologists, who are surgeons who specialize in treating disorders of the ears, nose, and throat.

A conventional myringotomy is usually done in an ambulatory surgical unit under general anesthesia, although some physicians do it in the office with sedation and local anesthesia, especially in older children and adults. In either case, it is considered same-day surgery. Laser-assisted myringotomies are usually performed in doctors' offices or outpatient surgery clinics.

with insertion of ear tubes need to undergo another procedure within five years.

The other risks include those associated with sedatives or **general anesthesia**. Some patients may prefer acupuncture for pain control in order to minimize these risks.

An additional element of **postoperative care** is the recommendation of many doctors that the child use ear plugs to keep water out of the ear during bathing or swimming to reduce the risk of infection and discharge.

### Normal results

Parents often report that children talk better, hear better, are less irritable, sleep better, and behave better after myringotomy with the insertion of ear tubes. Normal results in adults include relief of ear pain and ability to resume flying or deep-sea diving without barotrauma.

### Morbidity and mortality rates

Morbidity following myringotomy usually takes the form of either otorrhea, which is a persistent discharge from the ear, or changes in the size or texture of the eardrum. The risk of otorrhea is about 13%. If the procedure is repeated, the eardrum may shrink, retract, or become flaccid. The eardrum may also develop an area of hardened tissue. This condition is known as tympanosclerosis. The risk of hardening is 51%; its effects on hearing aren't known, but they appear to be insignificant.

## QUESTIONS TO ASK THE DOCTOR

- What alternatives to myringotomy might work for my child?
- How can I lower my child's risk of recurrent ear infections?
- Do you perform laser-assisted myringotomies?
- What is your opinion of removing my child's adenoids to lower the risk of future hospitalizations?

A report published in 2002 indicates that morbidity following myringotomy in the United States is highest among children from families of low socioeconomic status. The study found that children from poor urban families had more episodes of otorrhea following tube insertion than children from suburban families. In addition, the episodes of otorrhea in the urban children lasted longer.

Mortality rates are extremely low; case studies of fatalities following myringotomy are rare in the medical literature, and most involve adults.

### Alternatives

#### *Preventive measures*

There are several lifestyle issues related to high rates of middle ear infection. One of the most serious is parental smoking. One study of the effects of passive smoking on children's health estimated that as many as 165,000 of the myringotomies performed each year on American children are related to the use of tobacco in the household.

Studies have shown that children in daycare have a higher risk of chronic ear infection, and therefore a higher risk of needing myringotomy..

A third factor that affects a child's risk of recurrent middle ear infection is breastfeeding. Toddlers who were breastfed as infants for at least four months have a lower risk of ear infection than those who were bottlefed.

#### *Other surgical approaches*

Because the adenoids may harbor infection, when myringotomy and tube placement fails, **adenoidectomy** may be performed in order to resolve chronic otitis media.

*Alternative medicine*

According to Dr. Kenneth Pelletier, former director of the program in complementary and alternative medicine at Stanford University, there is some evidence that homeopathic treatment is effective in reducing the pain of otitis media in children and lowering the risk of recurrence.

**Resources****BOOKS**

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Siegel, G. J., and R. K. Chandra. "Laser Office Ventilation of Ears with Insertion of Tubes." *Otolaryngology Head and Neck Surgery* 127 (July 2002): 60-66.

**ORGANIZATIONS**

- American Academy of Medical Acupuncture (AAMA). 4929 Wilshire Boulevard, Suite 428, Los Angeles, CA 90010. (323) 937-5514. <http://www.medicalacupuncture.org>.
- American Academy of Otolaryngology, Head and Neck Surgery, Inc. One Prince Street, Alexandria, VA 22314 3357. (703) 836-4444. <http://www.entnet.org>.
- American Academy of Pediatrics (AAP). 141 Northwest Point Boulevard, Elk Grove Village, IL 60007. (847) 434-4000. <http://www.aap.org>.

Mary Zoll, PhD  
Rebecca Frey, PhD

# N

Narcotics see **Analgesics, opioid**

Nasal septum surgery see **Septoplasty**

## Necessary surgery

### Definition

Necessary surgery is a term that refers both to a medical requirement for the surgery determined by a physician and to an insurance plan's inclusion of the surgery in the covered conditions. For the most part, these two ways of talking about required surgery coincide. When they do not, the physician is asked to demonstrate to the insurance plan that the surgery is necessary by reference to the medical condition to be treated and the customary medical practice that deems it required as opposed to optional or elective.

### Purpose

Not all surgery is an emergency. Not all surgery is medically required. Some surgeries are for cosmetic or for aesthetic enhancements and are deemed optional or elective, both by physicians and by insurance plans.

Necessary surgery refers to surgical procedures that pertain to a condition that cannot be treated by other methods and, if left untreated, would threaten the life of the patient, fail to repair or improve a body function, increase the patient's pain, or prevent the diagnosis of a serious or painful condition. The emphasis here is that, according to medical judgment, surgery is mandated.

Not all necessary surgery is absolutely required until the patient is satisfied that he or she has all the information needed to opt for surgery. All surgery has risks and the decision to have surgery is one that needs to be made by both the physician and the patient.

### Description

The decision to have surgery should be made by the patient after:

- complete evaluation by a physician to determine if the surgery is medically indicated
- discussion with the physician about alternative treatments
- discussion that allows the patient to understand why the surgery is necessary, what the surgery involves, and why the particular procedure has been chosen by the surgeon
- discussion of the complete risks and benefits of the procedure
- second opinion has been enlisted about the surgery and its components and/or alternatives (Many health insurance plans require this step and will pay for the second opinion.)

Only after a physician has taken the condition and symptoms into account with a complete evaluation of alternatives, will surgery be judged to be necessary. During the course of this evaluation, and after non-surgical treatments have failed, the patient needs to be actively involved in understanding the actual procedure that might mitigate the condition, the full array of risks and benefits of the surgery, and why the surgeon has arrived at the particular procedure. The patient should understand the likelihood of danger or risk if he or she foregoes the surgery and the patient needs to understand that there may be a possibility of improvement, given sufficient time, without the surgery. Before choosing to undergo a particular surgical procedure, the patient should get a **second opinion** about the wisdom, efficacy, risk, and benefits of the procedure.

### Diagnosis/Preparation

Preparation for surgery should include knowing:



## KEY TERMS

**Alternatives to surgery**—Other treatments for the condition or illness that do not involve surgery; these are usually tried before surgery is an option.

**Elective surgery**—Surgery chosen by someone over 18 and/or a guardian for a patient that is not medically required for an illness, condition, or pain relief.

**Surgical alternatives**—Surgical options within a range of surgical procedures used to treat a specific condition.

- Where surgery will take place and the length of stay in the hospital. Some insurance companies may press for shorter hospital stays.
- What pain medication will be used, and how medications for home use will be ordered for discharge. The physician should know all medications that are currently being taken.
- Who will make decisions on the patient's behalf and with what legal authority, should the patient be unable to make a decision in the hospital. The physician and the nursing team need to know who this "patient advocate" is.
- What the visiting hours, rules, and limits on children are.
- That the hospital plans to accommodate any dietary restrictions the patient may have.
- That there is sufficient at-home assistance and resources for the patient upon discharge.
- The dietary and behavioral requirements for the days just preceding surgery.

## Resources

### BOOKS

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### ORGANIZATIONS

Patient Rights and Responsibilities. Agency for Health Care Research and Quality. <http://www.consumer.gov/qualityhealth/rights.htm/>.

Questions To Ask Your Doctor Before You Have Surgery. Agency for Health Care Research and Quality. <http://www.ahcpr.gov/consumer/surgery.htm#head2/>.

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Nancy McKenzie, PhD

Neck dissection see **Radical neck dissection**

## Needle bladder neck suspension

### Definition

Needle bladder neck suspension, also known as needle suspension, or paravaginal surgery, is performed to support the hypermobile, or moveable urethra using sutures to attach it to tissues covering the pelvic floor. Of the three popular surgical procedures for urethral instability and its results in urinary stress incontinence, needle bladder neck suspension is the quickest and easiest to perform. It has many variants, such as the Raz, Stamey, modified Pereyra, or Gattes procedures, but its long-term results are less impressive than other, more extensive, anti-incontinent surgeries.

### Purpose

Fifty years of work to treat incontinence, especially in women, has resulted in three types of surgery tied to essentially three causes of a particular type of incontinence related to muscle weakening of the urethra and the "gate-keeping" sphincter muscles. Stress urinary incontinence, the uncontrollable leakage of urine when pressure is put on the bladder during sneezing, coughing, laughing, or exercising, is very common in women. It is estimated to affect 50% of elderly women in long-term care facilities. The inability to hold urine has two causes. One has to do with support for the urethra and bladder, known as genuine stress incontinence (GSI), and the other is related to the inability of sphincter muscles, or intrinsic sphincter deficiency (ISD), to keep the opening of the bladder closed.

In GSI, weak muscles supporting the urethra allow it to be displaced and/or descend into the pelvic-floor fascia (connective tissues) and create cystoceles, or pockets. The goal of surgery for GSI is to stabilize the suburethral fascia to prevent the urethra from being overly mobile during increased abdominal pressure.

The other major source of stress incontinence is due to weakening of the internal muscles of the sphincter, as they affect closure of the bladder. These muscles, called the intrinsic sphincter muscles, regulate the opening and

## KEY TERMS

**Genuine stress incontinence (GSI)**—A specific term for a type of incontinence that has to do with the instability of the urethra due to weakened support muscles.

**Hypermobile urethra**—A term that denotes the movement of the urethra that allows for leakage or spillage of urine.

**Intrinsic sphincter deficiency**—A type of incontinence caused by the inability of the sphincter muscles to keep the bladder closed.

**Urinary stress incontinence**—The involuntary release of urine due to pressure on the abdominal muscles during exercise or laughing or coughing.

closing of the bladder when a decision is made to urinate. Deficiency of the intrinsic sphincter muscles causes the opening to remain open and thus leads to chronic incontinence. ISD is a source of severe stress incontinence and may be combined with urethral hypermobility.

The challenge of surgery for stress incontinence is to adequately evaluate the actual source of incontinence, whether GSI or ISD, and also to determine the likelihood of cystoceles that may need repair. Under good diagnostic conditions, surgery for stress incontinence will utilize a suprapubic (above the pubic area) procedure, or Burch procedure, to secure the hypermobile urethra and stabilize it in a neutral position. Surgery for ISD uses what is known as a **sling procedure**, or “hammock” effect, that uses auxiliary tissue to undergird the urethra and provide contractive pressure to the sphincter. Most stress incontinence surgeries fall into one of these two procedures and their variants.

Needle neck bladder suspension, the third most utilized procedure for stress incontinence, simply attempts to attach the urethra neck to the posterior pelvic wall through the vagina or abdomen in order to stabilize the urethra. It is, however, considered a poor choice in comparison to the other two procedures because of its lack of long-term efficacy and its high incidence of urinary retention as an operative complication.

## Demographics

More than 13 million people in the United States, both males and females, have urinary incontinence. Women experience it twice as often as men due to pregnancy, childbirth, menopause, and the structure of the female urinary and gynecological systems. Anyone can become incontinent due to neurological injury, birth

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Surgery is performed by a urological surgeon who has a medical degree with advanced training in urology and in surgery. Surgery is performed in a general hospital.

defects, cardiac conditions, multiple sclerosis, and chronic conditions in later life. Incontinence does not naturally accompany old age but is associated with many chronic conditions that occur as age increases. Incontinence is highly associated with obesity and lack of **exercise**. As many as 15–30% of adults over 60 have some form of urinary incontinence. Stress incontinence is, by far, the most frequent form of incontinence and is the most common type of bladder control problem in younger and middle-age women.

## Description

Needle bladder neck suspension surgery can be performed as open abdominal or vaginal surgery, or laproscopically, which allows for small incisions, video magnification of the operative field, and precise placement of sutures. Under a general anesthetic, the patient is placed in a position on her back with legs in stirrups allowing access to the suprapubic area. A Foley catheter is inserted into the bladder. The open procedure involves the passage of a needle from the suprapubic area to the vagina with multiple sutures through looping. Cytoscopic monitoring (using an endoscope passed into the urethra) prevents passage of the needle through the bladder or the urethra. The laparoscopic method allows visualization of the needle pass made from the suprapubic area to the vagina and the looping technique. The vagina and the surrounding areas are thoroughly irrigated with an antibiotic solution throughout the procedure. The patient is discharged the same evening or the next morning with the catheter in place. She is kept on **antibiotics** and examined on the fourth day after surgery with the removal of the catheter. The follow-up examination includes wound inspection and a evaluation of residual urine. A pelvic examination is performed to check for bleeding or injury.

## Diagnosis/Preparation

Stress urinary incontinence can have a number of causes. It is important that patients confer with their physicians to rule out medication-related, psychological, and/or behavioral sources of incontinence as well as physical and neurological causes. This involves complete medical history, as well as medication, clinical,

## QUESTIONS TO ASK THE DOCTOR

- Is surgery my only alternative to living with urinary incontinence?
- Are there other surgical procedures that are more effective for my incontinence?
- Can you recommend any literature I can read that explains my surgical options for incontinence?
- Can you explain why this procedure is preferable to what is known as a “sling procedure?”

neurological, and radiographic evaluations. Once these are completed, urodynamic tests that evaluate the urethra, bladder, flow, urine retention, and leakage, are performed and allow the physician to determine the primary source of the stress incontinence. Patients who are obese and/or engage in high-impact exercise are not good candidates for this surgery. Patients with ISD may not be cured with this procedure, since it is primarily intended to treat the hypermobile urethra.

### Morbidity and mortality rates

**Urologic surgery** has inherent morbidity and mortality risks related primarily to **general surgery**, with lung conditions, blood clots, infections, and cardiac events occurring in a small percentage of surgeries, independent of the type of procedure. In addition, the American Urological Association (AUA) has concluded that needle suspension surgery has a number of complications related directly to suturing in the suprapubic area. These complications include:

- a 5% incidence of bladder injury
- urethral injury, although rare, in a small percentage of cases
- bleeding, with an incidence of 3–5%, primarily from the area below the pubic area
- nerve entrapment (8–16% of cases) due to lateral placement of the sutures into the fascia at the back of the suprapubic area (This has improved with a change in the placement of sutures.)
- wound infections in about 7% of cases, with higher rates among those with diabetes or obesity

These operative complications, coupled with the procedure's high rate (10%) of reported pain after surgery, and its relatively high rate (5%) of urinary retention lasting longer than four weeks, have resulted in needle neck suspension having a limited role in the management of stress urinary incontinence.

### Normal results

Despite modifications in the needle suspension procedure, the long-term outcome of the procedure does not indicate its lasting efficacy. According to a recent report by the AUA, a study of the effects of needle suspension found only a 72-91% cure, or “dry rate,” after 48 months, with delayed failures of sutures in a very high percentage (33-80%) of cases.

### Resources

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- Takahashi, S., et al. “Complications of Stamey Needle Suspension for Female Stress Urinary Incontinence.” *Urology International* 86 (January 2002): 148–151.

#### ORGANIZATIONS

- American Foundation for Urologic Diseases. The Bladder Health Council. 300 West Pratt Street, Suite 401, Baltimore, MD 21201.
- American Urological Association. 1120 North Charles Street, Baltimore, MD 21201. (410) 727 1100. Fax: 410 223 4370. <http://www.urologyhealth.org>.
- The Simon Foundation for Continence. P.O. Box 835, Wilmette, IL 60091. (800) 237 simon or (800) 237 4666. Toll free (847) 864 3913. (847) 864 9758.

#### OTHER

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Nancy McKenzie, PhD

Needle suspension see **Needle bladder neck suspension**

Needles see **Syringe and needle**

## Negative pressure rooms

### Definition

A negative pressure room is a volumetric space in which the internal atmospheric pressure is lower than the spaces into which it opens.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

An infectious disease or emergency physician usually admits patients to negative pressure rooms in hospitals or other healthcare facilities.

### Purpose

The purpose of a negative pressure room is to confine pathogens to a single closed environment and to prevent the release of pathogens into other adjacent spaces.

### Demographics

Official counts of negative pressure rooms do not exist. Experts estimate that approximately 4000-5000 negative pressure rooms exist in hospitals throughout the United States.

### Description

A negative pressure room is designed to confine pathogens to a small volume of space. It is also intended to prevent the accidental release of pathogens into a greater space thereby protecting workers and employees in a hospital or other healthcare facility.

All communications between a negative pressure room and adjacent spaces are controlled. Communications include doors and ventilations ducts. These are sealed. Air flow is controlled by airlocks for human travel and vacuum pumps for ventilation systems.

### Diagnosis/Preparation

Negative pressure rooms require special construction. All points of entrance or egress must be able to be tightly sealed so that air cannot pass by the seals. The room ventilation system must be equipped with a vacuum pump that must create a constant but relatively low level vacuum. This creates the negative pressure.

In operation, the vacuum created stops the outflow of air, thus containing

Two doors, separated by at least 6 feet, must be installed to create an airlock. Only one door is opened at a time. This preserves the vacuum, maintains the negative pressure and prevents pathogens from escaping.

## QUESTIONS TO ASK YOUR DOCTOR

- Why am I being confined in a negative pressure room?
- What treatment options do I have?

All air exhausted from the room is routed through special filters that are designed to trap and contain pathogens.

Negative pressure rooms are used when the presence of an airborne pathogen such as tuberculosis is suspected.

### Aftercare

Entrance and egress protocols must be followed by all people that enter or leave a negative pressure room.

Seals on vents and airlocks must be checked on a regular basis.

Negative pressure rooms must be decontaminated before being cleaned after being occupied.

### Risks

Seal, pump or protocol failure destroys the negative pressure and increases the chances that pathogens will be released.

Inadequate cleaning after occupancy puts subsequent occupants at risk of exposure to a potentially dangerous pathogen.

### Normal results

In a properly operating negative pressure room, the expected and normal result is containment of a potentially dangerous pathogen.

### Morbidity and mortality rates

Data on morbidity and mortality related to negative pressure rooms is not available.

### Alternatives

The only feasible alternative to a negative pressure room is quarantine and isolation. This practice is very difficult to enforce. Even when enforced, it is not as microbiologically efficient.



## KEY TERMS

**Anthrax**—A dangerous pathogen that should be contained in a negative pressure room.

**Ebola virus** —A dangerous pathogen that should be contained in a negative pressure room.

**Tuberculosis**—A dangerous pathogen that should be contained in a negative pressure room.

## Resources

### BOOKS

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- McGhee, M. *A Guide to Laboratory Investigations*. 5th ed. Oxford, UK: Radcliffe Publishing Ltd, 2008.
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### ORGANIZATIONS

- American Academy of Family Physicians. 11400 Tomahawk Creek Parkway, Leawood, KS 66211–2672. (913) 906–6000. E mail: fp@aafp.org. <http://www.aafp.org>.
- American Academy of Pediatrics. 141 Northwest Point Boulevard, Elk Grove Village, IL 60007–1098. (847)

434 4000, Fax: (847) 434 8000. E mail: kidsdoc@aap.org. <http://www.aap.org/default.htm>.

American College of Physicians. 190 N. Independence Mall West, Philadelphia, PA 19106–1572. (800) 523–1546, x2600, or (215) 351–2600. <http://www.acponline.org>.

American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464–5000. <http://www.ama-assn.org>.

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## Nephrectomy

### Definition

A nephrectomy is a surgical procedure for the removal of a kidney or section of a kidney.

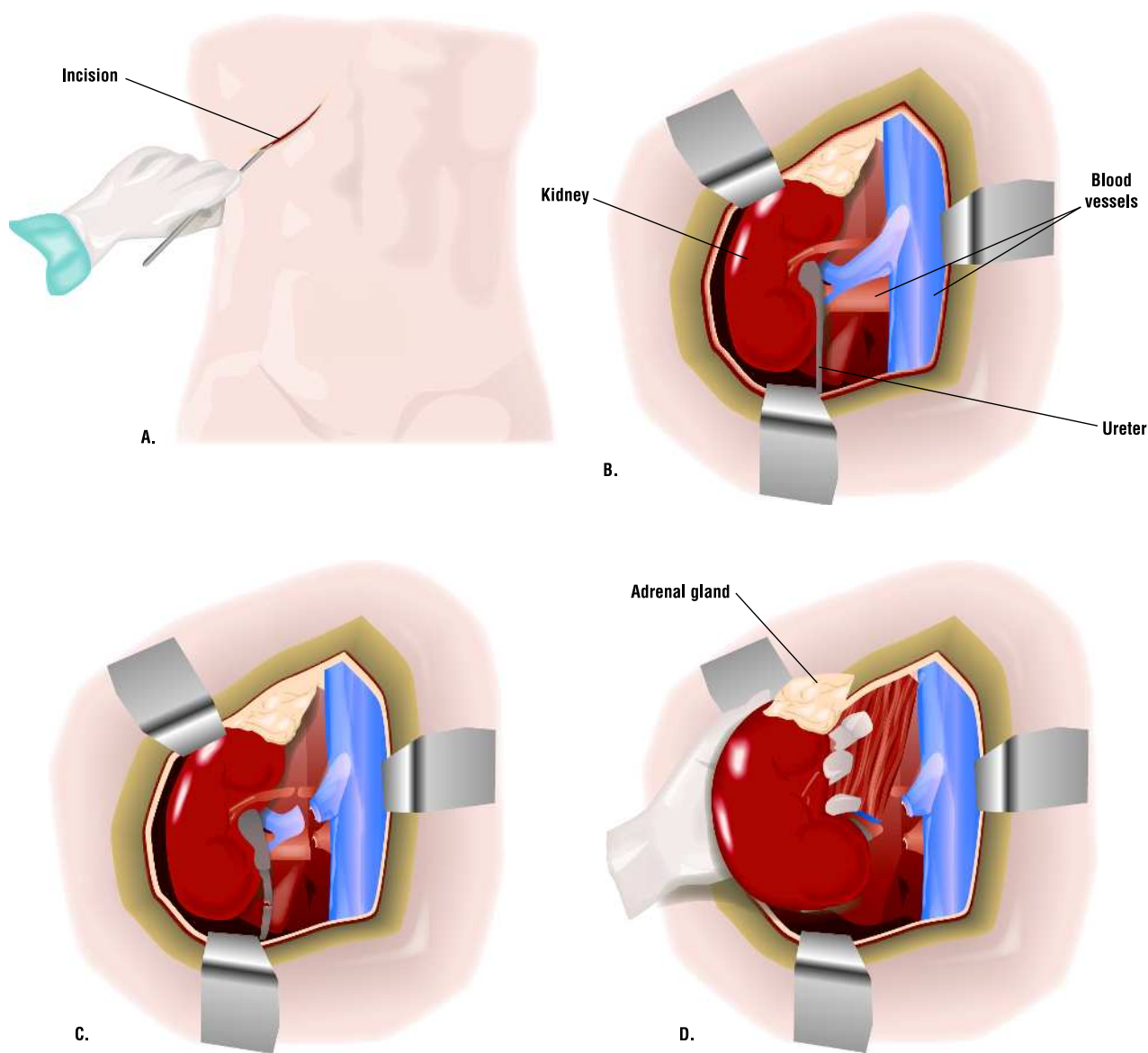
### Purpose

Nephrectomy, or kidney removal, is performed on patients with severe kidney damage from disease, injury, or congenital conditions. These include cancer of the kidney (renal cell carcinoma); polycystic kidney disease (a disease in which cysts, or sac-like structures, displace healthy kidney tissue); and serious kidney infections. It is also used to remove a healthy kidney from a donor for the purposes of **kidney transplantation**.

### Demographics

The HCUP Nationwide Inpatient Sample from the Agency for Healthcare Research and Quality (AHRQ) reports that 46,130 patients underwent partial or radical nephrectomy surgery for non-transplant-related indications in the United States in 2000. Patients with kidney cancer accounted for over half of those procedures. About 51,190 new cases of renal cell

## Nephrectomy



To remove a kidney in an open procedure, an incision is made below the ribcage (A). The kidney is exposed (B) and connections to blood vessels and the ureter are severed (C). The kidney is removed in one piece (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

carcinoma were expected to be diagnosed in 2007, per the American Cancer Society.

According to the United Network for Organ Sharing (UNOS), 5,086 people underwent nephrectomy to become living kidney donors in 2007. Of these, 2,911 were male and 2,975 were female. Related donors were more common than non-related donors, with full siblings being the most common relationship

between living donor and kidney recipients (28.5% of living donors).

### Description

Nephrectomy may involve removing a small portion of the kidney or the entire organ and surrounding tissues. In partial nephrectomy, only the diseased or

## KEY TERMS

**Cadaver kidney**—A kidney from a brain-dead organ donor used for purposes of kidney transplantation.

**Polycystic kidney disease**—A hereditary kidney disease that causes fluid- or blood-filled pouches of tissue called cysts to form on the tubules of the kidneys. These cysts impair normal kidney function.

**Renal cell carcinoma**—Cancer of the kidney.

infected portion of the kidney is removed. Radical nephrectomy involves removing the entire kidney, a section of the tube leading to the bladder (ureter), the gland that sits atop the kidney (adrenal gland), and the fatty tissue surrounding the kidney. A simple nephrectomy performed for living donor transplant purposes requires removal of the kidney and a section of the attached ureter.

### *Open nephrectomy*

In a traditional, open nephrectomy, the kidney donor is administered **general anesthesia** and a 6–10 in (15.2–25.4 cm) incision through several layers of muscle is made on the side or front of the abdomen. The blood vessels connecting the kidney to the donor are cut and clamped, and the ureter is also cut between the bladder and kidney and clamped. Depending on the type of nephrectomy procedure being performed, the ureter, adrenal gland, and/or surrounding tissue may also be cut. The kidney is removed and the vessels and ureter are then tied off and the incision is sutured (sewn up). The surgical procedure can take up to three hours, depending on the type of nephrectomy being performed.

### *Laparoscopic nephrectomy*

Laparoscopic nephrectomy is a form of minimally invasive surgery that utilizes instruments on long, narrow rods to view, cut, and remove the kidney. The surgeon views the kidney and surrounding tissue with a flexible videoscope. The videoscope and **surgical instruments** are maneuvered through four small incisions in the abdomen, and carbon dioxide is pumped into the abdominal cavity to inflate it and improve visualization of the kidney. Once the kidney is isolated, it is secured in a bag and pulled through a fifth incision, approximately 3 in (7.6 cm) wide, in the front of the abdominal wall below the navel. Although this surgical technique takes slightly longer than a traditional nephrectomy, preliminary studies have

shown that it promotes a faster recovery time, shorter hospital stays, and less post-operative pain.

A modified laparoscopic technique called hand-assisted laparoscopic nephrectomy may also be used to remove the kidney. In the hand-assisted surgery, a small incision of 3–5 in (7.6–12.7 cm) is made in the patient's abdomen. The incision allows the surgeon to place his hand in the abdominal cavity using a special surgical glove that also maintains a seal for the inflation of the abdominal cavity with carbon dioxide. This technique gives the surgeon the benefit of using his hands to feel the kidney and related structures. The kidney is then removed by hand through the incision instead of with a bag.

## Diagnosis/Preparation

Prior to surgery, blood samples will be taken from the patient to type and crossmatch in case **transfusion** is required during surgery. A catheter will also be inserted into the patient's bladder. The surgical procedure will be described to the patient, along with the possible risks.

## Aftercare

Nephrectomy patients may experience considerable discomfort in the area of the incision. Patients may also experience numbness, caused by severed nerves, near or on the incision. Pain relievers are administered following the surgical procedure and during the recovery period on an as-needed basis. Although deep breathing and coughing may be painful due to the proximity of the incision to the diaphragm, breathing exercises are encouraged to prevent pneumonia. Patients should not drive an automobile for a minimum of two weeks.

## Risks

Possible complications of a nephrectomy procedure include infection, bleeding (hemorrhage), and post-operative pneumonia. There is also the risk of kidney failure in a patient with impaired function or disease in the remaining kidney.

## Normal results

Normal results of a nephrectomy are dependent on the purpose of the procedure and the type of nephrectomy performed. Immediately following the procedure, it is normal for patients to experience pain near the incision site, particularly when coughing or breathing deeply. Renal function of the patient is monitored carefully after surgery. If the remaining kidney is

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

If nephrectomy is required for the purpose of kidney donation, it will be performed by a transplant surgeon in one of over 200 UNOS-approved hospitals nationwide. For patients with renal cell carcinoma, nephrectomy surgery is typically performed in a hospital setting by a surgeon specializing in urologic oncology.

healthy, it will increase its functioning over time to compensate for the loss of the removed kidney.

Length of hospitalization depends on the type of nephrectomy procedure. Patients who have undergone a laparoscopic radical nephrectomy may be discharged two to four days after surgery. Traditional open nephrectomy patients are typically hospitalized for about a week. Recovery time will also vary, on average from three to six weeks.

### Morbidity and mortality rates

Survival rates for living kidney donors undergoing nephrectomy are excellent; mortality rates are only 0.03%—or three deaths for every 10,000 donors. Many of the risks involved are the same as for any surgical procedure: risk of infection, hemorrhage, blood clot, or allergic reaction to anesthesia.

For patients undergoing nephrectomy as a treatment for renal cell carcinoma, survival rates depend on several factors, including the stage of the cancer and the patient's overall **health history**. According to the American Cancer Society, the five-year survival rate for patients with stage I renal cell carcinoma is 96 percent, while the five-year survival rate for stage II kidney cancer is 82 percent. Stage III and IV cancers have metastasized, or spread, beyond the kidney and have a lower survival rate, 64 percent for stage III and about 23 percent for stage IV. Chemotherapy, radiation, and/or immunotherapy may also be required for these patients.

### Alternatives

Because the kidney is responsible for filtering wastes and fluid from the bloodstream, kidney function is critical to life. Nephrectomy candidates diagnosed with serious kidney disease, cancer, or infection usually have few treatment choices aside from this

## QUESTIONS TO ASK THE DOCTOR

- How many procedures of this type have you performed, and what are your success rates?
- Will my nephrectomy surgery be performed with a laparoscopic or an open technique?
- Will my nephrectomy be partial or radical, and what are the risks involved with my particular surgery?
- What will my recovery time be after the procedure?
- What are the chances that the transplant will be successful? (For those undergoing a nephrectomy to donate a kidney.)
- What are the odds of success, and will I require adjunctive treatment such as chemotherapy or immunotherapy? (For those undergoing a nephrectomy to treat kidney cancer.)

procedure. However, if kidney function is lost in the remaining kidney, the patient will require chronic dialysis treatments or transplantation of a healthy kidney to sustain life.

### Resources

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National Kidney Foundation. 30 East 33rd St., Suite 1100, New York, NY 10016. (800) 622 9010. <http://www.kidney.org>.

United Network for Organ Sharing (UNOS). 700 North 4th St., Richmond, VA 23219. (888) 894 6361. UNOS Transplant Connection: <http://www.transplantliving.org>.

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Paula Anne Ford-Martin



## Nephrolithotomy, percutaneous

### Definition

Percutaneous nephrolithotomy, or PCNL, is a procedure for removing medium-sized or larger renal calculi (kidney stones) from the patient's urinary tract by means of a nephroscope passed into the kidney through a track created in the patient's back. PCNL was first performed in Sweden in 1973 as a less invasive alternative to open surgery on the kidneys. The term "percutaneous" means that the procedure is done through the skin. Nephrolithotomy is a term formed from two Greek words that mean "kidney" and "removing stones by cutting."

### Purpose

The purpose of PCNL is the removal of renal calculi in order to relieve pain, bleeding into or obstruction of the urinary tract, and/or urinary tract infections resulting from blockages. Kidney stones range in size from microscopic groups of crystals to objects as large as golf balls. Most calculi, however, pass through the urinary tract without causing problems.



**Intravenous pyelogram (IVP) of kidneys, ureters, and urinary bladder.** (Scott Camazine / Phototake. Reproduced by permission.)

Renal calculi are formed when the urine becomes supersaturated (overloaded) with mineral compounds that can form stones. This supersaturation may occur because the patient has low urinary output, is excreting too much salt, or has very acid urine. Urolithiasis is the medical term for the formation of kidney stones; the word is also sometimes used to refer to disease conditions associated with kidney stones.

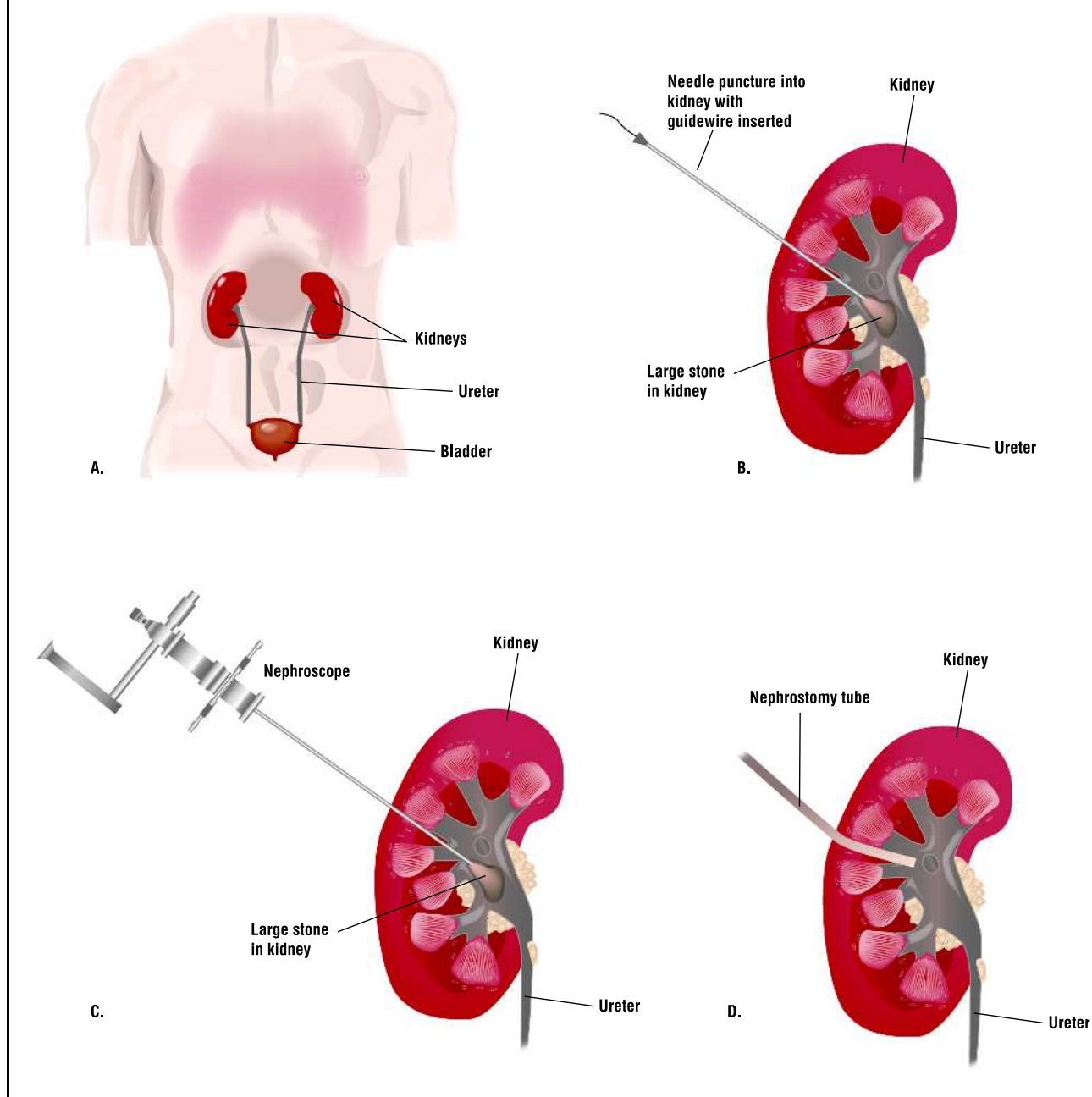
There are several different types of kidney stones, in terms of chemical composition:

- **Calcium oxalate calculi.** About 80% of calculi found in patients in the United States are formed from calcium combined with oxalate, which is a salt formed from oxalic acid. Some foods, such as rhubarb and spinach, are high in oxalic acid. Oxalic acid is also formed in the body when vitamin C is broken down. Oxalic acid is ordinarily excreted through the urine but may be absorbed in large amounts due to chronic pancreatic disease or surgery involving the small intestine.
- **Uric acid calculi.** These stones develop from crystals of uric acid that form in highly acidic urine. Uric acid calculi account for about 5% of kidney stones. In addition, some kidney stones are a combination of calcium oxalate and uric acid crystals.
- **Cystine calculi.** Cystine calculi represent about 2% of kidney stones. Cystine is an amino acid found in proteins that may form hexagonal crystals in the urine when it is excreted in excessive amounts. Kidney stones made of cystine indicate that the patient has cystinuria, a hereditary condition in which the kidneys do not reabsorb this amino acid.
- **Struvite calculi.** Struvite is a hard crystalline form of magnesium aluminum phosphate. Kidney stones made of this substance are formed in patients with urinary tract infections caused by certain types of bacteria. Struvite calculi are also known as infection calculi for this reason.
- **Staghorn calculi.** Staghorn calculi are large branched calculi composed of struvite. They are often discussed separately because their size and shape complicate their removal from the urinary tract.

Some people are more likely than others to develop renal calculi. Risk factors for kidney stones include:

- Male sex.
- Family history. Having a first-degree relative with urolithiasis increases a person's risk of developing kidney stones.
- Age over 30.

# Percutaneous nephrolithotomy



During a percutaneous nephrolithotomy, the surgeon inserts a needle through the patient's back directly into the kidney (B). A nephroscope uses an ultrasonic or laser probe to break up large kidney stones (C). Pieces of the stones are suctioned out with the scope, and a nephrostomy tube drains the kidney of urine (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

- **Diet.** People whose diet is high in protein or who eat foods rich in oxalate are more likely to develop kidney stones.
- **Dehydration.** People who do not drink enough fluid each day to replace what is lost through perspiration and excretion produce very concentrated urine. It is

## KEY TERMS

**Bougie**—A slender, flexible tube or rod inserted into the urethra in order to dilate it.

**Calculus (plural, calculi)**—The medical term for a kidney or gallbladder stone.

**Cystine**—An amino acid found in protein molecules that may form kidney stones when excreted in excessive amounts in the urine.

**Cystinuria**—A hereditary condition characterized by chronic excessive excretion of cystine and three other amino acids.

**Infection calculi**—Another name for struvite calculi.

**Lithotripsy**—A technique for breaking up kidney stones within the urinary tract, followed by flushing out the fragments.

**Nephrolithotomy**—The removal of renal calculi by an incision through the kidney. The term by itself usually refers to the standard open procedure for the surgical removal of kidney stones.

**Nephroscope**—An instrument used to view the inside of the kidney during PCNL. A nephroscope has channels for a fiberoptic light, a telescope, and an irrigation system for washing out the affected part of the kidney.

**Percutaneous**—Through the skin.

**Staghorn calculus**—A kidney stone that develops a branched shape resembling the antlers of a stag. Staghorn calculi are composed of struvite.

**Struvite**—A crystalline form of magnesium ammonium phosphate. Kidney stones made of struvite form in urine with a pH above 7.2.

**Ureter**—The tubelike structure that carries urine from the kidney to the bladder.

**Ureteroscope**—A special type of endoscope that allows a surgeon to remove kidney stones from the lower urinary tract without the need for an incision.

**Urolithiasis**—The medical term for the formation of kidney stones. It is also used to refer to disease conditions related to kidney stones.

easier for crystals to form in concentrated than in dilute urine, and to grow into kidney stones.

- Metabolic disorders affecting the body's excretion of salt or its absorption of calcium or oxalate. Most cases of urolithiasis in children are related to metabolic disorders.
- Intestinal bypass surgery and ostomies. People who have had these surgical procedures lose larger than average amounts of water from the digestive tract.

## Demographics

Calculi in the urinary tract are common in the general United States population. Between seven and 10 of every 1,000 hospitalizations each year are due to urolithiasis; in addition, kidney stones are found in about 1% of bodies at autopsy. An estimated 10% of the population will suffer from kidney stones at some point in life. 12% of men and 6% of women will have kidney stones at some point over the course of their lifetimes.

In terms of age groups, most people with urolithiasis are between the ages of 20 and 40; kidney stones are rare in children. A person who develops one kidney stone has a 50% chance of developing another.

With regard to race, Caucasians are more likely to develop kidney stones than African Americans.

## Description

### Standard PCNL

A standard percutaneous nephrolithotomy is performed under **general anesthesia** and usually takes about three to four hours to complete. After the patient has been anesthetized, the surgeon makes a small incision, about 0.5 in (1.3 cm) in length in the patient's back on the side overlying the affected kidney. The surgeon then creates a track from the skin surface into the kidney and enlarges the track using a series of Teflon dilators or bougies. A sheath is passed over the last dilator to hold the track open.

After the track has been enlarged, the surgeon inserts a nephroscope, which is an instrument with a fiberoptic light source and two additional channels for viewing the inside of the kidney and irrigating (washing out) the area. The surgeon may use a device with a basket on the end to grasp and remove smaller kidney stones directly. Larger stones are broken up with an ultrasonic or electrohydraulic probe, or a holmium laser lithotripter. The holmium laser has the advantage of being usable on all types of calculi.

A catheter is placed to drain the urinary system through the bladder and a **nephrostomy** tube is placed in the incision in the back to carry fluid from the kidney into a drainage bag. The catheter is removed after 24

hours. The nephrostomy tube is usually removed while the patient is still in the hospital but may be left in after the patient is discharged.

### *Mini-percutaneous nephrolithotomy*

A newer form of PCNL is called mini-percutaneous nephrolithotomy (MPCNL) because it is performed with a miniaturized nephroscope. MPCNL has been found to be 99% effective in removing calculi between 0.4 and 1 in (1 and 2.5 cm) in size. Although it cannot be used for larger kidney stones, MPCNL has the advantage of fewer complications, a shorter operating time (about one and a half hours), and a shorter recovery time for the patient.

## Diagnosis/Preparation

### *Diagnosis*

Kidney stones may be discovered during a routine x-ray study of the patient's abdomen. These stones, which would ordinarily pass through the urinary tract unnoticed, are sometimes referred to as silent stones. In most cases, however, the patient seeks medical help for sudden intense pain in the lower back, usually on the side of the affected kidney. The pain is caused by the movement of the stone in the urinary tract as it irritates the tissues or blocks the passage of urine. If the stone moves further downward into the ureter (the tube that carries urine from the kidney to the bladder), pain may spread to the abdomen and groin area. The patient may also have nausea and vomiting, blood in the urine, pain on urination, or a need to urinate frequently. If the stone is associated with a UTI, the patient may also have chills and fever. The doctor will order both laboratory studies and imaging tests in order to rule out such other possible causes of the patient's symptoms as appendicitis, pancreatitis, peptic ulcer, and dissecting aneurysm.

The imaging studies most commonly performed are x ray and **ultrasound**. Pure uric acid and cystine calculi, however, do not show up well on a standard x ray, so the doctor may also order an intravenous pyelogram, or IVP. In an IVP, the radiologist injects a radioactive contrast material into a vein in the patient's arm, and records its passage through the urinary system in a series of x-ray images. Blood and urine samples will be taken to test for indications of a urinary tract infection. If the patient passes the kidney stone, it is saved and sent to a laboratory for analysis.

### *Preparation*

Most hospitals require patients to have the following tests before a PCNL: a complete **physical examination**;

**complete blood count**; an **electrocardiogram** (EKG); a comprehensive set of metabolic tests; a urine test; and tests that measure the speed of blood clotting.

**Aspirin** and arthritis medications should be discontinued seven to 10 days before a PCNL because they thin the blood and affect clotting time. Some surgeons ask patients to take a laxative the day before surgery to minimize the risk of constipation during the first few days of recovery.

The patient is asked to drink only clear fluids (chicken or beef broth, clear fruit juices, or water) for 24 hours prior to surgery, with nothing by mouth after midnight before the procedure.

## Aftercare

A standard PCNL usually requires hospitalization for five to six days after the procedure. The urologist may order additional imaging studies to determine whether any fragments of stones are still present. These can be removed with a nephroscope if necessary. The nephrostomy tube is then removed and the incision covered with a bandage. The patient will be given instructions for changing the bandage at home.

The patient is given fluids intravenously for one to two days after surgery. Later, he or she is encouraged to drink large quantities of fluid in order to produce about 2 qt (1.2 l) of urine per day. Some blood in the urine is normal for several days after PCNL. Blood and urine samples may be taken for laboratory analysis of specific risk factors for calculus formation.

## Risks

There are a number of risks associated with PCNL:

- Inability to make a large enough track to insert the nephroscope. In this case, the procedure will be converted to open kidney surgery.
- Bleeding. Bleeding may result from injury to blood vessels within the kidney as well as from blood vessels in the area of the incision.
- Infection.
- Fever. Running a slight temperature (101.5°F; 38.5°C) is common for one or two days after the procedure. A high fever or a fever lasting longer than two days may indicate infection, however, and should be reported to the doctor at once.
- Fluid accumulation in the area around the incision. This complication usually results from irrigation of the affected area of the kidney during the procedure.
- Formation of an arteriovenous fistula. An arteriovenous fistula is a connection between an artery and



a vein in which blood flows directly from the artery into the vein.

- Need for retreatment. In general, PCNL has a higher success rate of stone removal than extracorporeal shock wave lithotripsy (ESWL), which is described below. PCNL is considered particularly effective for removing stones larger than 1 in (0.5 cm); staghorn calculi; and stones that have remained in the body longer than four weeks. Retreatment is occasionally necessary, however, in cases involving very large stones.
- Injury to surrounding organs. In rare cases, PCNL has resulted in damage to the spleen, liver, lung, pancreas, or gallbladder.

### Normal results

PCNL has a high rate of success for stone removal, over 98% for stones that remain in the kidney and 88% for stones that pass into the ureter.

### Morbidity and mortality rates

Standard PCNL has a higher rate of complications than extracorporeal shock wave **lithotripsy**; however, it is more successful in removing calculi. The overall rate of complications following PCNL is reported as 5.6% in one recent study and 6.5% in a second article. About 20% of patients scheduled for PCNL require a blood **transfusion** during the procedure, with 2.8% needing treatment for bleeding after the procedure. The rate of fistula formation is about 2.5%.

### Alternatives

Patients with kidney stones may be treated with one or more of the following procedures in addition to PCNL, depending on the size of their renal calculi and possible complications. One frequently used combination, known as sandwich therapy, is extracorporeal shock wave lithotripsy for smaller stones followed by PCNL to remove larger calculi.

#### *Conservative approaches*

Conservative forms of treatment include the following:

- Watchful waiting.
- Hydration. Increasing the patient's fluid intake (to seven or more glasses of fluid each day) is a major component of treatment intended to prevent the formation of kidney stones. At least half of the fluid should be water.
- Dietary modification. Depending on the type of stone that has formed, the patient may benefit from

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A PCNL or mini-PCNL is performed under general anesthesia in a hospital by a urologist, who is a surgeon with specialized training in treating disorders of the urinary tract. ESWL may be done as an outpatient procedure in an ambulatory surgery facility.

eating less animal protein, avoiding vegetables with high oxalate content, cutting down on table salt and vitamin C intake, etc.

- Medications. Patients who tend to form uric acid stones may be given allopurinol, which decreases the formation of uric acid; those who form calcium oxalate stones may be given thiazide diuretics; and those who develop infection stones can be treated with oral antibiotics.

#### *Open surgery*

Open surgery is the most invasive form of treatment for urolithiasis. As of 2003, it is performed primarily to remove very large and complex staghorn calculi or extremely hard stones that cannot be broken down by lithotripsy. Other indications for open surgery are extreme obesity, an anatomically abnormal kidney, or an infected and nonfunctioning kidney requiring complete removal. Patients are usually hospitalized for a week after open kidney surgery and take about six weeks to recover at home.

#### *Extracorporeal shock wave lithotripsy (ESWL)*

ESWL is a noninvasive procedure that was developed in the 1980s as a less invasive alternative to PCNL. It is presently used more often than PCNL to treat smaller renal calculi. In ESWL, the patient is given a local anesthetic and placed in a water bath or on a soft cushion while shock waves are transmitted through the tissues of the back to the stones inside the kidney. The shock waves cause the calculi to break up into smaller pieces that can be passed easily in the urine.

Although patients need less time to recuperate from ESWL, it has several disadvantages. It has lower success rates (50–90%) than PCNL. Moreover, it cannot be used to treat cystine calculi or calculi larger than 1.2 in (3 cm). An additional concern with shock wave lithotripsy is its safety in treating small or anatomically abnormal kidneys; it has been reported

## QUESTIONS TO ASK THE DOCTOR

- Am I a candidate for a mini-PCNL?
- Do you consider the higher success rate of a PCNL a greater advantage than the lower rate of complications with ESWL?
- What can I do to prevent recurrence of kidney stones?
- What are the chances of my needing another operation?

to cause temporary damage to kidney tubules in smaller-than-average kidneys.

### Ureteroscopy

Ureteroscopy refers to removal of calculi that have moved downward into the ureter with the help of a special instrument. A ureteroscope is a small fiberoptic endoscope that can be passed through the patient's urethra and bladder into the ureter. The ureteroscope allows the surgeon to locate and remove stones in the lower urinary tract without the need for an incision.

### Complementary and alternative (CAM) approaches

Vegetarian and other low-protein diets have been found helpful in preventing kidney stone formation. In addition, recent ethnobotanical studies of ammi visnaga (toothpick weed), a plant belonging to the parsley family, and *Phyllanthus niruri*, a traditional Brazilian folk remedy for kidney stones, indicate that extracts from these plants are effective in increasing urinary output and inhibiting the development of calcium oxalate calculi.

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American Foundation for Urologic Disease (AFUD). 1128 North Charles Street, Baltimore, MD 21201. (800) 242-2383. <http://www.afud.org>.

American Urological Association (AUA). 1120 North Charles Street, Baltimore, MD 21201. (410) 727-1100. <http://www.auanet.org>.

National Kidney Foundation. 30 East 33rd Street, Suite 1100, New York, NY 10016. (800) 622-9010 or (212) 889-2210. <http://www.kidney.org>.

National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC). 3 Information Way, Bethesda, MD 20892-3580.

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Rebecca Frey, Ph.D.

## Nephrostomy

### Definition

A nephrostomy is a surgical procedure by which a tube, stent, or catheter is inserted through the skin and into the kidney.

### Purpose

The ureter is the fibromuscular tube that carries urine from the kidney to the bladder. When this tube is blocked, urine backs up into the kidney. Serious, irreversible kidney damage can occur because of this backflow of urine. Infection is also a common consequence in this stagnant urine.

Nephrostomy is performed in several different circumstances:

- The ureter is blocked by a kidney stone.
- The ureter is blocked by a tumor, abscess, or fluid collection.
- There is a hole in the ureter or bladder and urine is leaking into the body. These may occur after trauma

## KEY TERMS

**Catheter**—A tubular, flexible, surgical instrument for withdrawing fluids from a cavity of the body, especially one for introduction into the bladder through the urethra for the withdraw of urine.

**Ostomy**—General term meaning a surgical procedure in which an artificial opening is formed to either allow waste (stool or urine) to pass from the body, or to allow food into the GI tract. An ostomy can be permanent or temporary, as well as single-barreled, double-barreled, or a loop.

**Septicemia**—Systemic disease associated with the presence and persistence of pathogenic microorganisms or their toxins in the blood.

**Stent**—A tube made of metal or plastic that is inserted into a vessel or passage to keep it open and prevent closure.

**Ureter**—The fibromuscular tube that conveys the urine from the kidney to the bladder.

or accidental injury during surgery (iatrogenic injury), or severe hemorrhagic cystitis.

- The ureter is obstructed during pregnancy.
- Access is needed in order to infuse materials/medications directly into the kidney, such as antibiotics, antifungal agents, chemotherapeutic agents, or chemicals that will dissolve stones.
- As a diagnostic procedure to assess kidney anatomy.
- As a diagnostic procedure to assess kidney function.

## Demographics

For unknown reasons, the number of people in the United States with kidney and ureter stones has been increasing over the past 20 years. White Americans are more prone to develop kidney stones than African Americans. Stones occur more frequently in men. The condition strikes most typically between the ages of 20 and 40. Once a person gets more than one stone, others are likely to develop.

Upper tract tumors develop in the renal pelvis (tissue in the kidneys that collects urine) and in the ureters. These cancers account for less than 1% of cancers of the reproductive and urinary systems. Upper tract tumors are often associated with bladder cancer.

## Description

First, the patient is given an anesthetic to numb the area where the catheter will be inserted. The doctor then inserts a needle into the kidney. There are several imaging technologies such as **ultrasound** and computed tomography (CT) that are used to help the doctor guide the needle into the correct place.

Next, a fine guide wire follows the needle. The catheter, which is about the same diameter as intravenous (IV) tubing, follows the guide wire to its proper location. The catheter is then connected to a bag outside the body that collects the urine. The catheter and bag are secured so that the catheter will not pull out. The procedure usually takes one to two hours.

## Diagnosis/Preparation

Either the day before or the day of the nephrostomy, blood samples are taken. Other diagnostic tests done before the procedure may vary, depending on why the nephrostomy is being done, but the patient may have a CT scan or ultrasound to help the treating physician locate the blockage.

Patients should not eat for eight hours before a nephrostomy. On the day of the procedure, the patient will have an IV line placed in a vein in the arm. Through this line, the patient will receive **antibiotics** to prevent infection, medication for pain, and fluids. The IV line will remain in place after the procedure for at least several hours, and often longer.

People preparing for a nephrostomy should review with their doctor all the medications they are taking. People taking anticoagulants (blood thinners such as Coumadin) may need to stop their medication. People taking metformin (Glucophage) may need to stop taking the medication for several days before and after nephrostomy. Diabetics should discuss modifying their insulin dose because fasting is required before the procedure.

## Aftercare

Outpatients are usually expected to stay in the clinic or hospital for eight to 12 hours after the procedure to make sure the nephrostomy tube is functioning properly. They should plan to have someone drive them home and stay with them for at least the first 24 hours after the procedure. Inpatients may stay in the hospital several days. Generally, people feel sore where the catheter is inserted for about a week to 10 days.

Care of the nephrostomy tube is important. It is located on the patient's back, so it may be necessary to have someone help with its care. The nephrostomy

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A nephrostomy is performed by an interventional radiologist or urologist with special training in the procedure. It can be done either on an inpatient or outpatient basis, depending on why it is required. For most cancer patients, nephrostomy is an inpatient procedure. Specially trained nurses called wound, ostomy continence nurses (WOCN) are commonly available for consultation in most major medical centers to assist patients.

tube should be kept dry and protected from water when taking showers. The skin around it should be kept clean, and the dressing over the area changed frequently. It is the main part of the urine drainage system, and it should be treated very carefully to prevent bacteria and other germs from entering the system. If any germs get into the tubing, they can easily cause a kidney infection. The drainage bag should not be allowed to drag on the floor. If the bag should accidentally be cut or begin to leak, it must be changed immediately. It is not recommended to place the drainage bag in a plastic bag if it leaks.

### Risks

A nephrostomy is an established and generally safe procedure. As with all operations, there is always a risk of allergic reaction to anesthesia, bleeding, and infection.

Bruising at the catheter insertion site occurs in about half of people who have a nephrostomy. This is a minor complication. Major complications include the following:

- injury to surrounding organs, including bowel perforation, splenic injury, and liver injury
- infection, leading to septicemia
- significant loss of functioning kidney tissue (<1%)
- delayed bleeding, or hemorrhage (<0.5%)
- blocking of a kidney artery (<0.5%)

### Normal results

In a successful nephrostomy, the catheter is inserted, and urine drains into the collection bag. How long the catheter stays in place depends on the reason for its insertion. In people with pelvic cancer or bladder cancer where the ureter is blocked by a

## QUESTIONS TO ASK THE DOCTOR

- Why am I having a nephrostomy?
- How do I prepare for surgery?
- How long will I have to stay in the hospital?
- How long do you expect the nephrostomy tube to stay in?
- How much help will I need in caring for the nephrostomy tube?

tumor, the catheter will stay in place until the tumor is surgically removed. If the cancer is inoperable, the catheter may have to stay in place for the rest of the patient's life.

### Morbidity and mortality rates

The mortality rate of nephrostomies is of the order of less than 0.05% and the incidence of the specific complications listed above ranges between less than 0.05% (hemorrhage, kidney arterial blocking, and loss of kidney tissue) to <1% (injury to surrounding organs and septicemia).

### Alternatives

In the treatment of ureter stones, extracorporeal shock wave **lithotripsy** (ESWL) has been most widely performed and has become the preferred treatment for this condition. ESWL is a new technique that offers an alternative to surgery for patients with kidney or ureter stones. ESWL works by pulverizing the stones into sand-like particles that can be excreted with little or no pain. This is achieved by the ESWL procedure approximately 90% of the time. The shock waves are a form of high-energy pressure that can travel in air or water. When generated outside the body, they pass through the tissues of the body without damaging them, but can destroy a stone inside a kidney or urethra. The shock waves pass through both without injury. A stone has a greater density and, when the shock wave hits it, the waves scatter and break it up.

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## Neurosurgery

### Definition

Neurosurgery is a specialized field of surgery for the treatment of diseases or conditions of the central nervous system (CNS) and spine.

### Description

Neurosurgery is the specialized field of surgery that treats diseases that affect the CNS—the brain and the spine. A neurosurgeon is a medical doctor who has received extensive training in the surgical and medical management of neurological diseases. The field of neurosurgery is one of the most sophisticated surgical specialties and encompasses advanced surgical and imaging technology and new research in molecular neurosurgery and gene therapy. There are five general categories of neurosurgical diseases that are commonly managed by neurosurgeons: cerebrovascular (hemorrhage [bleeding] and aneurysms); traumatic head injury (THI, traumatic injury caused by accident); degeneration diseases of the spine; tumors in the CNS; functional neurosurgery; surgery for congenital abnormalities; and neurosurgical management of the CNS.

Cerebrovascular diseases that usually require surgery include spontaneous intracranial hemorrhage (bleeding within the skull), spontaneous subarachnoid hemorrhage (bleeding beneath the outer membranous covering of the brain), spontaneous intracerebral hemorrhage (bleeding within the brain), cerebral aneurysms (outpouchings of the blood vessel), hypertensive intracerebral hemorrhage (due to high blood pressure), and angiomatous malformations.

### Brain hemorrhage

Spontaneous intracranial hemorrhage is a condition characterized by hemorrhage in the brain (hemorrhagic stroke) that results in a sudden onset of neurologically worsening symptoms (that include focal neurologic deficits and loss of consciousness). **CT scans** are helpful in identifying the intracranial hemorrhage, of which there are two types—subarachnoid hemorrhage and intracerebral hematoma.

The subarachnoid space is an area that exists between two layers of coverings (membranes) that wrap around the brain. A spontaneous subarachnoid hemorrhage is defined as blood (not caused by trauma), in the subarachnoid space. The amount of blood in the subarachnoid space can be a focal (small area) amount or a larger, more diffuse hemorrhage, which can be further complicated by having an intraventricular hemorrhage or intracerebral hematoma at the same time.

The incidence of subarachnoid hemorrhage is 10 per 100,000 persons per year; approximately 30% of Americans will sustain a subarachnoid hemorrhage annually. Smoking is a major factor in increasing the odds of sustaining a subarachnoid hemorrhage.

## KEY TERMS

**Angiomatous malformations**—Tumors in blood vessels.

**Cerebral aneurysms**—A sac in a blood vessel in the brain that can rupture and cause bleeding in the brain.

**Craniosynostosis**—Premature closure of the skull, which results in skull deformities.

**Craniotomy**—Procedure to remove a lesion in the brain through an opening in the skull.

**Desiccation**—Tissue death.

**Encephaloceles**—Protrusion of the brain through a defect in the skull.

**Germinoma**—A tumor of germ cells (ovum and sperm cells that participate in production of the developing embryo).

**Hydrocephalus**—A defect characterized by an increase in cerebrospinal fluid (CSF), which bathes and nourishes the brain and spinal cord.

**Intraventricular hemorrhage**—Hemorrhage in the ventricles of the brain.

**Lymphoma**—A tumor of lymph glands or lymph tissues.

**Meninges**—Membranes that cover the brain.

**Myelomeningoceles (MMC)**—A protrusion in the vertebral column containing spinal cord and meninges.

**Subarachnoid space**—A space between membranes that covers and protects the brain.

Subarachnoid hemorrhage can affect adults of all ages, but usually peaks in the fourth and fifth decades of life. Approximately 60% of patients are female. Approximately 30% of subarachnoid hemorrhages occur during sleep.

The most frequent cause of spontaneous subarachnoid hemorrhage is rupture of an intracranial aneurysm. The symptoms of subarachnoid hemorrhage are a sudden onset of severe headache that worsens over time, nausea, loss of consciousness (with or without seizure), and vomiting. Depending on the severity of bleeding, additional symptoms can also include visual sensitivity to light (photophobia), a stiff neck, and minor (low-grade) fever. Symptoms occur before rupture of the aneurysm in 40% of patients, usually in those with a minor hemorrhage. These symptoms can also include headache or dizziness, and tend to go unnoticed.

After a subarachnoid hemorrhage, most patients are hypertensive (have high blood pressure) and experience changes in heart rate and rhythm. CT scans are the best diagnostic tool for subarachnoid hemorrhage. The hemorrhage can be visualized in the first 24 hours after onset in 90% of patients and in more than 50% in the first week. Spinal taps to sample the cerebrospinal fluid (CSF) may be required to evaluate some patients who have the potential to suffer a subarachnoid hemorrhage. This procedure involves the insertion of a thin needle between the lumbar vertebral bodies (L-4 and L-5) to allow the removal of a small amount of fluid to look for either red or white blood cells (WBCs). Once the aneurysm has been identified, the patient is taken for surgery. A **craniotomy** is performed using microsurgical techniques. The operative microscope helps to identify the aneurysm, which is then clipped. Berry, or congenital aneurysm, is the reason for over half of all cases of spontaneous subarachnoid hemorrhage.

A spontaneous intracerebral hemorrhage (or hematoma) (SICH) is a blood clot in brain tissue that can arise abruptly and is strongly correlated with hypertension. There are approximately 40,000 new cases of SICH in the United States annually. Stroke is the third leading cause of **death** in the United States, and SICH accounts for 10% of all stroke cases. Advancing age is a major predisposing factor for SICH: The incidence of SICH is two per 1,000 persons per year by age 45, and rises to 350 per 100,000 persons per year in those aged 80 years or more. Hypertensive intracerebral hemorrhage can occur in different areas within the brain. Damage to some areas may be associated with a very high death rate. Treatment includes comprehensive ICU (**intensive care unit**) management of hypertension and maintenance of adequate cerebral perfusion (oxygenated blood going to the brain).

Accidental head injury is a major public health problem. Trauma causes approximately 150,000 deaths annually in the United States; approximately half of these deaths were caused by fatal head trauma. Additionally, there are 10,000 new spinal cord injuries annually. The cost of disability (e.g., chronic long-term care, lost wages, and work) is very high. Approximately 200,000 persons in the United States are living with disabilities associated with head and spinal cord trauma.

Severe head injury is defined as an injury that produces coma (patient will not open eyes even to painful stimulus; incapable of following simple commands; and inability to utter words). These clinical criteria are defined on the well-established Glasgow Coma Scale (GCS). A **physical examination** and neurologic assessment by a neurosurgeon and brain scan

imaging (CT scan) are necessary for the initial evaluation. Additionally, a special catheter to monitor intracranial pressure (due to brain swelling) is necessary. A blood clot larger than 25 to 30 cubic centimeters is considered clinically large enough to cause progressive brain injury.

Tumors inside the brain (intracranial tumors) are typically of two types, primary and secondary intracranial tumors. Primary intracranial tumors (PICT) rarely metastasize and usually originate in the brain, coverings (membranes) of the brain, or the pituitary gland. The incidence of primary intracranial tumors is 11.5 per 100,000, or approximately 35,000 persons per year.

Secondary intracranial tumors arise from outside the brain coverings (meninges). Quite commonly, secondary intracranial tumors are bloodborne metastatic disease from primary malignant cancer outside the brain (i.e., cancer from some other location that has spread to the brain). Approximately 250,000 persons per year are affected by secondary intracranial tumors. A tumor in the brain can cause increased intracranial pressure, or cause symptoms associated with localized compression of the brain (i.e., a tumor grows and compresses part of the brain against the skull). One common cause of increased intracranial pressure is growth of a tumor that obstructs the duct system of cerebrospinal fluid (CSF), which bathes and nourishes the brain and spinal cord. Common symptoms can include nausea, vomiting, headache that is worse in the morning, and a reduced level of consciousness that causes drowsiness. Tumors causing focal compression on or irritation of the brain usually result in loss of neurologic function. This progressive loss of neurologic function can manifest as tinnitus (ringing in the ears) or aphasia (language problems).

Technical advancement has made surgical removal of brain tumors more effective and safer. Surgical management of intracranial tumors focuses on diagnosis and reduction of tumor mass. Depending on tumor location and patient health status, the neurosurgeon may perform a needle biopsy (called image-directed stereotactic needle biopsy) or a craniotomy to extract a piece of tumor for pathologic analysis. If the tumor is located in an area where surgery can be performed, the neurosurgeon generally will remove the mass if the patient can tolerate **general anesthesia**. Exceptions to a surgical option may be exercised to treat malignant tumors that are very sensitive to chemotherapy or radiation therapy (i.e., to manage lymphoma or germinoma). One of the most common types of tumors is the glioma, which accounts for 50% of all primary brain tumors.

### *Degenerative disorders of the spine*

Degenerative disorders of the spine are a common problem. Between 50% and 90% of the population will experience back pain at some point in their lifetime. Most of these symptoms subside on their own within a few weeks; the cost, however, is realized in decreased productivity and lost wages—a public health problem. Pain in the lumbar spine is the most common reason adults seek medical attention. The lumbar spine comprises five lumbar vertebra and supports the weight of the entire vertebral column and head. Lower back disorders are among the most frequent reasons for referral to a neurosurgeon. Lumbar discs are prone to herniation and desiccation (drying out) as a result of the heavy load they bear and the motion to which they are subject. Nerves that run from the vertebrae extend out to distant body parts, and degeneration of the discs may change bony structures in such a manner that can cause nerve compression. Typically, patients with degenerative disorders of the spine may experience pain, numbness, paresthesia (tingling), and restriction of neck movement (if the affected vertebra is in the cervical spine, which is located in the back of the neck).

### *Surgery for congenital abnormalities*

Congenital abnormalities arise during embryonic development. Important changes in growth and chemistry occur during the second week of human gestation; these changes contribute to the development of the nervous system. Several different types of cells proliferate as they move together or separate into other structures according to an orchestrated, natural timeline. Defects can occur at different stages of development. Among the defects with which infants can be born include myelomeningoceles, encephaloceles, hydrocephalus, and craniosynostosis.

### *Central nervous system infections*

Solitary or multiple brain abscesses can occur as a result of infection in the brain. Patients present with clinical symptoms such as focal (a specific area is affected) neurologic signs, seizures, altered mental status, and increased intracranial pressure. CT scans and **magnetic resonance imaging** (MRI) are helpful for identification of brain abscesses. Surgery is usually indicated if the abscess fails to resolve or worsens following antibiotic treatment, or if there are signs of mass effect and brain herniation. Although rare, a spinal epidural abscess can occur. Typically, bacteria can spread in patients who have acute bacterial meningitis (infection of the subarachnoid spaces and meninges). The specific type of bacteria varies according to the patient's age.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A neurosurgeon performs the procedure in a major hospital. The neurosurgeon is a medical doctor who has obtained two years of general surgery training, plus an additional five years of training in neurosurgery.

### *Functional neurosurgery*

Functional neurosurgery is a special type of surgical procedure used to manage movement disorder, epilepsy, and pain. Stereotactic neurosurgery makes use of a coordinate system that provides accurate navigation to a specific point or region in the brain. This is usually done by placing and fixing into position a frame on the scalp (using four threaded pins that penetrate the outer skull to stabilize the frame in position) under **local anesthesia**. A special box and stereotactic arc are placed to precisely determine X, Y, and Z coordinates of any point within the frame.

### *Epilepsy surgery*

Approximately 70 per 100,000 population in the United States takes antiepileptic medications for seizure disorders. The risk of developing epilepsy over a lifetime is 3%, and there are 100,000 new cases per year. The majority of cases (approximately 60,000) are epilepsy of the temporal lobe (the brain lobes located on the sides of the head). Approximately 25% of temporal lobe seizure patients who are prescribed antiepileptic drugs continue to have seizures that are not controlled or that can be controlled, but the side effects of the medication outweigh the therapeutic benefits. Approximately 5,000 new cases per year require epilepsy surgery (partial **anterior temporal lobectomy**). The patient and neurosurgeon should consider surgery if continued seizures cause injuries due to repeated falls; driving restrictions; limitation of social interactions; problems related to education and learning; and employment limitations.

### **The future of neurosurgery**

Neurosurgery as a field is faced with many new opportunities and challenges, based on advanced technological approaches and molecular approaches to neurosurgical problems. Advances in technology have allowed the neurosurgeon to precisely locate abnormal tissue in the brain and spinal cord, thereby preserving

## QUESTIONS TO ASK THE DOCTOR

- What the potential side effects that can arise as a result of surgery?
- How likely are complications to develop?
- How long will recovery take?
- Will I undergo rehabilitation, and if so, for how long?

normal tissues from surgical trauma. In addition to cardiovascular neurosurgery, functional neurosurgery, neuro-oncologic neurosurgery (surgical removal of brain tumors), and spinal surgery, the future holds many new research innovations. In the new millennium, the field of molecular neurosurgery can make it possible to introduce genetic material into nerve cells and to redirect protein synthesis—to work toward reversing the disease process, in general.

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Nissen fundoplication see **Gastroesophageal reflux surgery**

Nitrite test see **Urinalysis**

NMR see **Magnetic resonance imaging**

Nonmelanoma skin cancer surgery see **Curettage and electrosurgery**



## Nonsteroidal anti-inflammatory drugs

### Definition

Nonsteroidal anti-inflammatory drugs (NSAIDs) are medications other than **corticosteroids** that relieve pain, swelling, stiffness, fever, and inflammation. The most commonly used NSAIDs, including **aspirin**, ibuprofen, and naproxen, are available as over-the-counter (OTC) preparations; most, however, are prescription drugs. The use of NSAIDs for inflammation and low-grade pain is steadily increasing; in the early 2000s, these drugs accounted for 70 million prescriptions and 30 billion OTC purchases every year in the United States alone. They are one of the oldest classes of pain relievers, aspirin having been introduced for human use in 1829. One important reason why NSAIDs are so widely prescribed and recommended is that they have a very low rate of addiction.

### Purpose

Nonsteroidal anti-inflammatory drugs are prescribed for a variety of painful conditions, including arthritis, bursitis, tendinitis, gout, menstrual cramps, sprains, strains, and other injuries. They may be used for treatment of postsurgical pain that is either too mild to require narcotic **analgesics** or follows a period of use of stronger analgesics. Ketorolac (Toradol) may be used in place of narcotics for treatment of acute pain in patients who should not receive narcotics.

### Description

The nonsteroidal anti-inflammatory drugs are a group of agents that inhibit prostaglandin synthetase, thereby reducing the process of inflammation. As a group, they are all effective analgesics. Some, including the salicylates, ibuprofen, and naproxen, are also useful antipyretics (fever-reducers).

Although NSAIDs fall into discrete chemical classes, they are usually divided into the nonselective NSAIDs and the COX-2 specific agents. Among the nonspecific NSAIDs are diclofenac (Voltaren), etodolac (Lodine), flurbiprofen (Ansaid), ibuprofen (Motrin, Advil, Rufen), ketoprofen (Orudis), ketorolac (Toradol), nabumetone (Relafen), naproxen (Naprosyn), naproxen sodium (Aleve, Anaprox, Naprelan), and oxaprozin (Daypro). The only COX-2 specific drug remaining on the market in the United States as of 2007 is celecoxib (Celebrex); four other drugs in this class were withdrawn in the United States in 2004 because of reports that they increased patients' risks

## KEY TERMS

**Ankylosing spondylitis**—An autoimmune disorder of the joints in the spinal column, usually marked by pain and stiffness in the lower part of the spine.

**Antipyretic**—A medication that lowers fever.

**Bursitis**—Inflammation of the tissue around a joint.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

**Metabolites**—The chemicals produced in the body after nutrients, drugs, enzymes or other materials have been changed (metabolized).

**Salicylates**—A group of drugs that includes aspirin and related compounds; used to relieve pain, reduce inflammation, and lower fever.

**Tendinitis**—Inflammation of a tendon a tough band of tissue that connects muscle to bone.

of heart attack and stroke, and a fifth in Australia in 2007 because of reports of increased risk of liver failure.

Nonselective NSAIDs inhibit both cyclooxygenase 1 and cyclooxygenase 2 (COX-2). Cyclooxygenase 1 is important for such body processes as platelet aggregation, the regulation of blood flow in the kidney and stomach, and the regulation of gastric acid secretion. The inhibition of cyclooxygenase 1 is considered the primary cause of NSAID toxicity, including gastric ulceration and bleeding disorders. COX-2 is the primary cause of pain and inflammation. Celecoxib is a relatively selective COX-2 agent; it may cause the same adverse effects as the nonselective drugs, although with somewhat reduced frequency.

The analgesic activity of NSAIDs has not been fully explained. Antipyretic activity may be caused by the inhibition of prostaglandin E2 (PGE2) synthesis.

Although not all NSAIDs have approved indications for all uses, as a class, they are used for:

- ankylosing spondylitis
- bursitis
- dental pain
- fever
- gout
- headache
- juvenile arthritis
- pain from metastatic bone cancer
- mild-to-moderate postoperative pain
- osteoarthritis

- premenstrual syndrome (PMS)
- primary dysmenorrhea (painful menstrual periods)
- renal colic
- rheumatoid arthritis
- tendinitis

As of the early 2000s, NSAIDs have been studied for their potential effectiveness in lowering the risk of certain types of cancer, particularly colon, prostate, and ovarian cancers. More research needs to be done, however, to confirm the drugs' ability to protect against cancer.

### Recommended dosage

Recommended doses vary, depending on the patient, the type of nonsteroidal anti-inflammatory drug prescribed, the condition for which the drug is prescribed, and the form in which it is used. The patient is advised to consult specific sources for detailed information or ask a physician.

### Precautions

The most common hazard associated with NSAID use is gastrointestinal intolerance and ulceration. This may occur without warning and is a greater risk among patients over the age of 65. The risk appears to rise with increasing length of treatment and increasing dose. Patients should be aware of the warning signs of gastrointestinal (GI) bleeding.

Allergic reactions are rare, but may be severe. Patients who have allergic reactions to aspirin should not be treated with NSAIDs.

Because NSAID metabolites are eliminated by the kidney, renal toxicity should be considered. Clinicians should monitor kidney function before and during NSAID use.

Among the NSAIDs that are classed as pregnancy category B are ketoprofen, naproxen, naproxen sodium, flurbiprofen, and diclofenac. Category C NSAIDs include Etodolac, ketorolac, mefenamic acid, meloxicam, nabumetone, oxaprozin, tolmetin, piroxicam, and celecoxib. Breastfeeding is not advised while taking NSAIDs.

Many other rare but potentially serious adverse effects have been reported with NSAIDs. The consumer should consult specific references.

### Interactions

Many drug interactions have been reported with NSAID therapy. The most serious are those that may affect the bleeding hazards associated with NSAIDs. Consumers are advised to consult specific references

for further information. A partial list of interacting drugs includes:

- blood-thinning drugs such as warfarin (Coumadin)
- other nonsteroidal anti-inflammatory drugs
- heparin
- tetracycline antibiotics
- cyclosporine
- digitalis drugs
- lithium
- methotrexate
- phenytoin (Dilantin)
- zidovudine (AZT, Retrovir)

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Norepinephrine see **Adrenergic drugs**

Nose job see **Rhinoplasty**

Nosocomial infections see **Hospital-acquired infections**

NSAIDs see **Nonsteroidal anti-inflammatory drugs**

Nuclear magnetic resonance see **Magnetic resonance imaging**

## Nursing homes

### Definition

A nursing home is a long-term care facility licensed by the state that offers 24-hour room and board and health care services, including basic and skilled nursing care, rehabilitation, and a full range of other therapies, treatments, and programs. Other names for nursing homes are skilled nursing facilities (SNFs) and skilled nursing units (SNUs). There were about 16,100 nursing homes in the United States as of 2005. People who live in nursing homes are referred to as residents.

### Description

Slightly over 5% of people 65 years and older occupy nursing homes, congregate housing, assisted living communities, and board-and-care homes. At any given time, approximately 4% of the population of the United States is in nursing homes with the rate of nursing home use increasing with age from 1.4% of the young-old to 24.5% of the oldest-old. Some SNFs accept younger adults (anyone over the age of 18) who need physical or occupational therapy following an



(Jim West/Alamy)

accident or illness. Nearly 50% of those 95 years old and older live in nursing homes. Nursing homes must meet the physical, emotional, and social needs of its residents.

### Required care plans

There are federal laws regarding the care given in a nursing home, and it is essential that staff members become aware of these regulations. Staff members are required to conduct a thorough assessment of each new resident during the first two weeks following admission. The assessment includes the resident's ability to move, his or her rehabilitation needs, the status of the skin, any medical conditions that are present, nutritional state, and abilities regarding activities of daily living.

In some cases, the nursing home residents are unable to communicate their needs to the staff. Therefore, it is particularly important for nurses and other professionals to look for problems during their assessments. Signs of malnutrition and dehydration are especially important when assessing nursing home residents.

It is not normal for an elderly person to lose weight. However, some people lose their ability to taste and smell as they age and may lose interest in food. This can result in malnutrition, which can lead to confusion and impaired ability to fight off disease.

Older people are also more susceptible to dehydration. Their medications may lead to dehydration as a side effect, or they may limit fluids because they are too afraid of uncontrolled urination. It is very dangerous to be without adequate fluid, so the nurse and other staff must be able to recognize early signs of dehydration.

When the assessment is complete, a care plan is developed. This plan is subject to change as changes in the resident's condition occur.

Nursing homes are often the only alternative for patients who require nursing care over an extended period of time. Such persons are too ill to remain at home, with families, or in less structured long-term facilities. These individuals are unable to live independently and need assistance with activities of daily living (ADLs). Some nursing homes offer specialized care for certain medical conditions such as Alzheimer's disease.

Commonly, nursing home residents are no longer able to participate in the activities they once enjoyed. However, it is required by law that these facilities help residents achieve their highest possible quality of life.

## KEY TERMS

**Activities of daily living (ADLs)**—Self-care activities performed during the course of a normal day such as eating, bathing, dressing, toileting, etc.

**Assisted living**—A type of facility for people who are not able to live independently but do not require the level of skilled nursing provided by a nursing home.

**Congregate housing**—A type of housing arrangement for seniors that offers independent living in separate apartments as well as opportunities to share activities of daily living with other residents. Congregate housing does not usually involve assisted living or skilled nursing care, however.

**Culture change**—A term that refers to a movement in the United States to make nursing homes more resident-centered and less like hospitals.

**Long-term care**—Residential care over a period of time. A nursing home is a type of long-term care facility that offers nursing care and assistance with daily living tasks.

**Medicaid**—The federally funded program in the United States for state-operated programs that provide medical assistance to permanently disabled patients and to low-income people. Medicaid is the medical assistance provided in Title XIX of the Social Security Act.

**Medicare**—The federally-funded national health insurance program, provided for by Title XVIII of the Social Security Act in the United States for all people over the age of 65.

**Restraint**—A physical device or a medication designed to restrict a person's movement.

**Skilled nursing facility (SNF)**—Another name for a nursing home.

It is important for residents to have as much control as possible over their everyday lives. Laws and regulations exist to raise nursing home quality of life and care standards.

By law, nursing homes cannot use chemical or physical restraints unless they are essential for treating a medical problem. There are many dangers associated with the use of restraints, including the chance of a fall if a resident tries to walk while restrained. The devices may also lead to depression and decreased self-esteem. A doctor's order is necessary before restraints can be used in a nursing home.

## Licensing

The Joint Commission (formerly the Joint Commission on the Accreditation of Health Care Organizations) offers accreditation to nursing homes through the Long Term Care Accreditation Program established in 1966. This group helps nursing homes improve their quality of care. The commission periodically surveys nursing homes to check on quality issues.

A nursing home may be certified by **Medicare** or **Medicaid** if it meets the criteria of these organizations; 98.5% of nursing homes in the United States were certified to participate in one or both programs as of 2005. Families should be informed of the certifications a nursing home holds. Medicare and Medicaid are the main sources of financial income for nursing homes in the United States.

The state in which a nursing home is located conducts inspections every nine to 15 months. Fines and other penalties may be enforced if the inspection reveals areas where the nursing home does not meet requirements set by that state and the federal government. Problem areas are noted in terms of scope and severity. The scope of a problem is how widespread it is, and the severity is the seriousness of its impact on the residents. When a nursing home receives an inspection report, it must post it in a place where it can be easily seen by residents and their guests.

## Contract

When a resident checks into a nursing home, a contract is drawn up between the patient and the facility. This document includes information regarding the rights of the residents. It also provides details regarding services provided and discharge policies.

## Resident decision-making

Decisions are made by each nursing home resident unless he or she has signed an advanced directive giving this authority to someone else. In order for health care decisions to be made by another person, the resident must have signed a document called a durable **power of attorney** for health care.

## Costs

Nursing **home care** is costly. The rate normally includes room and board, housekeeping, bedding, nursing care, activities, and some personal items. Additional fees may be charged for haircuts, telephones, and other personal items.

Medicare covers the cost of some nursing home services, such as skilled nursing or rehabilitative care.



This payment may be activated when the nursing home care is provided after a Medicare qualifying stay in the hospital for at least three days. It is common for nursing homes to have only a few beds available for Medicare or Medicaid residents. Residents relying solely on these types of coverage must wait for a Medicare or Medicaid bed to become available.

Medicare supplemental insurance, such as Medigap, assists with the payment of nursing home expenses that are not covered by Medicare.

Medicaid qualifications vary in each state. Families of potential residents should check with their state government to determine coverage options. According to a federal law, a nursing home that drops out of the Medicaid program cannot evict current residents whose care is supported by Medicaid.

Private insurance, such as long-term insurance, may cover costs associated with a nursing home. People may enroll in these plans through their employers or other group insurance policies.

In many cases, nursing homes are paid for by the residents' personal funds. When these funds are exhausted, the residents sometimes become eligible for Medicaid assistance.

### *Patients' rights*

It is important for the professionals working in nursing homes to be aware of the residents' rights. Residents are informed of their rights when they are admitted. Residents have the right to:

- manage their finances
- privacy (for themselves and their belongings)
- make decisions (unless advanced directives or durable power of attorney exist)
- see visitors in private
- receive information regarding their medical care and treatments
- have social services
- leave the nursing home after giving the required amount of notice (A stay in a nursing home is normally considered voluntary; however, the facility will consider a variety of factors before discharging a resident. These factors include the resident's health, safety, and potential danger to self or others, as well as the resident's payment for services. The contract will state how much notice is required before a resident may transfer to another facility, return home, or move in with a family member.)

### *Family involvement*

In some cases, a nursing home is chosen after the family has only a short time to prepare for the change. For example, when a patient is unable to care for himself or herself due to a sudden illness or injury, the family must turn to nursing home care without having the luxury of researching this option over time. The nursing home's costs must be explained to the resident or family prior to admission. It is important for the nursing home staff to be willing to answer the family's questions and reassure them about the care their loved one will receive. To help with choosing a nursing home, Medicare has set up a Nursing Home Compare website at <http://www.medicare.gov/NHCompare/> that allows users to search by geography, proximity, the name of the nursing home, or special focus.

Nursing home professionals have an opportunity to continue to work closely with the resident's family and loved ones over the course of a resident's stay. In these facilities, concerned family members and friends of the resident are involved in his or her care, and may have guardianship or other decision-making responsibility. These individuals may voice their concerns through meetings between staff and family members. Those with legal guardianship are entitled to see a resident's medical records, care plans, and other related material.

### *Communication*

As in other health care settings, communication among nursing home staff is very important. In nursing homes, the care is based on a team approach. Physicians, nurses, and allied health professionals work together to make sure the resident is able to experience the highest quality of life possible.

In many cases, physicians who have had a long-term relationship with a patient continue treatment after the patient has been admitted to a nursing home. It is important for the nursing home staff to leave blocks of time open in the schedule for physician visits. It is also the staff's duty to keep the personal physicians apprised of a resident's medical condition.

The resident, physician, and resident's legal guardian and family must be told immediately if any of the following situations arise: an accident involving the resident, the need for a major treatment change, and a decision regarding discharge or transfer. Unless an emergency arises, the nursing home must give 30 days written notice of discharge or transfer. The family may appeal the decision.

### Culture change

Culture change refers to a movement to transform nursing homes into more homelike and less hospital-like communities. Spearheaded by groups like LIFESPAN, the Eden Alternative, and the Green House Project, people involved in changing nursing homes formed the Pioneer Network in 2000. The network advocates giving elders as much choice and self-determination as possible, including more opportunities for human companionship and keeping pets. As of 2004, nine states (Colorado, Florida, Illinois, Michigan, New Jersey, North Carolina, Pennsylvania, South Carolina, and Washington) had formed culture change coalitions.

The Pioneer Network drew up a list of values and principles that has been adopted by the NCCNHR (formerly the National Citizens' Coalition for Nursing Home Reform and other groups:

- Know each person.
- Each person can and does make a difference.
- Relationship is the fundamental building block of a transformed culture.
- Respond to spirit, as well as mind and body.
- Risk taking is a normal part of life.
- Put person before task.
- All elders are entitled to self-determination wherever they live.
- Community is the antidote to institutionalization.
- Do unto others as you would have them do unto you—yes, the Golden Rule.
- Promote the growth and development of all.
- Shape and use the potential of the environment in all its aspects: physical, organizational, psycho/social/spiritual.
- Practice self-examination, searching for new creativity and opportunities for doing better.
- Recognize that culture change and transformation are not destinations but a journey, always a work in progress.

### Results

The quality of care in nursing homes is an important issue. Quality issues include:

- Ratios of staff to patients. Advocacy groups are pushing for increased staff-to-patient ratios in nursing homes.) The NCCNHR recommends one direct care staff member (R.N., L.V.N., or C.N.A.) per five residents during the day shift, per 10 residents during the evening shift, and per 15 residents during the night shift.
- Elder abuse. It is important for nursing home personnel to look for signs of abuse or neglect when a

### WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The nursing home staff may include an administrator, medical director, director of nursing, and directors for other allied health services. It is important for nursing home staff to understand the policies regarding care in these types of facilities.

The following professionals may provide care and treatments in nursing homes:

- physicians, including psychiatrists
- nurses
- nursing assistants
- dietitians
- physical, occupational, and speech therapists
- pharmacists
- social activities staff
- dentists
- social workers or psychological counselors
- chaplains
- such other staff as custodians and office personnel

resident checks in and during a resident's stay. Signs of abuse include bodily injuries that appear suspicious, visible harm to the wrist or ankles that may indicate the use of restraints, skin ulcers that seem neglected, poor hygiene, inadequate nutrition, unexplained dehydration, untreated medical problems, or such personality disorders as excessive nervousness or withdrawal. The nurse or allied health professional is to report any signs of abuse to the supervisor or physician.

- Reimbursement. Nursing home administrators report that reimbursements do not cover the expenses, while nursing home advocates would like a higher portion of revenues to be allocated for direct patient care.

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## Obstetric and gynecologic surgery

### Definition

Obstetric and gynecologic surgery refers to procedures that are performed to treat a variety of conditions affecting the female reproductive organs. The main structures of the reproductive system are the vagina, the uterus, the ovaries, and the fallopian tubes.

### Description

Obstetrics is the branch of medicine that focuses on women during pregnancy, childbirth, and the postpartum period. Gynecology is a broader field, focusing on the general health care of women and treating conditions that affect the female reproductive organs. Medical doctors who choose to specialize in obstetrics and gynecology must undergo at least four years of post-medical school training (called a residency) in the areas of women's general health, pregnancy, labor and delivery, preconceptional and postpartum care, prenatal testing, and genetics. Obstetrician-gynecologists (also called OB-GYNs) may also subspecialize in the areas of gynecologic oncology (the treatment of cancers that affect the reproductive system), maternal-fetal medicine (the care of high-risk pregnancies), reproductive endocrinology and infertility (the study and treatment of the reproductive glands and hormones and the causes of infertility), and urogynecology (treatment of urinary tract and pelvic disorders).

### *Surgical procedures*

There are a wide range of surgical procedures that have been developed to treat the various conditions that affect the female reproductive organs.

**THE VAGINA.** The vagina is the muscular canal that extends from the opening of the vulva (the external female genitals) to the cervix, the lower part of the

uterus. The vagina is the outlet for menstrual blood and is also where the penis is inserted during sexual intercourse.

Some common surgical procedures that are performed on the vagina include:

- **Episiotomy.** A surgical incision made in the perineum (the area between the vagina and anus) to expand the opening of the vagina to prevent tearing during delivery.
- **Colporrhaphy.** Surgical repair of the vagina may be necessary after childbirth, sexual assault, or other injuries.
- **Colpotomy.** This incision into the wall of the vagina may be used to excise ovarian cysts, perform tubal ligation, or remove uterine fibroids.
- **Egg Retrieval.** This is a procedure used to extract the eggs from the ovaries prior to in vitro fertilization. A needle is placed through the vaginal wall to extract the eggs from the ovaries under ultrasound guidance.
- **Colposcopy.** A colposcope is a specialized instrument used to visualize the vagina and cervix, to diagnose abnormalities, or to test for the presence of precancerous or cancerous cells.

**THE UTERUS.** The uterus is the hollow, muscular organ at the top of the vagina. The cervix is the neck-shaped opening at the lower part of the uterus, while the fundus is the rounded upper portion. The endometrium is the inner lining of the uterus; it is where a fertilized egg will implant during the early days of pregnancy. The endometrium normally sheds during each menstrual cycle if the egg released during ovulation has not been fertilized. The myometrium is the middle muscular layer of the uterus; it is the myometrium that rhythmically contracts during labor contractions.

Some common surgical procedures that are performed on the uterus include:



## KEY TERMS

**Ectopic pregnancy**—A pregnancy that occurs outside of the uterus, most often in the fallopian tubes.

**Endometriosis**—A condition in which the endometrium (lining of the uterus) grows outside of the uterus.

**Ovarian cysts**—Fluid-filled cavities on the surface of the ovary that may cause pain and bleeding if they become too large.

**Uterine fibroids**—Also called leiomyomas; benign growths in the smooth muscle of the uterus.

**Uterine prolapse**—A condition which the uterus descends into or beyond the vagina.

- **Myomectomy.** A procedure in which myomas (uterine fibroids) are surgically removed from the uterus.
- **Cesarean section.** A surgical procedure in which incisions are made through the woman's abdomen and uterus to deliver her baby.
- **Cervical cerclage.** The cervix is stitched closed to prevent a miscarriage or premature birth.
- **Cervical cryosurgery.** Cryosurgery freezes and destroys an area of the cervix in which precancerous cells have been found.
- **Induced abortion.** The intentional termination of a pregnancy before the fetus can live independently.
- **Hysterectomy.** The removal of part or all of the uterus may be done to treat uterine cancer, fibroid tumors, endometriosis, uterine prolapse, or other conditions of the uterus.
- **Hysterotomy.** This incision into the uterus is done during a cesarean section, open fetal surgery, and some second-trimester abortions.
- **Dilatation and curettage.** D&C is a gynecological procedure in which the cervix is dilated (expanded) and the lining of the uterus (endometrium) is scraped away.

**THE OVARIES.** The ovaries are egg-shaped structures located to each side of the uterus. It is within the ovaries that the female egg develops. A mature egg is released from one of the ovaries approximately every 28 days during a process called ovulation.

The surgical procedures that are performed on the ovaries include:

- **Oophorectomy.** One or both ovaries may be removed during this procedure to prevent or treat ovarian or other cancers, to remove large ovarian cysts, or to treat endometriosis.

- **Cystectomy.** An ovarian cystectomy may be used to remove part of an ovary to treat ovarian tumors or cysts.

**THE FALLOPIAN TUBES.** The fallopian tubes are the structures that carry a mature egg from the ovaries to the uterus. These tubes, which are about 4 in (10 cm) long and 0.2 in (0.5 cm) in diameter, are found on the upper outer sides of the uterus, and open into the uterus through small channels. It is within a fallopian tube that fertilization, the joining of the egg and the sperm, takes place.

Some common surgical procedures that are performed on the fallopian tubes include:

- **Salpingostomy.** An incision is made in the fallopian tube, often to excise an ectopic pregnancy.
- **Salpingectomy.** One or both fallopian tubes are removed in this procedure. It may be used to treat ruptured or bleeding fallopian tubes (as a result of ectopic pregnancy), infection, or cancer.
- **Tubal ligation.** A permanent form of birth control in which a woman's fallopian tubes are surgically cut or blocked off to prevent pregnancy.

**THE VULVA.** The external female genital organs (or vulva) include the labia majora, two lips or folds that enclose the labia minora. The labia minora, in turn, are two lips or folds that enclose the clitoris, a small sensitive organ with a high number of nerve endings.

Some examples of surgeries that affect the vulva are:

- **Vulvectomy.** The vulva may be partially or completely removed, as in the case of vulvar cancer.
- **Laceration or hematoma repair.** Vulvar hematoma (a localized collection of blood) or laceration may result from a "straddle" injury, sexual assault, or childbirth. Severe hematomas may need surgical drainage.

### *Obstetric and gynecologic anesthesia*

There are a number of options available to women for pain relief during obstetric or gynecologic surgery. Pain medications given intravenously (into a vein) or intramuscularly (into a muscle) help to decrease the amount of pain during childbirth or certain procedures, although they will generally not completely eliminate pain.

Regional anesthesia, either a spinal or an epidural, is the preferred method of pain relief during childbirth and certain surgical procedures such as cesarean section, tubal ligation, **cervical cerclage**, and others that do not require the patient to be unconscious. The benefits of regional anesthesia include allowing the patient to be awake during the surgery, avoiding the risks of **general anesthesia**, and allowing early

contact between mother and child in the case of a cesarean section. Spinal anesthesia involves inserting a needle into a region between the vertebrae of the lower back and injecting numbing medications. An epidural is similar to a spinal except that a catheter is inserted so that numbing medications may be administered as needed. Some women experience a drop in blood pressure when a regional anesthetic is administered; this can be countered with fluids and/or medications.

In some instances, use of general anesthesia may be indicated. General anesthesia can be more rapidly administered in the case of an emergency (e.g. severe fetal distress). If the mother has a coagulation disorder that would be complicated by a drop in blood pressure (a risk with regional anesthesia), general anesthesia is an alternative. General anesthesia is also used for some of the more complicated and prolonged obstetric and gynecologic surgeries.

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Obstetric sonogram see **Pelvic ultrasound**

# Omphalocele repair

## Definition

An omphalocele is a congenital defect in which internal organs such as the liver, stomach, and intestines, are on the outside of the abdomen, at the umbilical cord, instead of being located inside the body. These abdominal cavity contents are enclosed in a thin, transparent, membranous sac that is actually formed inside the umbilical cord tissue. An omphalocele repair is a surgical procedure in which the organs are returned to the inside of the body, and the opening in the abdominal wall is closed. Whenever possible, a normal-looking belly button is created.

## Purpose

The internal organs need to be enclosed inside the abdomen for protection against injury, and to ensure that the tissue remains properly hydrated. The omphalocele repair is necessary to return the tissue to the inside of the body.

## Demographics

Omphaloceles usually occur in full-term infants, more frequently in boys than in girls. A recent study found that the ratio is two girls to three boys.

The presence of an omphalocele often occurs with other birth defects, including:

- heart defects, such as the tetralogy of Fallot
- imperforate anus, a malformation of the anorectal area of the gastrointestinal system
- urinary problems
- genetic disorders
- Beckwith-Wiedemann syndrome, with enlarged tongue, gigantism, and enlarged internal organs
- pentalogy of Cantrell, with malformations in the chest and abdominal area, including heart defects, and high mortality rate

To check for other congenital defects, x rays are usually taken of the heart, lungs, and diaphragm once the infant's condition has been stabilized after birth.

## Description

An omphalocele is a defect that can be viewed on sonogram during an **ultrasound** performed while the mother is pregnant. At about six to eight weeks of fetal development, the abdominal contents come out of the fetus's abdomen at the base of the umbilical cord. They return to the inside as development continues.

## KEY TERMS

**Congenital**—Present at the time of birth.

**Edema**—Swelling, or filling with fluid.

**Gigantism**—A condition in which the individual grows to an abnormally large size. Mental development may or may not be normal.

**Intravenous**—The use of a special tube, or catheter, inserted into a vein. Through the catheter, the infant may receive medications, as well as feedings, until taking food directly into the stomach is possible.

**Sonogram**—Image, or picture, obtained when using a machine called an ultrasound to look inside the uterus when the mother is pregnant. It is a painless procedure that sends out sound waves to the baby, and as the sound waves bounce off the object the baby an image is created on a monitor.

If this process is interrupted in some way during the seventh to tenth week of fetal development, the contents remain on the outside, and an omphalocele develops. Because the abdominal contents are now on the outside of the body, the inside cavity may not develop properly. For this reason, a large omphalocele cannot simply be placed back inside because the cavity may be too small. The internal organs will need to be protected and kept hydrated while the inside is gradually stretched. Small amounts of the omphalocele are returned at any one time to allow the cavity to gradually stretch to accommodate them. If the sac surrounding the tissue has ruptured, or broken, there is a greater risk of infection, tissue damage, loss of **body temperature**, and dehydration.

The repair may be performed in stages. If the omphalocele is very small, it may be possible to return all of the contents to the inside, and surgically close the opening. If the omphalocele is too large to do this all at once, some contents will remain on the outside while a sterile pouch is created to protect the tissue that remains on the outside. To be sure that the tissue does not dry out, it will be covered with warm and moist sterile **dressings**. The infant can lose considerable body heat through the large amount of exposed surface area, so keeping him or her warm, and closely monitoring body temperature is a high priority. An antibacterial solution may be used to decrease the risk of infection. The infant will have a tube that goes in through the nose or mouth and down into the stomach, called a nasogastric tube. Suction is used to keep the stomach empty, avoiding the chance of vomiting,

or of the fluid moving from the stomach up into the lungs. The contents of the sac will be carefully examined to make sure that none of the tissue is damaged or dead, and to check for signs of intestinal birth defects before being inserted into the body.

The omphalocele repair is a surgical procedure performed under **general anesthesia**. The infant will receive medication to relax his or her muscles, and to help the surgery move forward without causing any pain. A large omphalocele repair may be done in stages over several weeks. The contents of the sac are often swollen, which makes it impossible to return them into the small cavity all at once. The return of the sac contents into the abdominal cavity creates intra-abdominal pressure, which may cause the infant to have difficulty breathing. To help the infant breathe, a special breathing tube may be inserted. The tube is attached to a machine that regulates the length and frequency of the breaths. When the necessary surgeries have been completed, the suturing will be done in such a way as to leave, if possible, a somewhat normal-looking belly button. A large omphalocele repair can leave a large, unsightly scar. For cosmetic purposes, the scar may be operated on at a later date to make it less noticeable. Gastroesophageal reflux, which may require additional surgery, is common in patients with a repaired omphalocele.

## Diagnosis/Preparation

The diagnosis of an omphalocele may take place during an ultrasound while the mother is still pregnant. A recent study found that 75% of omphaloceles were diagnosed by ultrasound, most commonly around week 18 of pregnancy. To avoid any injury to the omphalocele sac, a cesarean birth may be performed so that the infant does not travel through the birth canal. If the omphalocele has not been detected prior to birth, it is immediately noticeable upon birth.

## Aftercare

The infant will need to spend some time after the surgery in the **intensive care unit**. Because infants are unable to properly regulate their temperature, they are placed in special beds that are kept warm. They will usually need oxygen and a breathing tube to help them breathe for a while. The breathing machine is referred to as **mechanical ventilation**, or a ventilator. This machine helps the baby breathe at the right depth and frequency for his or her age, allowing the infant to conserve energy for other functions. An infant that is struggling for air spends much energy on breathing, which slows the healing process.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

This procedure is performed by a surgeon, preferably board certified, who specializes in pediatric surgery and has experience with such conditions. The repair needs to be done in a hospital, preferably one with a neonatal intensive care unit, with specially-trained pediatric intensive care nurses and staff.

Once the bowels are moving normally, feedings will be slowly started. Feedings are usually first done through a nasogastric tube so the infant does not need to use energy for sucking and swallowing. Sucking on a pacifier is avoided because this could cause the bowel to expand with air and slow down the healing process. Until the nasogastric tube is used, the infant will be fed intravenously. The intravenous line provides the infant with needed **antibiotics**, pain medication, and fluids.

Infants with an omphalocele may spend quite some time, perhaps several months, in the hospital before being discharged home. It may take them some time to learn to feed through normal infant sucking and swallowing. Their development may be delayed, and they may require help for months as they catch up to the physical and mental development that is normal for their age. If the parents do not live near the hospital, they should be encouraged to spend as much time with their infant as possible to ensure infant-parent bonding. When the repair is done in stages, it can be difficult for the parents to remain patient. The birth of a child with a birth defect can be quite emotionally difficult for the parents. Individuals trained to assist parents through this time should meet with them to provide information and support.

## Risks

All surgery has risks, from the procedure itself as well as the anesthesia. Infection and bleeding are the two primary risks of surgery. Breathing problems and reactions to the anesthetics are the main risks from anesthesia. In addition to these standard surgical risks, an omphalocele repair has the associated risks of damage to the organs on the outside of the body, additional breathing problems from the added pressure inside the abdominal cavity when the contents are returned, infection of the abdominal cavity (peritonitis), and a slowing or paralysis of the bowels (paralytic ileus).

## QUESTIONS TO ASK THE DOCTOR

- In addition to the omphalocele, what other medical conditions does the child have?
- What is the chance of surviving the procedures needed to correct these problems?
- What quality of life can the child have if all the procedures are successfully performed?
- How many of these procedures has the surgeon performed?
- What outcomes has the surgeon's patients had?
- How long will the child need to stay in the hospital?
- What about breastfeeding?
- What is the likelihood of a similar condition being present in future children for this couple?

## Normal results

The expected results depend on many factors, including:

- size of the omphalocele
- degree of development of the abdominal cavity
- presence and extent of other congenital defects
- damage to or loss of intestinal tissue
- whether the infant was full-term or premature at birth

Many omphaloceles can be completely corrected with excellent results.

## Morbidity and mortality rates

An omphalocele occurs in about one in 5,000 live births. Other congenital defects are common. In one recent study, 50% of infants with omphalocele had other birth defects, primarily heart-related. On average, the infants spent three days on a ventilator, with about 45 total days spent in the hospital. The mortality rate was 8%, mostly due to heart problems.

## Alternatives

There are no non-surgical alternatives to omphalocele repair. The abdominal contents need to be returned to the abdominal cavity, and the opening closed. While awaiting surgical repair, a sterile elastic bandage may be placed on the omphalocele to decrease edema (fluid accumulation).



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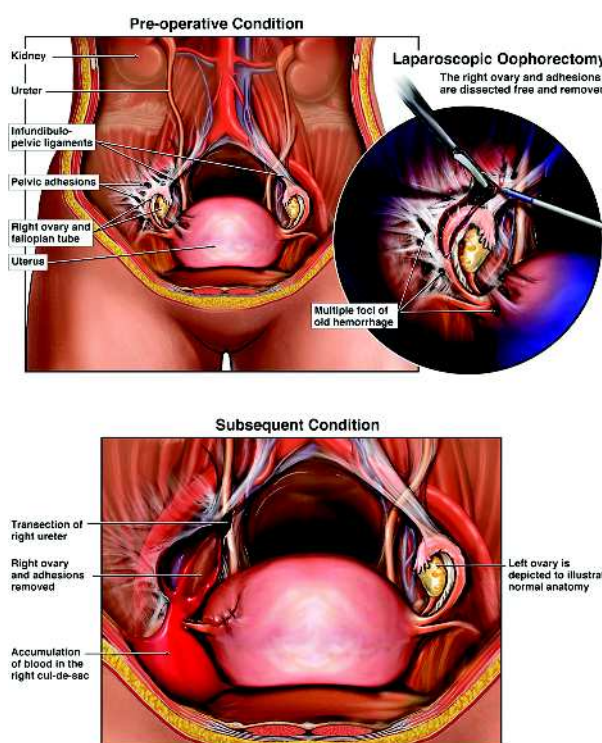
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Oncology surgery see **Surgical oncology**



**Ovarian surgery.** (Nucleus Medical Art, Inc. / Alamy)

## Oophorectomy

### Definition

Unilateral oophorectomy (also called an ovariectomy) is the surgical removal of an ovary. If one ovary is removed, a woman may continue to menstruate and have children. If both ovaries are removed, a procedure called a bilateral oophorectomy, menstruation stops and a woman loses the ability to have children.

### Purpose

Oophorectomy is performed to:

- remove cancerous ovaries
- remove the source of estrogen that stimulates some cancers
- remove a large ovarian cyst
- excise an abscess
- treat endometriosis

In an oophorectomy, one or a portion of one ovary may be removed or both ovaries may be removed. When an oophorectomy is done to treat ovarian cancer or other spreading cancers, both ovaries are removed (called a bilateral oophorectomy). Removal of the ovaries and fallopian tubes is performed in about one-third of hysterectomies (surgical removal of the uterus), often to reduce the risk of ovarian cancer.

Oophorectomies are sometimes performed on premenopausal women who have estrogen-sensitive breast cancer in an effort to remove the main source of estrogen from their bodies. This procedure has become less common than it was in the 1990s. Today, chemotherapy drugs are available that alter the production of estrogen and tamoxifen blocks any of the effects any remaining estrogen may have on cancer cells.

Until the 1980s, women over age 40 having hysterectomies routinely had healthy ovaries and fallopian tubes removed at the same time. This operation is called a bilateral **salpingo-oophorectomy**. Many physicians reasoned that a woman over 40 was approaching menopause and soon her ovaries would stop secreting estrogen and releasing eggs. Removing the ovaries would eliminate the risk of ovarian cancer and only accelerate menopause by a few years.

In the 1990s, the thinking about routine oophorectomy began to change. The risk of ovarian cancer in women who have no family history of the disease is less than 1%. Meanwhile, removing the ovaries increases the risk of cardiovascular disease and accelerates osteoporosis unless a woman takes prescribed hormone replacements.

Under certain circumstances, oophorectomy may still be the treatment of choice to prevent breast and

## KEY TERMS

**Cyst**—An abnormal sac containing fluid or semi-solid material.

**Endometriosis**—A benign condition that occurs when cells from the lining of the uterus begin growing outside the uterus.

**Fallopian tubes**—Slender tubes that carry ova from the ovaries to the uterus.

**Hysterectomy**—Surgical removal of the uterus.

**Osteoporosis**—The excessive loss of calcium from the bones, causing the bones to become fragile and break easily.

ovarian cancer in certain high-risk women. A study done at the University of Pennsylvania and released in 2000 showed that healthy women who carried the BRCA1 or BRCA2 genetic mutations that predisposed them to breast cancer had their risk of breast cancer drop from 80% to 19% when their ovaries were removed before age 40. Women between the ages of 40 and 50 showed less risk reduction, and there was no significant reduction of breast cancer risk in women over age 50. A 2002 study showed that five years after being identified as carrying BRCA1 or BRCA2 genetic mutations, 94% of women who had received a bilateral salpingo-oophorectomy were cancer-free, compared to 79% of women who had not received surgery.

The value of ovary removal in preventing both breast and ovarian cancer has been documented. However, there are disagreements within the medical community about when and at what age this treatment should be offered. Preventative oophorectomy, also called prophylactic oophorectomy, is not always covered by insurance. One study conducted in 2000 at the University of California at San Francisco found that only 20% of insurers paid for preventive bilateral oophorectomy (PBO). Another 25% had a policy against paying for the operation, and the remaining 55% said that they would decide about payment on an individual basis.

## Demographics

Overall, ovarian cancer accounts for only 4% of all cancers in women. But the lifetime risk for developing ovarian cancer in women who have mutations in BRCA1 is significantly increased over the general population and may cause an ovarian cancer risk of 30% by age 60. For women at increased risk,

oophorectomy may be considered after the age of 35 if childbearing is complete.

Other factors that increase a woman's risk of developing ovarian cancer include age (most ovarian cancers occur after menopause), the number of menstrual periods a woman has had (affected by age of onset, pregnancy, breastfeeding, and oral contraceptive use), history of breast cancer, diet, and family history. The incidence of ovarian cancer is highest among Native Americans (17.5 cases per 100,000 population), white (15.8 per 100,000), Vietnamese (13.8 per 100,000), white Hispanic (12.1 per 100,000), and Hawaiian (11.8 per 100,000) women; it is lowest among Korean (7.0 per 100,000) and Chinese (9.3 per 100,000) women. African American women have an ovarian cancer incidence of 10.2 per 100,000 population.

## Description

Oophorectomy is done under general or regional anesthesia. It is often performed through the same type of incision, either vertical or horizontal, as an abdominal **hysterectomy**. Horizontal incisions leave a less noticeable scar, but vertical incisions give the surgeon a better view of the abdominal cavity. After the incision is made, the abdominal muscles are stretched apart, not cut, so that the surgeon can see the ovaries. Then the ovaries, and often the fallopian tubes, are removed.

Oophorectomy can sometimes be done with a laparoscopic procedure. With this surgery, a tube containing a tiny lens and light source is inserted through a small incision in the navel. A camera can be attached that allows the surgeon to see the abdominal cavity on a video monitor. When the ovaries are detached, they are removed through a small incision at the top of the vagina. The ovaries can also be cut into smaller sections and removed.

The advantages of abdominal incision are that the ovaries can be removed even if a woman has many adhesions from previous surgery. The surgeon gets a good view of the abdominal cavity and can check the surrounding tissue for disease. A vertical abdominal incision is mandatory if cancer is suspected. The disadvantages are that bleeding is more likely to be a complication of this type of operation. The operation is more painful than a laparoscopic operation and the recovery period is longer. A woman can expect to be in the hospital two to five days and will need three to six weeks to return to normal activities.

## Diagnosis/Preparation

Before surgery, the doctor will order blood and urine tests, and any additional tests such as **ultrasound**

or x rays to help the surgeon visualize the woman's condition. The woman may also meet with the anesthesiologist to evaluate any special conditions that might affect the administration of anesthesia. A colon preparation may be done, if extensive surgery is anticipated.

On the evening before the operation, the woman should eat a light dinner, then take nothing by mouth, including water or other liquids, after midnight.

### Aftercare

After surgery a woman will feel discomfort. The degree of discomfort varies and is generally greatest with abdominal incisions, because the abdominal muscles must be stretched out of the way so that the surgeon can reach the ovaries. In order to minimize the risk of postoperative infection, **antibiotics** will be given.

When both ovaries are removed, women who do not have cancer are started on hormone replacement therapy to ease the symptoms of menopause that occur because estrogen produced by the ovaries is no longer present. If even part of one ovary remains, it will produce enough estrogen that a woman will continue to menstruate, unless her uterus was removed in a hysterectomy. To help offset the higher risks of heart and bone disease after loss of the ovaries, women should get plenty of **exercise**, maintain a low-fat diet, and ensure intake of calcium is adequate.

Return to normal activities takes anywhere from two to six weeks, depending on the type of surgery. When women have cancer, chemotherapy or radiation are often given in addition to surgery. Some women have emotional trauma following an oophorectomy, and can benefit from counseling and support groups.

### Risks

Oophorectomy is a relatively safe operation, although, like all major surgery, it does carry some risks. These include unanticipated reaction to anesthesia, internal bleeding, blood clots, accidental damage to other organs, and post-surgery infection.

Complications after an oophorectomy include changes in sex drive, hot flashes, and other symptoms of menopause if both ovaries are removed. Women who have both ovaries removed and who do not take estrogen replacement therapy run an increased risk for cardiovascular disease and osteoporosis. Women with a history of psychological and emotional problems before an oophorectomy are more likely to experience psychological difficulties after the operation.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Oophorectomies are usually performed in a hospital operating room by a gynecologist, a medical doctor who has completed specialized training in the areas of women's general health, pregnancy, labor and childbirth, prenatal testing, and genetics.

Complications may arise if the surgeon finds that cancer has spread to other places in the abdomen. If the cancer cannot be removed by surgery, it must be treated with chemotherapy and radiation.

### Normal results

If the surgery is successful, the ovaries will be removed without complication, and the underlying problem resolved. In the case of cancer, all the cancer will be removed. A woman will become infertile following a bilateral oophorectomy.

### Morbidity and mortality rates

Studies have shown that the complication rate following oophorectomy is essentially the same as that following hysterectomy. The rate of complications associated with hysterectomy differs by the procedure performed. Abdominal hysterectomy is associated with a higher rate of complications (9.3%), while the overall complication rate for vaginal hysterectomy is 5.3%, and 3.6% for laparoscopic vaginal hysterectomy. The risk of **death** is about one in every 1,000 women having a hysterectomy. The rates of some of the more commonly reported complications are:

- excessive bleeding (hemorrhaging): 1.8–3.4%
- fever or infection: 0.8–4.0%
- accidental injury to another organ or structure: 1.5–1.8%

Because of the cessation of hormone production that occurs with a bilateral oophorectomy, women who lose both ovaries also prematurely lose the protection these hormones provide against heart disease and osteoporosis. Women who have undergone bilateral oophorectomy are seven times more likely to develop coronary heart disease and much more likely to develop bone problems at an early age than are premenopausal women whose ovaries are intact.

## QUESTIONS TO ASK THE DOCTOR

- Why is a oophorectomy being recommended?
- How will the procedure be performed?
- Will I have a remaining ovary (or portion of ovary)?
- What alternatives to oophorectomy are available to me?

### Alternatives

Depending on the specific condition that warrants an oophorectomy, it may be possible to modify the surgery so at least a portion of one ovary remains, allowing the woman to avoid early menopause. In the case of prophylactic oophorectomy, drugs such as tamoxifen may be administered to block the effects that estrogen may have on cancer cells.

### Resources

#### PERIODICALS

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#### ORGANIZATIONS

American Cancer Society. 1599 Clifton Road NE, Atlanta, GA 30329. (800) ACS 2345. <http://www.cancer.org>.

American College of Obstetricians and Gynecologists. 409 12th St., SW, PO Box 96920, Washington, DC 20090 6920. <http://www.acog.org>.

Cancer Information Service, National Cancer Institute. Building 31, Room 10A19, 9000 Rockville Pike, Bethesda, MD 20892. (800) 4 CANCER. <http://www.nci.nih.gov/cancerinfo/index.html>.

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Open decompression see **Laminectomy**

Open fracture reduction see **Fracture repair**

## Open prostatectomy

### Definition

Open prostatectomy is a procedure for removal of an enlarged prostate gland.

### Purpose

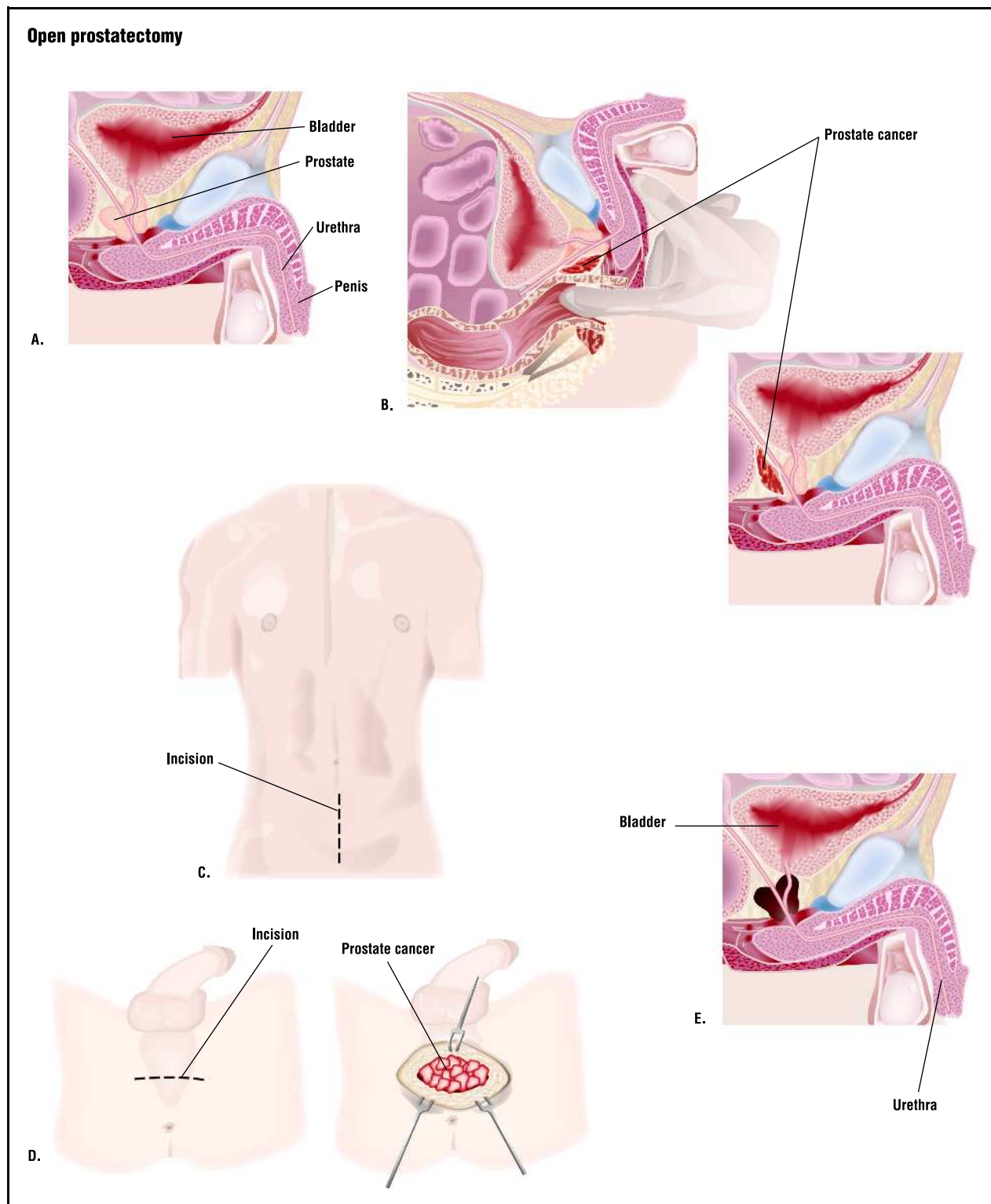
The prostate gland is located at the base of the male urethra. The primary indication for open prostatectomy is benign prostatic hyperplasia (BPH), a condition whereby benign or noncancerous nodules grow in the prostate gland. The prostate gland is composed of smooth muscle cells, glandular cells, and cells that give the gland structure (stromal cells). A dense fibrous capsule surrounds the prostate gland. The glandular cells produce a milky fluid that mixes with seminal fluid and sperm to make semen. The prostate gland also produces a hormone called dihydrotestosterone (DHT) that has a major impact on the gland's development.

### Description

The prostate gland undergoes several changes as a man ages. The pea-size gland at birth grows only slightly during puberty and reaches its normal adult shape and size (similar to a walnut) when a male is in his early twenties. The prostate gland remains stable until the mid-forties. At that time in most men, the number of cells begins to multiply, and the gland starts to enlarge. The enlargement, called hyperplasia, is due to an increase in the number of cells. Cell proliferation in the prostates of older men can cause symptoms (referred to as lower urinary tract symptoms, LUTS), which often include:

- straining when urinating
- hesitation before urine flow starts
- dribbling at the end of urination or leakage afterward
- weak or intermittent urinary strain
- painful urination





During a digital rectal exam (B), the doctor may feel an enlargement of the prostate that can be benign or cancerous. If an open prostatectomy is needed, an incision may be made in the lower abdomen (C) or the perineal area (D). In either case, the prostate and any cancer is removed (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Bladder mucosa**—Mucous coat of the bladder.

**Cerebrovascular accident**—Brain hemorrhage, also known as a stroke.

**Cystoscopy**—Examination of the bladder using a special instrument to visualize the organ.

**Cystotomy**—An incision in the bladder.

**Pulmonary embolus**—A thrombus that typically detaches from a deep vein of a lower extremity.

**Trendelenburg**—Position in which the head is low and the body and legs are on an inclined plane.

Other symptoms (called storage symptoms) sometimes appear, and may include:

- urgent need to urinate
- bladder pain when urinating
- increased frequency of urination, especially at night
- bladder irritation during urination

The cause of BPH is not fully understood. Currently, it is thought to be caused by a hormone that the prostate gland synthesizes, called dihydrotestosterone (DHT). The hormone is synthesized from testosterone.

Surgery is generally indicated for persons with moderate to severe symptoms, particularly if urinary retention is very poor or if the enlarged prostate (BPH) contributes to urinary tract infections, blood in the urine, bladder stones, or kidney problems.

Open prostatectomy is the treatment of choice for approximately 2–3% of BPH patients who have a very large prostate, a damaged bladder, or another serious related problem. Open prostatectomy is used when the prostate is so large (2.8–3.5 oz [80–100 g]) that **transurethral resection of the prostate** (TURP, a less invasive surgical procedure to remove a smaller prostate) cannot be performed. Additionally, open prostatectomy is indicated for males with:

- recurrent or persistent urinary tract infections.
- acute urinary distention.
- bladder outlet obstructions.
- recurrent blood in urine of prostate origin.
- pathological changes in the bladder, ureters, or kidneys due to prostate obstruction.

Contraindications to open prostatectomy (reasons not to do the procedure) include previous prostatectomy, prostate cancer, a small fibrous prostate

gland, and previous pelvic surgery that may obstruct access to the prostate gland.

## Demographics

The cause of BPH is not entirely known; however, the incidence increases with advancing age. Before 40 years of age, approximately 10% of males have BPH. A small amount of hyperplasia is present in 80% of males over 40 years old. Approximately 8–31% of males experience moderate to severe lower urinary tract symptoms (LUTS) in their fifties. By age 80, about 80% of men have LUTS. A risk factor is the presence of normally functioning testicles; research indicates that castration can minimize prostatic enlargement. It appears that the glandular tissues that multiply abnormally use male hormones produced in the testicles differently than the normal tissues do.

Approximately 10 million American men and 30 million men worldwide have symptoms of BPH. It is more prevalent in the United States and Europe, and less common among Asians. BPH is more common in men who are married rather than single, and there is a strong genetic correlation. A man's chance for developing BPH is greater if three or more family members have the condition.

## Description

Open prostatectomy can be performed by either the retropubic or suprapubic approach. The preferred anesthesia for open prostatectomy is a spinal or epidural nerve block. Regional anesthesia can help reduce blood loss during surgery, and lowers the risk of complications such as pulmonary embolus and postoperative deep vein thrombosis. **General anesthesia** may be used if the patient has an anatomic or medical contraindication for regional anesthesia.

### *Retropubic prostatectomy*

The retropubic prostatectomy is accomplished through a direct incision of the anterior (front) prostatic capsule. The overgrowth of glandular cells (hyperplastic prostatic adenoma) is removed. These are the cells forming a mass in the prostate because of their abnormal multiplication.

A **cystoscopy** is performed before the open prostatectomy. The patient lies on his back on the operating table, and is prepared and draped for this procedure. Following the cystoscopy, the patient is changed to a Trendelenburg (feet higher than head) position. The surgical area is shaved, draped, and prepared. A catheter is placed in the urethra to drain urine. An incision is made from the umbilicus to the pubic area. The

abdominal muscle (rectus abdominis) is separated, and a retractor is placed at the incision site to widen the surgical field. Further maneuvering is essential to clearly locate the veins (dorsal vein complex) and the bladder neck. Visualization of the bladder neck exposes the patient's main arterial blood supply to the prostate gland. Once the structures have been identified and the blood supply controlled, an incision is made deep into the level of the tumor. Scissors are used to dissect the prostatic tissue (prostatic capsule) from the underlying tissue of the prostatic tumor. The wound is closed after complete removal of the tumor and hemostasis (stoppage of bleeding) occurs.

The advantages of the retropubic prostatectomy include:

- direct visualization of the prostatic tumor.
- accurate incisions in the urethra, which will minimize the complication of urinary continence.
- excellent anatomic exposure and visualization of the prostate.
- clear visualization to control bleeding after tumor removal.
- little or no surgical trauma to the urinary bladder.

### *Suprapubic prostatectomy*

Suprapubic prostatectomy (also called transvesical prostatectomy) is a procedure to remove the prostatic overgrowth via a different surgical route. The suprapubic approach utilizes an incision of the lower anterior (front) bladder wall. The primary advantage over the retropubic approach is that the suprapubic route allows for direct visualization of the bladder neck and bladder mucosa. Because of this, the procedure is ideally suited for persons who have bladder complications, as well as obese men. The major disadvantage is that visualization of the top part of the tumor is reduced. Additionally, with the subrapubic approach, hemostasis (stoppage of bleeding during surgery) may be more difficult due to poor visualization after removal of the tumor.

Using a scalpel, a lower midline incision is made from the umbilicus to the pubic area. A cystotomy (incision into the bladder) is made, and the bladder inspected. Using electrocautery (a special tool that produces heat at the tip, useful for hemostasis or tissue excision) and scissors, dissection proceeds until the prostatic tumor is identified and removed. After maintaining hemostasis and arterial blood supply to the prostate, the incisions to the bladder and abdominal wall are closed.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The procedure is performed by a urological surgeon who typically completes one year of general surgery training, and four to five years of urology training. The procedure is usually performed in a large hospital.

## Diagnosis/Preparation

The presence of symptoms is indicative of the disease. Age also has an associated risk for an enlarged prostate, and can help establish diagnostic criteria.

Men must have a special blood test called the prostate specific antigen (PSA) test and routine digital rectal examination (DRE) before surgery. If the PSA levels and DRE are suspiciously indicative of prostate cancer, a transrectal **ultrasound** guided needle biopsy of the prostate must be performed before open prostatectomy, to detect the presence of prostate cancer.

Additionally, preoperative patients should have lower urinary tract studies, including urinary flow rate and post void residual urine in the bladder. Because most patients are age 60 or older, preoperative evaluation should also include a detailed history and **physical examination**; standard blood tests; chest x-ray; and **electrocardiogram** (EKG) to detect any possible preexisting conditions.

## Aftercare

Open prostatectomy is a major surgical operation requiring an inpatient hospital stay of four to seven days. Blood transfusions are generally not required due to improvements in surgical technique. Immediately after the operation, the surgeon must closely monitor urinary output and fluid status. On the first day after surgery, most patients are given a clear liquid diet and asked to sit up four times. Morphine sulfate, given via a patient controlled analgesic pump (IV), is used to control pain.

On the second postoperative day, the urethral catheter is removed if the urine does not contain blood. Oral pain medications are begun if the patient can tolerate a regular diet.

On the third postoperative day, the pelvic drain is removed if drainage is less than 75 ml in 24 hours. The patient should gradually increase activity. Follow-up with the surgeon is necessary following **discharge**.

## QUESTIONS TO ASK THE DOCTOR

- Why is an open prostatectomy recommended?
- What form of open prostatectomy (retropubic or suprapubic) will be used?
- What forms of anesthesia and pain relief will be given?
- Where will the incision be located?
- What are the risks of the procedure?
- Is the surgeon a board certified urologist?
- Is there an alternative to open prostatectomy?
- What are the chances of after effects, including erectile problems?

**from the hospital.** Full activity is expected to resume within four to six weeks after surgery.

### Risks

Improvements in surgical technique have lowered blood loss to a minimal level. For several weeks after open prostatectomy, patients may have urgency and urge incontinence. The severity of bladder problems depends on the patient's preoperative bladder status. Erectile dysfunction occurs in 3–5% of patients undergoing this procedure. Retrograde (backward flow) ejaculation occurs in approximately 50–80% of patients after open prostatectomy. The most common non-urologic risks include pulmonary embolism, myocardial infarction (heart attack), deep vein thrombosis, and cerebrovascular accident (stroke). The incidence of any one of these potentially adverse effects is less than 1%.

### Normal results

Normally, patients will not have the adverse effects of bleeding. Hematuria (blood in the urine) is typically resolved within two days after surgery. The patient should begin a regular diet and moderate increases in activity soon after surgery. His presurgical activity level should be restored within four to six weeks after surgery.

### Morbidity and mortality rates

The overall rate of morbidity and mortality is extremely low. The overall mortality (**death**) rate for open prostatectomy is approximately zero.

### Alternatives

For smaller prostates, treatment using medication may help to control abnormal prostatic growth. When the prostate gland is large (75 grams and bigger), surgery is indicated.

### Resources

#### BOOKS

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## Operating room

### Definition

An operating room (OR), also called surgery center, is the unit of a hospital where surgical procedures are performed.

### Purpose

An operating room may be designed and equipped to provide care to patients with a range of conditions, or it may be designed and equipped to provide specialized care to patients with specific conditions.

### Description

#### OR environment

Operating rooms are sterile environments. All personnel wear protective clothing called scrubs, as well as shoe covers, masks, caps, eye shields, and other coverings to prevent the spread of germs. The operating room is brightly lit and the temperature is very cool; operating rooms are air-conditioned to help prevent infection.



## KEY TERMS

**Advance directives**—Legal documents that increase a patient's control over medical decisions. A patient may select medical treatment in advance, in the event that he or she becomes physically or mentally unable to communicate his or her wishes. Advance directives either state what kind of treatment the patient wants to receive (living will), or authorize another person to make medical decisions for the patient when he or she is unable to do so (durable power of attorney).

**Anesthesiologist**—A specially trained physician who administers anesthesia.

**Arterial line**—A catheter inserted into an artery and connected to a physiologic monitoring system to allow direct measurement of oxygen, carbon dioxide, and invasive blood pressure.

**Catheter**—A small, flexible tube used to deliver fluids or medications. A catheter may also be used to drain fluid or urine from the body.

**Central venous line**—A catheter inserted into a vein and connected to a physiologic monitoring system to directly measure venous blood pressure.

**Chest tube**—A tube inserted into the chest to drain fluid and air from around the lungs.

**Critical care**—The multidisciplinary healthcare specialty that provides care to patients with acute, life-threatening illness or injury.

**Edema**—An abnormal accumulation of fluids in intercellular spaces in the body; causes swelling.

**Endotracheal tube**—A tube inserted through the patient's nose or mouth that functions as an airway and is connected to a ventilator.

**Foley catheter**—A tube inserted into the bladder to drain urine into an external bag.

**Gastrointestinal tube**—A tube surgically inserted into the stomach for feeding a patient who is unable to eat by mouth.

**Infectious disease team**—A team of physicians and hospital staff who help control the hospital environment to protect patients against harmful sources of infection.

**Inpatient surgery**—Surgery that requires an overnight stay of one or more days in the hospital. The number of days spent in the hospital after surgery depends on the type of procedure performed.

**Life support**—Methods of replacing or supporting a failing bodily function, such as using mechanical ventilation to support breathing. In treatable or curable conditions, life support is used temporarily to aid healing until the body can resume normal functioning.

**Nasogastric tube**—A tube inserted through the nose and throat and into the stomach for directly feeding the patient.

**Nothing by mouth (NPO)**—NPO refers to the time after which the patient is not allowed to eat or drink prior to a procedure or treatment.

**Outpatient surgery**—Also called same-day or ambulatory surgery. The patient arrives for surgery and returns home on the same day. Outpatient surgery can take place in a hospital, surgical center, or outpatient clinic.

**Swan-Ganz catheter**—Also called a pulmonary artery catheter, this is a type of tubing inserted into a large vessel in the neck or chest. It is used to measure the amount of fluid in the heart, and to determine how well the heart is functioning.

The patient is brought to the operating room in a wheelchair or a bed with wheels called a gurney. The patient is transferred to the operating table, which is narrow and has safety straps to keep him or her positioned correctly.

The monitoring equipment and anesthesia used during surgery are usually kept at the head of the operating table. The anesthesiologist sits here to monitor the patient's condition during surgery.

Depending on the nature of the surgery, various forms of anesthesia or sedation are administered. The surgical site is cleansed and surrounded by a sterile drape.

The instruments used during a surgical procedure are different for external and internal treatment; different tools are used on the outside and on the inside of the body. Once internal surgery is started, the surgeon uses smaller, more delicate devices.

### *OR equipment*

An operating room has special equipment such as respiratory and cardiac support, emergency resuscitative devices, patient monitors, and diagnostic tools.

### ***Life support and emergency resuscitative equipment***

Equipment for life support and emergency resuscitation includes:

- Heart-lung bypass machine, also called a cardiopulmonary bypass pump, which takes over for the heart and lungs during some surgeries, especially heart or lung procedures. The heart-lung machine removes carbon dioxide from the blood and replaces it with oxygen. A tube is inserted into the aorta to carry the oxygenated blood from the bypass machine to the aorta for circulation to the body. The heart-lung machine allows the heart's beating to be stopped during surgery.
- Ventilator, also called a respirator, which assists with or controls pulmonary ventilation. Ventilators consist of a flexible breathing circuit, gas supply, heating/humidification mechanism, monitors, and alarms. They are microprocessor-controlled and programmable, and regulate the volume, pressure, and flow of respiration.
- Infusion pump is a device that delivers fluids intravenously or epidurally through a catheter. Infusion pumps employ automatic, programmable pumping mechanisms to deliver continuous anesthesia, drugs, and blood infusions to the patient.
- Crash cart, also called resuscitation cart or code cart, is a portable cart containing emergency resuscitation equipment for patients who are "coding" (i.e., vital signs are in a dangerous range). The emergency equipment includes a defibrillator, airway intubation devices, resuscitation bag/mask, and medication box. Crash carts are strategically located in the operating room for immediate accessibility if a patient experiences cardiorespiratory failure.
- Intra-aortic balloon pump is a device that helps reduce the heart's workload and helps blood flow to the coronary arteries for patients with unstable angina, myocardial infarction, or those awaiting organ transplants. Intra-aortic balloon pumps use a balloon placed in the patient's aorta. The balloon is on the end of a catheter that is connected to the pump's console, which displays heart rate, pressure, and electrocardiogram (ECG) readings. The patient's ECG is used to time the inflation and deflation of the balloon.

### ***Patient monitoring equipment***

Patient monitoring equipment includes:

- Acute care physiologic monitoring system is a comprehensive patient monitoring system that can be configured to continuously measure and display various parameters via electrodes and sensors connected

to the patient. Parameters monitored may include the electrical activity of the heart via an ECG, respiratory (breathing) rate, blood pressure (noninvasive and invasive), body temperature, cardiac output, arterial hemoglobin oxygen saturation (blood oxygen level), mixed venous oxygenation, and end-tidal carbon dioxide.

- Pulse oximeter monitors the arterial hemoglobin oxygen saturation (oxygen level) of the patient's blood with a sensor clipped over the finger or toe.
- Intracranial pressure monitor measures the pressure of fluid in the brain in patients with head trauma or other conditions affecting the brain (such as tumors, edema, or hemorrhage). Intracranial pressure monitors are connected to sensors inserted into the brain through a cannula (tube) or bur hole. These devices signal elevated pressure and record or display pressure trends. Intracranial pressure monitoring may be a capability included in a physiologic monitor.

### ***Diagnostic equipment***

The use of diagnostic equipment may be required in the operating room. Mobile x-ray units are used for bedside radiography, particularly of the chest. These portable units use a battery-operated generator that powers an x-ray tube. Handheld portable clinical laboratory devices, called point-of-care analyzers, are used for blood analysis at the bedside. A small amount of whole blood is required, and blood chemistry parameters can be provided much faster than if samples were sent to the central laboratory.

### ***Other OR equipment***

Disposable OR equipment includes urinary (Foley) catheters to drain urine during surgery, catheters used for arterial and central venous lines to monitor blood pressure during surgery or to withdraw blood samples, Swan-Ganz catheters to measure the amount of fluid in the heart and to determine how well the heart is functioning, chest and endotracheal tubes, and monitoring electrodes.

### ***New surgical techniques***

Minimally invasive surgery, also called laparoscopic surgery, is an operative technique performed through a few small incisions, rather than one large incision. Through these small incisions, surgeons insert a laparoscope (viewing instrument that displays the site on a computer screen for easier viewing) and endoscopic instruments to perform the surgery.

**Robot-assisted surgery** allows surgeons to perform certain procedures through small incisions. In

robotic surgery, a surgeon sits at a console several feet from the operating table and uses a joystick, similar to that used for video games, to guide the movement of robotic arms that hold endoscopic instruments, as well as an endoscope (small camera). The surgeon uses the robotic arms to perform precise, fine hand movements and to provide access to parts of the body that are difficult to reach manually. In addition, robotic surgery provides a three-dimensional image, and the surgical field can be magnified to a greater extent than traditional or minimally invasive surgery. The goal of robotic surgery is to decrease incision size and **length of hospital stay**, while improving patient comfort and lessening recovery time.

Lasers are “scalpels of light” that offer new alternatives for some surgical procedures. Lasers can be used to cut, burn, or destroy abnormal or diseased tissue; shrink or destroy lesions or tumors; sculpt tissue; and seal blood vessels. Lasers may help surgeons perform some procedures more effectively than other traditional methods. Because lasers cause minimal bleeding, the operative area may be more clearly viewed by the surgeon. Lasers may also provide access to parts of the body that may not have been as easily reached manually.

### Surgery centers

Freestanding surgery centers are available in many communities, primarily for the purpose of providing outpatient surgical procedures. The patient should make sure that the surgery center has been accredited by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO), a professionally sponsored program that stimulates a high quality of patient care in healthcare facilities. There is also an accreditation option that is available for **ambulatory surgery centers**.

Choosing a surgery center with experienced staff is important. Here are some questions to consider when choosing a surgery center:

- How many surgeries are performed annually and what are the outcomes and survival rates for those procedures?
- How does the surgery center's outcomes compare with the national average?
- Does the surgery center offer procedures to treat a particular disease?
- Does the surgery center have experience treating patients in certain age groups?
- How much does surgery cost at this facility?
- Is financial assistance available?
- If the surgery center is far from the patient's home, will accommodations be provided for caregivers?

## Resources

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## Ophthalmologic surgery

### Definition

Ophthalmologic surgery is a surgical procedure performed on the eye or any part of the eye.

### Purpose

Surgery on the eye is routinely performed to repair retinal defects, remove cataracts or cancer, or to repair eye muscles. The most common purpose of ophthalmologic surgery is to restore or improve vision.

### Demographics

Patients from the very young to very old have ocular conditions that warrant eye surgery. Two of the most common procedures are **phacoemulsification for cataracts** and elective refractive surgeries.

Cataract surgery is the most common ophthalmic procedure. More than 1.5 million cataract surgeries are performed in the United States each year. According to the National Eye Institute (NEI), more than half of all Americans age 80 or older have a cataract or have had cataract surgery.

Elective refractive surgeries, especially **laser in-situ keratomileusis (LASIK)**, attract younger patients in their 30s and 40s. Recently, the American Academy of Ophthalmology (AAO) estimated that 95% of the 1.8 million refractive surgery procedures performed in a year were **LASIK**.

### Description

The surgeon, **operating room** nurses, and an anesthesiologist are present for ophthalmologic surgery. For many eye surgeries, only a local anesthetic is used, and the patient is awake. The patient's eye area is scrubbed prior to surgery, and sterile drapes are placed over the shoulders and head. Heart rate and blood pressure are monitored throughout the procedure. The patient is required to lie still and, for some surgery, especially refractive surgery, he or she is asked to focus on the light of the operating microscope. A speculum is placed in the eye to hold it open throughout surgery.

Common ophthalmologic surgery tools include scalpels, blades, forceps, speculums, and scissors. Many ophthalmologic surgeries now use lasers, which decrease the operating time as well as recovery time.

Surgeries requiring suturing can take as long as two or three hours. These intricate surgeries sometimes require the skill of a corneal or vitreo-retinal

## KEY TERMS

**Ablation**—During LASIK, the vaporization of eye tissue.

**Cataract**—A clouding of the eye's lens that affects vision.

**Cornea**—The clear, curved tissue layer in front of the eye. It lies in front of the colored part of the eye (iris) and the black hole in the center of the iris (pupil).

**Glaucoma**—Disease of the eye characterized by increased pressure of the fluid inside the eye. Untreated, glaucoma can lead to blindness.

**Macular degeneration**—A condition usually associated with age in which the area of the retina called the macula is impaired due to hardening of the arteries (arteriosclerosis). This condition interferes with vision.

**Retina**—The inner, light-sensitive layer of the eye containing rods and cones; transforms the images it receives into electrical messages sent to the brain via the optic nerve.

specialist, and require the patient to be put under **general anesthesia**.

### *Refractive surgeries*

Refractive surgeries use an excimer laser to reshape the cornea. The surgeon creates a flap of tissue across the cornea with an instrument called a microkeratome, ablates the cornea for about 30 seconds, and then replaces the flap. The laser allows this surgery to take only minutes, without the use of **stitches**.

### *Trabeculectomy*

**Trabeculectomy** surgery uses a laser to open the drainage canals or make an opening in the iris to increase outflow of aqueous humor. The purpose is to lower intraocular pressure in the treatment of glaucoma.

### *Laser photocoagulation*

Laser photocoagulation is used to treat some forms of wet age-related macular degeneration. The procedure stops leakage of abnormal blood vessels by burning them to slow the progress of the disease.



## Diagnosis/Preparation

Patients complaining of any ocular problem that requires surgery will receive a similar initial examination. A complete patient history is taken, including the chief complaint. The patient needs to disclose any allergies, medication usage, family eye and medical histories, and vocational and recreational vision requirements.

The diagnostic exam should include measurement of visual acuity under both low and high illumination, biomicroscopy with pupillary dilation, stereoscopic fundus examination with pupillary dilation, assessment of ocular motility and binocularity, visual fields, evaluation of pupillary responses to rule out afferent pupillary defects, refraction, and measurement of intraocular pressure (IOP).

Other examination procedures include corneal mapping, a keratometer reading to determine the curvature of the central part of the cornea, and a slit lamp exam to determine any damage to the cornea and evidence of glaucoma and cataracts. A fundus exam also will be performed to check for retinal holes, and macular degeneration and disease.

The patient's overall health must also be considered. Poor general health will affect the ophthalmologic-surgery outcome. Surgeons may request a complete **physical examination**, in addition to the eye examination, prior to surgery.

### *Presurgery preparation*

Patients having ophthalmologic surgery usually must stop taking **aspirin**, or aspirin-like products, 10 days before surgery unless directed otherwise by the surgeon. Patients taking blood thinners also must check with their physician to find out when they should stop taking the medication before surgery. A number of pain relievers may affect outcomes, making it important for the patient to disclose all medication. Some prescription medicines have been known to cause postsurgical scarring or flecks under the corneal flap after LASIK.

To reduce the chance of infection, the surgeon may request that the patient begin using antibiotic drops before surgery. Depending on the procedure, the patient may also be advised to discontinue contact lens wear and stop using creams, lotions, make-up, or perfume. Patients may also be asked to scrub their eyelashes for a period of time to remove any debris.

Patients are advised not to drink alcoholic beverages at least 24 hours before and after the ophthalmic procedure.

Patients must usually avoid eating or drinking anything after midnight on the day before the surgery; however, some patients may be allowed to have clear liquids in the morning. It is important for patients to ask their physician for a list of foods and medications permitted on the morning of surgery. Some patients may take morning medications (with physician approval) with the exclusion of **diuretics**, insulin, or diabetes pills. Patients are advised to dress comfortably for the surgery, and wear shirts that will not have to pass over the head.

Pre-surgical tests sometimes are administered when the patient arrives for surgery. For refractive surgeries, this ensures the laser is set for the correct refractive error. Before cataract surgery, measurements help determine the refractive power of the intraocular lens (IOL). Other tests, such as a **chest x ray**, blood work, or **urinalysis**, may also be requested depending on the patient's overall health.

Most ophthalmic surgeries are done on an outpatient basis, and patients must arrange for someone to take them home after the procedure.

Before surgery, doctors will review the pre-surgical tests and instill any dilating eye drops, antibiotic drops, and a corticosteroid or nonsteroidal anti-inflammatory drops as needed. Anesthetic eye drops also will be administered. Many ophthalmologic surgeries are performed under a local anesthetic, and patients remain in an awake but relaxed state.

## Aftercare

After surgery, the patient is monitored in a recovery area. For most outpatient procedures, the patient is advised to rest for at least 24 hours until he or she returns to the surgeon's office for follow-up care. Over-the-counter (OTC) medications are usually advised for pain relief, but patients should check with their doctor to see what is recommended. Some pain relievers interfere with surgical outcomes. Patients may also use ice packs to help ease pain.

Some patients may experience slight drooping or bruising of the eye. This condition improves as the eye heals. Severe pain, nausea, or vomiting should be reported to the surgeon immediately.

After surgery, patients may be advised not to stoop, lift heavy objects, **exercise** vigorously, or swim. Patients may also be required to wear an eye shield while sleeping, and sunglasses or some type of protective lens during the day to avoid injury. Wearing make-up may be prohibited for weeks after surgery. The patient may be restricted from driving and air travel.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Ophthalmologists and optometrists may detect ophthalmic problems; however, only an ophthalmologist can perform surgery. An ophthalmologist has received specialized training in diseases of the eye and their surgical treatment. Some ophthalmologists further specialize in certain areas of the eye, such as corneal or vitreo-retinal specialists. Depending on the severity of the disease, the general ophthalmologist may refer the patient to a specialist for treatment.

An anesthesiologist may be on hand during surgery to administer the local anesthetic. Surgical nurses will assist the ophthalmologist in the operating room, and assist the patient preoperatively and postoperatively.

Most ophthalmic surgery is performed on an outpatient basis. Ambulatory surgery centers designed for ophthalmologic surgery are commonly used. Surgery may also be performed in hospital operating rooms designed for outpatient surgeries.

Patients usually have their first postoperative visit the day after the eye surgery. Subsequent exams are commonly scheduled at one, three, and six to eight weeks following surgery. This schedule depends on the patient's healing, and any complications he or she might experience.

Some patients will be required to instill eye drops for a number of weeks after surgery to prevent infection, pain, and to lessen inflammation. Eye drops also are used to lower intraocular pressure. In some cases, correct eye drop usage is critical to a successful surgery outcome.

### Risks

Complications may occur during any surgery. Ophthalmologic surgery, however, is usually very safe.

Some risks include:

- Undercorrection or overcorrection in refractive surgery. Undercorrected refractive surgery patients usually can be treated with an enhancement, but overcorrected patients will need to use eyeglasses or contact lenses.
- Debilitating symptoms. These include glare, halos, double vision, and poor nighttime vision. Some

## QUESTIONS TO ASK THE DOCTOR

- If both eyes are diseased, will they be treated simultaneously?
- Will the eyes need to rest after surgery? Will protective lenses be required following the procedure?
- Will eyeglasses be needed?
- How many times has the surgeon performed this specific procedure?
- Should the physician be contacted if pain develops after the surgery?
- When can normal activities, such as driving, be resumed?

patients may also lose contrast sensitivity. These symptoms may be temporary or permanent.

- Dry eye. Some patients are treated with artificial tears or punctal plugs.
- Retinal detachment. The retina can become detached by the surgery if this part of the eye has any weakness when the procedure is performed. This may not occur for weeks or months.
- Endophthalmitis. An infection in the eyeball is a complication that is less common today because of newer surgery techniques and antibiotics.

Other serious complications that may occur are blindness, glaucoma, or hemorrhage.

### Normal results

Normal results include restored or improved vision, and a much improved quality of life. Specific improvements depend on the type of ophthalmologic surgery performed, and the type of ocular ailment being treated.

### Morbidity and mortality rates

**Death** from ophthalmologic surgery is rare. However, complications can still arise from the use of general anesthesia. With most ophthalmic surgeries requiring only local anesthetic, that risk has been widely eliminated.

Blindness, which was sometimes caused by serious infection, has also been reduced because of more effective **antibiotics**.

## Alternatives

Some medications can be used to treat certain ophthalmic conditions. For example, surgery for glaucoma is performed only in patients who do not respond to medication. Patients with myopia (nearsightedness), hyperopia (farsightedness), or presbyopia (difficulty focusing up close) can wear contact lenses or eyeglasses instead of having refractive surgery to improve their refractive errors.

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## Ophthalmoscopy

### Definition

Ophthalmoscopy involves the use of a lighted scope (ophthalmoscope) that has a very bright light and a number of magnifying lenses. The scope used may be

a handheld scope that provides both light source and magnifying lenses (direct ophthalmoscope). Alternatively, the examiner may wear a binocular device and hold a lens to perform this examination (indirect ophthalmoscope). The ophthalmoscope is used to examine the back of the eye (called the fundus). The fundus is lined by the light-sensitive tissue of the retina, and also contains the optic disc, choroids, and blood vessels.

### Purpose

Ophthalmoscopy is performed during the course of all routine physical examinations. Additionally, ophthalmoscopy can be performed when symptoms suggest the possible presence of a condition that could affect the eyes. For example, eye diseases such as macular degeneration, glaucoma, retinal detachment, or tumors on the optic nerve can be diagnosed or monitored through ophthalmoscopy. Ophthalmoscopy may also be used to evaluate and monitor the deleterious effects of diseases of other body systems that may also affect the health of the eye, including such conditions as high blood pressure, atherosclerosis, vascular disease, diabetes, and brain tumors.

### Description

Ophthalmoscopy is performed in a dark room. The bright light from the ophthalmoscope will be shined into each of the patient's eyes, and the examiner will change the internal lens of the scope to the power that provides the clearest image. The scope will be moved so that all quadrants of the eye can be examined. The individual undergoing the examination may be asked to move his or her eyes in various directions. An instrument to measure pressure in the eyeball may be briefly applied to each eyeball to test for glaucoma. The entire examination is usually completed in under five to ten minutes.

### Preparation

There is no advance preparation required for ophthalmoscopy. In some cases, such as indirect ophthalmoscopy, drops which can dilate the pupils may be put into the patient's eyes several minutes prior to the examination. When the pupils are dilated, it can make the examination easier to perform, and the structures within the eye can be more clearly visualized by the examiner.

### Aftercare

When patients have received dilating eyedrops prior to ophthalmoscopy, they should wear sunglasses

## KEY TERMS

**Atherosclerosis**—A disease in which plaques of material along the arterial walls cause the arteries to become abnormally hard and stiff. This disease puts people at higher risk for heart attack and stroke.

**Choroid**—Blood vessels which run between the white of the eye (sclera) and the retina, carrying nutrients and oxygen to the retina.

**Glaucoma**—A disease in which there is excessive fluid pressure within the eyeball.

**Macular degeneration**—A progressive disease in which the central portion of the retina (the macula) is gradually destroyed.

**Optic disc**—A visually inactive portion of the retina from which the optic nerve and blood vessels emerge.

**Retina**—The light-sensing tissue within the eye that sends signals to the brain in order to generate a visual image.

while outside for the next several hours to protect their eyes from sunlight. Some people find that their vision is affected by the dilatation of their pupils. In this case, they should be advised not to drive until they feel that their vision has returned to normal. Other than these precautions, there is no aftercare necessary following ophthalmoscopy. The patient can immediately return to a normal diet and normal activities.

### Risks

Ophthalmoscopy poses no risk to the patient. Under rare circumstances, patients may have a reaction to the dilating eyedrops, such as nausea, vomiting, dry mouth, flushing, dizziness, or a glaucoma episode.

### Normal results

Normal results of ophthalmoscope reveal normal anatomy of the back of the eye.

### Abnormal results

Abnormalities in the ophthalmoscopic examination may indicate a variety of eye disease, trauma to the eye, or other systemic diseases that have effects on the structure or functioning of structures within the eye.

## Resources

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Opioid analgesics see **Analgesics, opioid**

Optional surgery see **Elective surgery**

## Oral glucose tolerance test

### Definition

The oral glucose tolerance test (OGTT) is a series of blood tests that are used to evaluate an individual's response to drinking a standard quantity of a specific glucose-containing solution. The patient drinks the solution, and then the blood is drawn at specific intervals over the next several hours. Each blood test measures the amount of glucose (a particular form of simple sugar) in the blood. The tests are used to evaluate patients for the possibility that they have diabetes.

When carbohydrates are ingested, they are broken down in the intestines into component parts, including sugars such as glucose. Glucose is absorbed from the small intestine into the bloodstream. It circulates throughout the body and is used by all of the body's tissues and organs to generate the energy necessary for their normal functioning. In order for glucose to enter the body's cells, insulin must be present. Insulin is a hormone produced in and excreted by the pancreas. Insulin functions to allow the transport of glucose into the cells of the body, as well as being involved in the body's storage of excess glucose in the form of glycogen or triglycerides.

The blood levels of glucose and insulin are intimately related. When carbohydrates are metabolized after a meal, the blood glucose begins to rise. Under normal circumstances, the pancreas then secretes insulin, in an amount relative to the blood glucose elevation. Between meals, or after heavy exertion, glucose levels may begin to drop below a safe threshold for the body's cells (particular cells of the brain and nervous system). In response to this lowering of blood glucose, the pancreas secretes a different hormone, called glucagon. Glucagon prompts the liver to convert glycogen into glucose, thereby elevating the blood glucose back into a safe range.



Abnormal levels of blood glucose can be life-threatening. High blood glucose is termed hyperglycemia; low blood glucose is termed hypoglycemia. Either of these conditions can result in organ failure, severe brain damage, coma, or **death**. Diabetes occurs when the pancreas fails to produce normal amounts of insulin, or when it completely stops producing any insulin at all (this is often referred to as insulin-dependent or type I diabetes). Diabetes can also occur when cells of the body become less responsive to the effects of insulin (this is often referred to as insulin-resistance, or type II diabetes). Diabetes causes abnormal perturbations of the **serum glucose level**. Over time, chronic high levels of serum glucose (which may occur in poorly controlled diabetes) can result in severe damage to the heart, the eyes, the kidneys, the circulatory system, and the nervous system. In diabetics, sudden, acute increases in the serum glucose level can result in the condition called diabetic ketoacidosis, in which the extremely high levels of blood glucose lead a life-threatening illness. Diabetics can also suffer from sudden drops in serum glucose levels; if untreated, glucose deprivation affecting the organs and tissues of the body can also be life-threatening.

Women are at risk of developing gestational diabetes during pregnancy. While this condition usually resolves after the birth of the baby, and rarely leads to a permanent diagnosis of diabetes, untreated gestational diabetes can result in problems for the baby as well as the mother. Gestational diabetes in early pregnancy can cause birth defects (particularly of the brain and/or heart) and increase the chance of miscarriage. Gestational diabetes in the second and third trimesters can cause the baby to grow very large (termed macrosomia). The baby's size can result in problems for the mother during labor and delivery. Additionally, once the baby is born, it can suffer sudden hypoglycemia. In utero, the baby will have acclimated to its mother's high serum glucose levels by producing high levels of insulin. After birth, suddenly deprived of that glucose, the baby's relatively high insulin levels can result in severe hypoglycemia. If the mother is known to have gestational diabetes, then the baby will be monitored more carefully for potential drops in its blood glucose, and, if necessary, treatment with an IV solution containing glucose can be instituted rapidly.

### Purpose

An oral glucose tolerance test is usually performed when there is a suspicion that an individual has Type II diabetes, for example when a serum glucose level has revealed an abnormality, when there is a strong family history of diabetes, when an individual has specific risk

factors for diabetes (such as being overweight), or when an individual is experiencing symptoms suggestive of diabetes (excessive thirst and/or hunger, urinary frequency, unintentional weight loss, severe fatigue and weakness, and poor healing). Additionally, an oral glucose tolerance test is almost always ordered as a routine part of prenatal care during the second trimester of pregnancy, usually between 24 and 28 weeks of pregnancy.

### Precautions

Serum glucose levels can be affected by a number of medications. Patients who are on these medications should inform their doctor, so that test results can be interpreted appropriately. Medications that may affect serum glucose levels include birth control pills, high blood pressure medications, phenytoin, furosemide, triamterene, hydrochlorothiazide, niacin, propranolol, and steroid medications. Additionally, the use of alcohol, caffeine, or recent illness, infection or emotional distress may affect test results.

Patients who are taking anticoagulant medications should inform their healthcare practitioner, since this may increase their chance of bleeding or bruising after a blood test.

### Description

This test requires blood to be drawn from a vein (usually one in the forearm), generally by a nurse or phlebotomist (an individual who has been trained to draw serum). The initial blood draw is performed prior to the patient drinking the glucose solution. The other blood draws are performed at set intervals over the three or so hours after the solution has been ingested.

A tourniquet is applied to the arm above the area where the needle stick will be performed. The site of the needle stick is cleaned with antiseptic, and the needle is inserted. The serum is collected in vacuum tubes. After collection, the needle is withdrawn, and pressure is kept on the serum draw site to stop any bleeding and decrease bruising. A bandage is then applied.

### Preparation

The oral glucose tolerance test should only be performed when the individual is in perfectly good health and normally ambulatory/active. For the 72 hours prior to undergoing the OGTT, the individual should be instructed to eat a high-carbohydrate diet (150-200 grams of carbohydrate per day). The test is done on a fasting basis, meaning that nothing should be eaten or drunk after midnight prior to the test (the

## KEY TERMS

**Gestational diabetes**—A type of diabetes that occurs during pregnancy. Untreated, it can cause severe complications for the mother and the baby. However, it usually does not lead to long-term diabetes in either the mother or the child.

**Glucose**—A simple sugar that is the product of carbohydrate metabolism. It is the major source of energy for all of the organs and tissues of the body.

**Glucagon**—A hormone produced in the pancreas that is responsible for elevating blood glucose when it falls below a safe level for the body's organs and tissues.

**Glycogen**—The form in which glucose is stored in the body.

**Hyperglycemia**—Elevated blood glucose levels.

**Hypoglycemia**—Low blood glucose levels.

**Insulin**—A hormone produced by the pancreas that is responsible for allowing the body's cells to utilize glucose. The deficiency or absence of insulin is one of the causes of the disease diabetes.

**Ketoacidosis**—A potentially life-threatening condition in which abnormally high blood glucose levels result in the blood become too acidic.

**Macrosomia**—The term used to describe a newborn baby with an abnormally high birth weight.

**Pancreas**—An organ located near the liver and stomach, responsible for various digestive functions. The pancreas produces insulin and glucagon, hormones that are responsible for maintaining safe blood levels of glucose.

fast should last a minimum of eight and a maximum of sixteen hours). The morning of the exam, the individual should be instructed not to smoke or drink any caffeinated beverages.

Upon arrival at the laboratory, a baseline fasting serum blood glucose will be drawn. Following this, the individual will be asked to drink a solution that contains 75 grams of glucose (pregnant women will drink a 100-gram solution). The solution must be ingested in no more than five minutes. Serum blood glucose levels will be drawn at 30- to 60-minute intervals over the next several hours. A classic oral glucose tolerance test involves five blood draws over the course of the three hour testing period. An abbreviated oral glucose tolerance involves a baseline serum glucose determination, a two-hour wait, and then a second serum glucose level.

## Aftercare

As with any blood tests, discomfort, bruising, and/or a very small amount of bleeding is common at the puncture site. Immediately after the needle is withdrawn, it is helpful to put pressure on the puncture site until the bleeding has stopped. This decreases the chance of significant bruising. Warm packs may relieve minor discomfort. Some individuals may feel briefly woozy after a serum test, and they should be encouraged to lie down and rest until they feel better.

## Risks

Basic blood tests, such as serum glucose levels, do not carry any significant risks, other than slight bruising and the chance of brief dizziness.

## Results

Normal results of a random serum glucose test range from 70-125 milligrams per deciliter (mg/dL). A normal serum glucose level at the two-hour point (two hours after ingesting the glucose solution) is less than 140 mg/dL. During the course of the two hours, any serum glucose levels should be less than 200 mg/dL.

## High levels

High serum glucose levels suggest the possibility of diabetes. However, a single high, random serum glucose level is not sufficient for definitively diagnosing diabetes. The American Diabetes Association has specific criteria that must be met in order to diagnose diabetes. They require that results are verified through testing on a minimum of two different days. The oral glucose tolerance is considered to be positive for diabetes when the blood draw at the two-hour point measures 200 mg/dL or higher.

Some individuals don't meet the criteria for an actual diagnosis of diabetes, but have a higher-than-normal fasting serum glucose level, also known as an impaired fasting glucose (ranging from 100 mg/dL to 125 mg/dL), and an elevated 2-hour serum glucose level (ranging between 140 and 199 mg/dL). These individuals are thought to have an increased risk of eventually developing diabetes, and should be followed closely. Some practitioners believe that these serum glucose levels are indicative of "prediabetes."

When an oral glucose tolerance test is performed on a pregnant woman, gestational diabetes is diagnosed if the test reveals any two of the following criteria:

- A fasting serum glucose level greater than 95 mg/dL
- A serum glucose level greater than 180 mg/dL, one hour after ingesting the standardized glucose solution

- A serum glucose level greater than 155 mg/dL, two hours after ingesting the standardized glucose solution
- A serum glucose level greater than 140 mg/dL, three hours after ingesting the standardized glucose solution

A number of conditions other than diabetes can cause high serum glucose levels, including:

- Severe stress
- Heart attack
- Stroke
- Cushing's syndrome
- Steroid medications
- Pheochromocytoma
- Polycystic ovarian disease
- Acromegaly (elevated growth hormone)

### *Low levels*

Low serum glucose levels may be due to:

- The presence of an insulinoma (a tumor that secretes insulin)
- Addison's disease
- Hypothyroidism (underactive thyroid)
- Pituitary gland tumor
- Liver disease, including cirrhosis
- Kidney disease
- Malnutrition
- Eating disorders, including anorexia nervosa
- Inappropriate doses of medicines used to treat diabetes, such as insulin or oral hypoglycemic agents

### **Resources**

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## **Orchiectomy**

### **Definition**

Orchiectomy is the surgical removal of one or both testicles, or testes, in the human male. It is also called an orchidectomy, particularly in British publications. The removal of both testicles is known as a bilateral orchiectomy, or castration, because the person is no longer able to reproduce. Emasculation is another word that is sometimes used for castration of a male. Castration in women is the surgical removal of both ovaries (bilateral **oophorectomy**).

### **Purpose**

An orchiectomy is done to treat cancer or, for other reasons, to lower the level of testosterone, the primary male sex hormone, in the body. Surgical removal of a testicle is the usual treatment if a tumor is found within the gland itself, but an orchiectomy may also be performed to treat prostate cancer or cancer of the male breast, as testosterone causes these cancers to grow and metastasize (spread to other parts of the body). An orchiectomy is sometimes done to prevent cancer when an undescended testicle is found in a patient who is beyond the age of puberty.

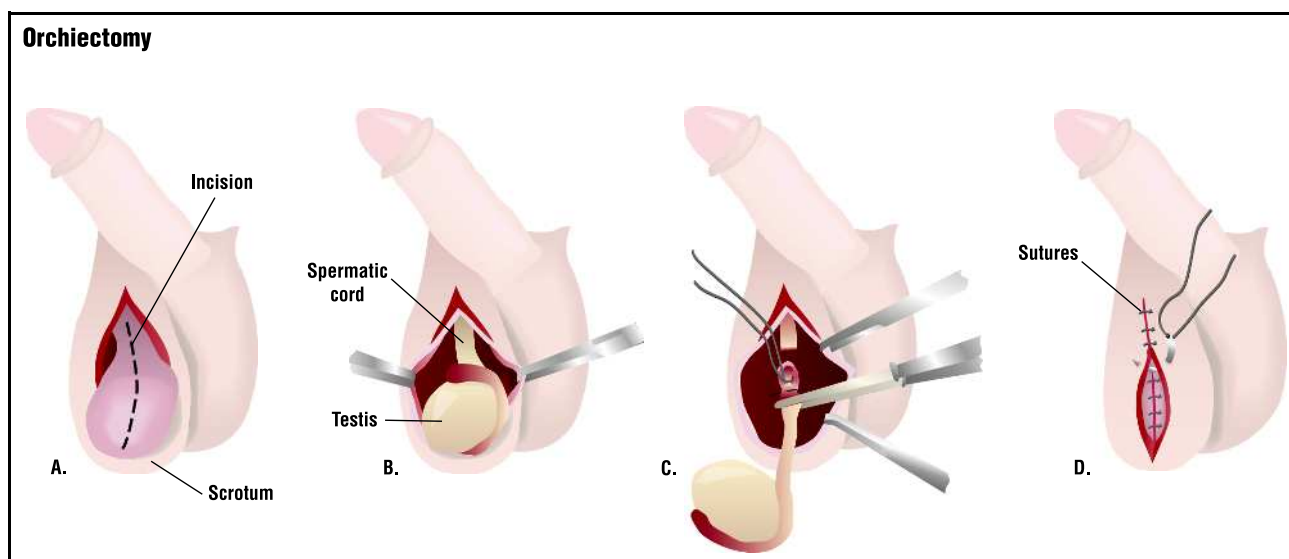
A bilateral orchiectomy is commonly performed as one stage in male-to-female (MTF) gender reassignment surgery. It is done both to lower the levels of male hormones in the patient's body and to prepare the genital area for later operations to construct a vagina and external female genitalia.

Some European countries and four states in the United States (California, Florida, Montana, and Texas) allow convicted sex offenders to request surgical castration to help control their sexual urges. This option is considered controversial in some parts of the legal system. A small number of men with very strong sex drives request an orchiectomy for religious reasons; it should be noted, however, that official Roman Catholic teaching is opposed to the performance of castration for spiritual purity.

### **Demographics**

#### **Cancer**

Cancers in men vary widely in terms of both the numbers of men affected and the age groups most likely to be involved. Prostate cancer is the single most common malignancy affecting American men over the age of 50; about 220,000 cases are reported each year. According to the Centers for Disease Control and Prevention



**In an orchiectomy, the scrotum is cut open (A). Testicle covering is cut to expose the testis and spermatic cord (B). The cord is tied and cut, removing the testis (C), and the wound is repaired (D).** (Illustration by GGS Information Services. Cengage Learning, Gale.)

(CDC), 31,000 men in the United States die every year from prostate cancer. African-American men are almost 70% more likely to develop prostate cancer than either Caucasian or Asian-American men; the reasons for this difference are not yet known. Other factors that increase a man's risk of developing prostate cancer include a diet high in red meat, fat, and dairy products, and a family history of the disease. Men whose father or brother(s) had prostate cancer are twice as likely as other men to develop the disease themselves. Today, however, there are still no genetic tests available for prostate cancer.

Testicular cancer, on the other hand, frequently occurs in younger men; in fact, it is the most common cancer diagnosed in males between the ages of 15 and 34. The rate of new cases in the United States each year is about 3.7 per 100,000 people. The incidence of testicular cancer has been rising in the developed countries at a rate of about 2% per year since 1970. It is not yet known whether this increase is a simple reflection of improved diagnostic techniques or whether there are other causes. There is some variation among racial and ethnic groups, with men of Scandinavian background having higher than average rates of testicular cancer, and African-American men having a lower than average incidence. Testicular cancer occurs most often in males in one of three age groups: boys 10 years old or younger; adult males between the ages of 20 and 40; and men over 60.

Other risk factors for testicular cancer include:

- Cryptorchidism, which is a condition in which a boy's testicles do not move down from the abdomen into the scrotum at the usual point in fetal development. It is also called undescended testicle(s). Ordinarily, the testicles descend before the baby is born; however, if the baby is born prematurely, the scrotal sac may be empty at the time of delivery. About 3–4% of full-term male infants are born with undescended testicles. Men with a history of childhood cryptorchidism are three to 14 times more likely to develop testicular cancer.
- Family history of testicular cancer.
- A mother who took diethylstilbestrol (DES) during pregnancy. DES is a synthetic hormone that was prescribed for many women between 1938 and 1971 to prevent miscarriage. It has since been found to increase the risk of certain types of cancer in the offspring of these women.
- Occupational and environmental factors. Separate groups of researchers in Germany and New Zealand reported in 2003 that firefighters have an elevated risk of testicular cancer compared to control subjects. The specific environmental trigger is not yet known.

### *Gender reassignment*

Statistics for orchiectomies in connection with gender reassignment surgery are difficult to establish



## KEY TERMS

**Androgen**—Any substance that promotes the development of masculine characteristics in a person. Testosterone is one type of androgen; others are produced in the adrenal glands located above the kidneys.

**Bilateral**—On both sides. A bilateral orchiectomy is the removal of both testicles.

**Capsule**—A general medical term for a structure that encloses another structure or body part. The capsule of the testicle is the membrane that surrounds the glandular tissue.

**Castration**—Removal or destruction by radiation of both testicles (in a male) or both ovaries (in a female), making the individual incapable of reproducing.

**Cryptorchidism**—A developmental disorder in which one or both testes fail to descend from the abdomen into the scrotum before birth.

**Emasculation**—Another term for castration of a male.

**Epidural**—A type of regional anesthetic delivered by injection into the area around the patient's lower spine. An epidural numbs the body below the waist but allows the patient to remain conscious throughout the procedure.

**Gender identity disorder (GID)**—A mental disorder in which a person strongly identifies with the other sex and feels uncomfortable with his or her biological sex. It occurs more often in males than in females.

**Gender reassignment surgery**—The surgical alteration and reconstruction of a person's sex organs to resemble those of the other sex as closely as possible; it is sometimes called sex reassignment surgery.

**Inguinal**—Referring to the groin area.

**Metastasis**—A process in which a malignant tumor transfers cells to a part of the body not directly connected to its primary site. A cancer that has spread from its original site to other parts of the body is said to be metastatic.

**Oophorectomy**—Removal of one or both ovaries in a woman.

**Orchiectomy**—Surgical removal of one or both testicles in a male. It is also called an orchidectomy.

**Scrotum**—The pouch of skin on the outside of the male body that holds the testes.

**Spermatic cord**—A tube-like structure that extends from the testicle to the groin area. It contains blood vessels, nerves, and a duct to carry spermatic fluid.

**Subcapsular**—Inside the outer tissue covering of the testicle. A subcapsular orchiectomy is a procedure in which the surgeon removes the inner glandular tissue of the testicle while leaving the outer capsule intact.

**Testis (plural, testes)**—The medical term for a testicle.

**Testosterone**—The major male sex hormone, produced in the testes.

**Tumor marker**—A circulating biochemical compound that indicates the presence of cancer. Tumor markers can be used in diagnosis and in monitoring the effectiveness of treatment.

**Urology**—The branch of medicine that deals with disorders of the urinary tract in both males and females, and with the genital organs in males.

because most patients who have had this type of surgery prefer to keep it confidential. Persons undergoing the hormonal treatments and periods of real-life experience as members of the other sex that are required prior to genital surgery frequently report social rejection, job discrimination, and other negative consequences of their decision. Because of widespread social disapproval of surgical gender reassignment, researchers do not know the true prevalence of gender identity disorders in the general population. Early estimates were 1:37,000 males and 1:107,000 females. A recent study in the Netherlands, however, maintains that a more accurate estimation is 1:11,900 males and 1:30,400 females. In any case, the number of surgical procedures is lower than the number of patients diagnosed with gender identity disorders.

## Description

There are three basic types of orchiectomy: simple, subcapsular, and inguinal (or radical). The first two types are usually done under local or epidural anesthesia, and take about 30 minutes to perform. An inguinal orchiectomy is sometimes done under **general anesthesia**, and takes between 30 minutes and an hour to complete.

### Simple orchiectomy

A simple orchiectomy is performed as part of gender reassignment surgery or as palliative treatment for advanced cancer of the prostate. The patient lies flat on an operating table with the penis taped against the abdomen. After the anesthetic has been given, the

surgeon makes an incision in the midpoint of the scrotum and cuts through the underlying tissue. The surgeon removes the testicles and parts of the spermatic cord through the incision. The incision is closed with two layers of sutures and covered with a surgical dressing. If the patient desires, a prosthetic testicle can be inserted before the incision is closed to give the appearance of a normal scrotum from the outside.

### ***Subcapsular orchiectomy***

A subcapsular orchiectomy is also performed for treatment of prostate cancer. The operation is similar to a simple orchiectomy, with the exception that the glandular tissue is removed from the lining of each testicle rather than the entire gland being removed. This type of orchiectomy is done primarily to keep the appearance of a normal scrotum.

### ***Inguinal orchiectomy***

An inguinal orchiectomy, which is sometimes called a radical orchiectomy, is done when testicular cancer is suspected. It may be either unilateral, involving only one testicle, or bilateral. This procedure is called an inguinal orchiectomy because the surgeon makes the incision, which is about 3 in (7.6 cm) long, in the patient's groin area rather than directly into the scrotum. It is called a radical orchiectomy because the surgeon removes the entire spermatic cord as well as the testicle itself. The reason for this complete removal is that testicular cancers frequently spread from the spermatic cord into the lymph nodes near the kidneys. A long non-absorbable suture is left in the stump of the spermatic cord in case later surgery is necessary.

After the cord and testicle have been removed, the surgeon washes the area with saline solution and closes the various layers of tissues and skin with various types of sutures. The wound is then covered with sterile gauze and bandaged.

## **Diagnosis/Preparation**

### ***Diagnosis***

**CANCER.** The doctor may suspect that a patient has prostate cancer from feeling a mass in the prostate in the course of a rectal examination, from the results of a transrectal **ultrasound** (TRUS), or from elevated levels of prostate-specific antigen (PSA) in the patient's blood. PSA is a tumor marker, or chemical, in the blood that can be used to detect cancer and monitor the results of therapy. A definite diagnosis of prostate cancer, however, requires a tissue biopsy. The tissue sample can usually be obtained with the needle technique. Testicular cancer is suspected when the doctor feels a mass in the

patient's scrotum, which may or may not be painful. In order to perform a biopsy for definitive diagnosis, however, the doctor must remove the affected testicle by radical orchiectomy.

**GENDER REASSIGNMENT.** Patients requesting gender reassignment surgery must undergo a lengthy process of physical and psychological evaluation before receiving approval for surgery. The Harry Benjamin International Gender Dysphoria Association (HBIGDA), which is presently the largest worldwide professional association dealing with the treatment of gender identity disorders, has published standards of care that are followed by most surgeons who perform genital surgery for gender reassignment. HBIGDA stipulates that a patient must meet the diagnostic criteria for gender identity disorders as defined by either the *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (DSM-IV) or the *International Classification of Diseases-10* (ICD-10).

### ***Preparation***

All patients preparing for an orchiectomy will have standard blood and urine tests before the procedure. They are asked to discontinue aspirin-based medications for a week before surgery and all non-steroidal anti-inflammatory drugs (NSAIDs) two days before the procedure. Patients should not eat or drink anything for the eight hours before the scheduled time of surgery.

Most surgeons ask patients to shower or bathe on the morning of surgery using a special antibacterial soap. They should take extra time to lather, scrub, and rinse their genitals and groin area.

Patients who are anxious or nervous before the procedure are usually given a sedative to help them relax.

**CANCER.** Patients who are having an orchiectomy as treatment for testicular cancer should consider banking sperm if they plan to have children following surgery. Although it is possible to father a child if only one testicle is removed, some surgeons recommend banking sperm as a precaution in case the other testicle should develop a tumor at a later date.

**GENDER REASSIGNMENT.** Most males who have requested an orchiectomy as part of male-to-female gender reassignment have been taking hormones for a period of several months to several years prior to surgery, and have had some real-life experience dressing and functioning as women. The surgery is not performed as an immediate response to the patient's request.

Because the standards of care for gender reassignment require a psychiatric diagnosis as well as a **physical examination**, the surgeon who is performing the orchiectomy should receive two letters of evaluation and recommendation by mental health professionals, preferably one from a psychiatrist and one from a clinical psychologist.

### Aftercare

Patients who are having an orchiectomy in an ambulatory surgery center or other outpatient facility must have a friend or family member to drive them home after the procedure. Most patients can go to work the following day, although some may need an additional day of rest at home. Even though it is normal for patients to feel nauseated after the anesthetic wears off, they should start eating regularly when they get home. Some pain and swelling is also normal; the doctor will usually prescribe a pain-killing medication to be taken for a few days.

Other recommendations for aftercare include:

- Drinking extra fluids for the next several days, except for caffeinated and alcoholic beverages.
- Avoiding sexual activity, heavy lifting, and vigorous exercise until the follow-up appointment with the doctor.
- Taking a shower rather than a tub bath for a week following surgery to minimize the risk of absorbable stitches dissolving prematurely.
- Applying an ice pack to the groin area for the first 24–48 hours.
- Wearing a jock strap or snug briefs to support the scrotum for two weeks after surgery.

Some patients may require psychological counseling following an orchiectomy as part of their long-term aftercare. Many men have very strong feelings about any procedure involving their genitals, and may feel depressed or anxious about their bodies or their relationships after genital surgery. In addition to individual psychotherapy, support groups are often helpful. There are active networks of prostate cancer support groups in Canada and the United States as well as support groups for men's issues in general.

Long-term aftercare for patients with testicular cancer includes frequent checkups in addition to radiation treatment or chemotherapy. Patients with prostate cancer may be given various hormonal therapies or radiation treatment.

### Risks

Some of the risks for an orchiectomy done under general anesthesia are the same as for other procedures. They include deep venous thrombosis, heart or breathing problems, bleeding, infection, or reaction to the anesthesia. If the patient is having epidural anesthesia, the risks include bleeding into the spinal canal, nerve damage, or a spinal headache.

Specific risks associated with an orchiectomy include:

- loss of sexual desire (This side effect can be treated with hormone injections or gel preparations.)
- impotence
- hot flashes similar to those in menopausal women, controllable by medication
- weight gain of 10–15 lb (4.5–6.8 kg)
- mood swings or depression
- enlargement and tenderness in the breasts
- fatigue
- loss of sensation in the groin or the genitals
- osteoporosis (Men who are taking hormone treatments for prostate cancer are at greater risk of osteoporosis.)

An additional risk specific to cancer patients is recurrence of the cancer.

### Normal results

#### *Cancer*

Normal results depend on the location and stage of the patient's cancer at the time of surgery. Most prostate cancer patients, however, report rapid relief from cancer symptoms after an orchiectomy. Patients with testicular cancer have a 95% survival rate five years after surgery if the cancer had not spread beyond the testicle. Metastatic testicular cancer, however, has a poorer prognosis.

#### *Gender reassignment*

Normal results following orchiectomy as part of a sex change from male to female are a drop in testosterone levels with corresponding decrease in sex drive and gradual reduction of such masculine characteristics as beard growth. The patient may choose to have further operations at a later date.

### Morbidity and mortality rates

Orchiectomy by itself has a very low rate of morbidity and mortality. Patients who are having an orchiectomy as part of cancer therapy have a higher risk of **dying** from the cancer than from testicular surgery.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Orchiectomy performed as part of cancer therapy may be done in a hospital under general anesthesia, but is most often done as an outpatient procedure in a urology clinic or similar facility. Most surgeons who perform orchiectomies to treat cancer are board-certified urologists or general surgeons.

Orchiectomies performed as part of gender reassignment surgery are usually done in clinics that specialize in genital surgery. The standards of care defined by the Harry Benjamin International Gender Dysphoria Association stipulate that the surgeon should be a board-certified urologist, gynecologist, plastic surgeon, or general surgeon, and that he or she must have undergone supervised training in genital reconstruction.

The morbidity and mortality rates for persons having an orchiectomy as part of gender reassignment surgery are about the same as those for any procedure involving general or epidural anesthesia.

## Alternatives

### Cancer

There is no effective alternative to radical orchiectomy in the treatment of testicular cancer; radiation and chemotherapy are considered follow-up treatments rather than alternatives.

There are, however, several alternatives to orchiectomy in the treatment of prostate cancer:

- watchful waiting
- hormonal therapy (The drugs that are usually given for prostate cancer are either medications that oppose the action of male sex hormones [anti-androgens, usually flutamide or nilutamide] or medications that prevent the production of testosterone [goserelin or leuprolide acetate].)
- radiation treatment
- chemotherapy

### Gender reassignment

The primary alternative to an orchiectomy for gender reassignment is hormonal therapy. Most patients seeking MTF gender reassignment begin taking female

## QUESTIONS TO ASK THE DOCTOR

- How effective is an orchiectomy in preventing a recurrence of my cancer?
- What side effects of this procedure am I most likely to experience?
- How many orchiectomies have you performed?
- Can you recommend a local men's network or support group?

hormones (estrogens) for three to five months minimum before requesting genital surgery. Some persons postpone surgery for a longer period of time, often for financial reasons; others choose to continue on estrogen therapy indefinitely without surgery.

## Resources

### BOOKS

"Congenital Anomalies: Renal and Genitourinary Defects." Section 19, Chapter 261 in *The Merck Manual of Diagnosis and Therapy*, edited by Mark H. Beers and Robert Berkow. Whitehouse Station, NJ: Merck Research Laboratories, 1999.

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#### ORGANIZATIONS

- American Board of Urology (ABU). 2216 Ivy Road, Suite 210, Charlottesville, VA 22903. (434) 979 0059. <http://www.abu.org>.
- American Cancer Society (ACS). (800) ACS 2345. <http://www.cancer.org>.
- American Prostate Society. P. O. Box 870, Hanover, MD 21076. (800) 308 1106. <http://www.ameripros.org>.
- Canadian Prostate Cancer Network. P. O. Box 1253, Lakefield, ON K0L 2H0 Canada. (705) 652 9200. <http://www.cpcn.org>.
- Centers for Disease Control and Prevention (CDC) Cancer Prevention and Control Program. 4770 Buford Highway, NE, MS K64, Atlanta, GA 30341. (888) 842 6355. <http://www.cdc.gov/cancer/comments.htm>.
- Harry Benjamin International Gender Dysphoria Association, Inc. (HBI-GDA). 1300 South Second Street, Suite 180, Minneapolis, MN 55454. (612) 625 1500. <http://www.hbgda.org>.
- National Cancer Institute (NCI). NCI Public Inquiries Office. Suite 3036A, 6116 Executive Boulevard, MSC8332, Bethesda, MD 20892 8322. (800) 4 CANCEER or (800) 332 8615 (TTY). <http://www.nci.nih.gov>.

#### OTHER

- Harry Benjamin International Gender Dysphoria Association (HBI-GDA). *Standards of Care for Gender Identity Disorders*, 6th version, February, 2001 [April 1, 2003]. <http://www.hbgda.org/socv6.html>.
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Rebecca Frey, PhD

## Orchiopexy

### Definition

Orchiopexy is a procedure in which a surgeon fastens an undescended testicle inside the scrotum, usually with absorbable sutures. It is done most often in male infants or very young children to correct cryptorchidism, which is the medical term for undescended testicles. Orchiopexy is also occasionally performed in adolescents or adults, and may involve one or both testicles. In adults, orchiopexy is most often done to treat testicular torsion, which is a urologic emergency resulting from the testicle's twisting around the spermatic cord and losing its blood supply.

Other names for orchiopexy include orchidopexy, inguinal orchiopexy, repair of undescended testicle, cryptorchidism repair, and testicular torsion repair.

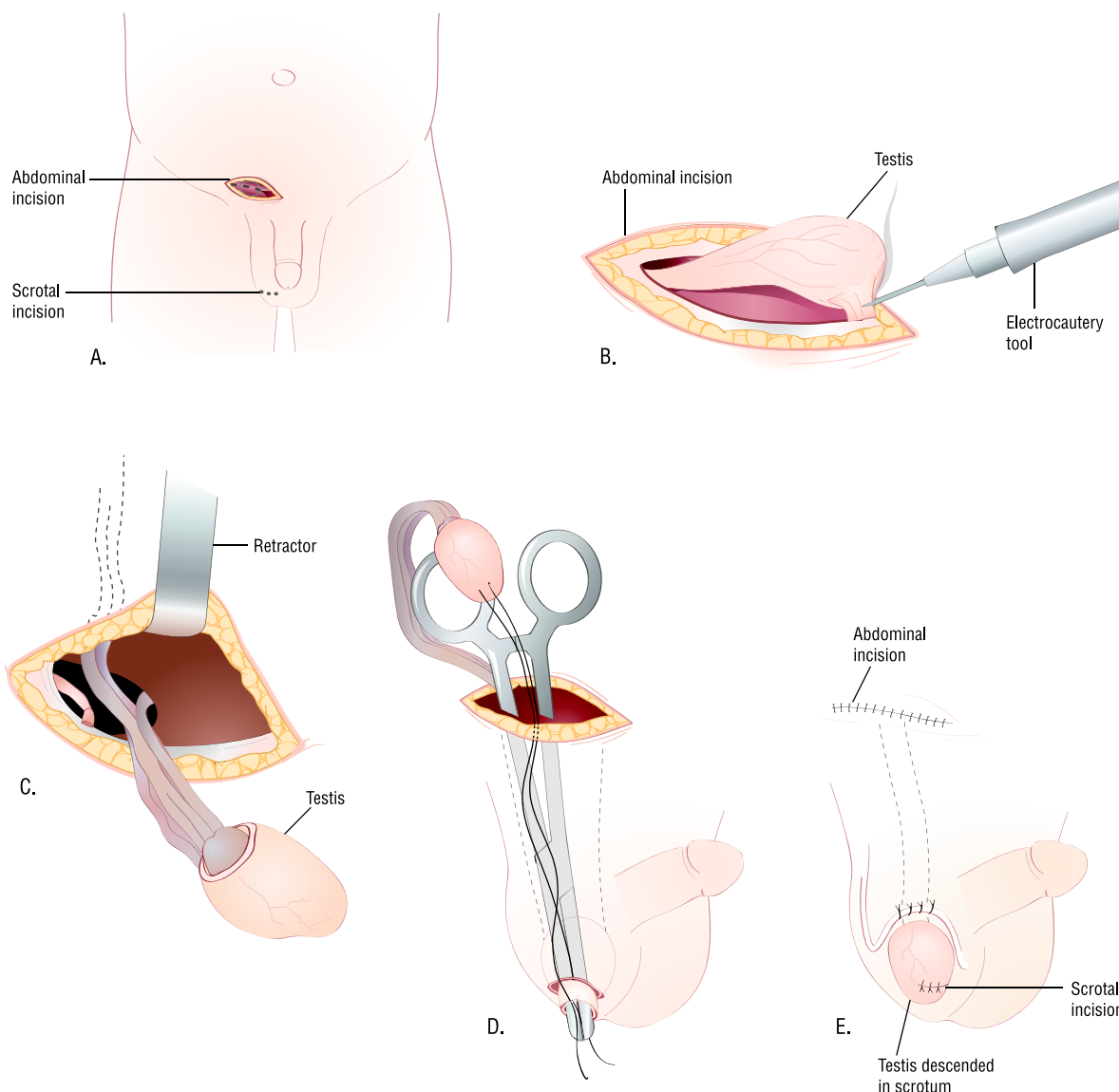
### Purpose

To understand the reasons for performing an orchiopexy in children, it is helpful to have an outline of the normal pattern of development of the testes in a male infant. The gubernaculum is an embryonic cord-like ligament that attaches the testes within the inguinal (groin) region of a male fetus up through the seventh month of pregnancy. Between the 28th and the 35th week of pregnancy, the gubernaculum migrates into the scrotum and creates space for the testes to descend. In normal development, the testes have followed the gubernaculum downward into the scrotum by the time the baby is born. The normal pattern may be interrupted by several possible factors, including inadequate androgen (male sex hormone) secretion, structural abnormalities in the boy's genitals, and defective nerves in the genital region.

Orchiopexy is performed in children for several reasons:

- To minimize the risk of infertility. Adult males with cryptorchidism typically have lower sperm counts and produce sperm of poorer quality than men with normal testicles. The risk of infertility rises

## Orchiopexy



An orchiopexy is used to repair an undescended testicle in childhood. An incision is made into the abdomen, the site of the undescended testicle, and another is made in the scrotum (A). The testis is detached from surrounding tissues (B) and pulled out of the abdominal incision attached to the spermatic cord (C). The testis is then pulled down into the scrotum (D) and stitched into place (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

with increasing age at the time of orchiopexy and whether both testicles are affected. Men with one undescended testicle have a 40% chance of being infertile; this figure rises to 70% in men with bilateral cryptorchidism.

- To lower the risk of testicular cancer. The incidence of malignant tumors in undescended testes has been estimated to be 48 times the incidence in normal testes. Men with cryptorchidism have a 10% chance of eventually developing testicular cancer.

## KEY TERMS

**Cremasteric reflex**—A reflex in which the cremaster muscle, which covers the testes and the spermatic cord, pulls the testicles back into the scrotum. It is important for a doctor to distinguish between an undescended testicle and a hyperactive cremasteric reflex in small children.

**Cryptorchidism**—A developmental disorder in which one or both testes fail to descend from the abdomen into the scrotum before birth. It is the most common structural abnormality in the male genital tract.

**Ectopic**—Located in an abnormal site or tissue. An ectopic testicle is one that is located in an unusual position outside its normal line of descent into the scrotum.

**Gonadotropins**—Hormones that stimulate the activity of the ovaries in females and testes in males.

**Hernia**—The protrusion of a loop or piece of tissue through an incision or abnormal opening in other tissues.

**Inguinal**—Referring to the groin area.

**Laparoscope**—An instrument that allows a surgeon to look inside the abdominal cavity.

**Non-palpable**—Unable to be detected through the sense of touch. A non-palpable testicle is one that is located in the abdomen or other site where the doctor cannot feel it by pressing gently on the child's body.

**Orchiectomy**—Surgical removal of one or both testicles in a male; also called an orchidectomy.

**Perineum**—The area between the scrotum and the anus.

**Peritoneum**—The smooth, colorless membrane that lines the inner surface of the abdomen.

**Prune belly syndrome (PBS)**—A genetic disorder associated with abnormalities of human chromosomes 18 and 21. Male infants with PBS often have cryptorchidism along with other defects of the genitals and urinary tract. PBS is also known as triad syndrome and Eagle-Barrett syndrome.

**Scrotum**—The pouch of skin on the outside of the male body that holds the testes.

**Spermatic cord**—A tube-like structure that extends from the testicle to the groin area. It contains blood vessels, nerves, and a duct to carry spermatic fluid.

**Testicular torsion**—Twisting of the testicle around the spermatic cord, cutting off the blood supply to the testicle. It is considered a urologic emergency.

**Testis (plural, testes)**—The medical term for a testicle.

**Urology**—The branch of medicine that deals with disorders of the urinary tract in both males and females, and with the genital organs in males.

- To lower the risk of traumatic injury to the testicle. Undescended testicles that remain in the patient's groin area are vulnerable to sports injuries and pressure from car seat belts.
- To prevent the development of an inguinal hernia. An inguinal hernia is a disorder that occurs when a portion of the contents of the abdomen pushes through an abnormal opening in the abdominal wall. It is likely to occur in a male infant with cryptorchidism because a sac known as the processus vaginalis, which connects the scrotum and the abdominal cavity, remains open after birth. In normal development, the processus vaginalis closes shortly after the testes descend into the scrotum. If the sac remains open, a section of the child's intestine can extend into the sac. It may become trapped (incarcerated) in the sac, forming what is called a strangulated hernia. The portion of the intestine that is trapped in the sac may die, which is a medical emergency.
- To prevent testicular torsion in adolescence.
- To maintain the appearance of a normal scrotum. Orchiopexy is considered a necessary procedure for psychological reasons, as boys with only one visible testicle are frequently subjected to teasing and ridicule after they start school.

The primary reason for performing an orchiopexy in an adolescent or adult male is treatment of testicular torsion, rather than cryptorchidism. Testicles that have not descended by the time a boy reaches puberty are usually removed by a complete **orchiectomy**.

## Demographics

### Cryptorchidism

Cryptorchidism is the most common abnormality of the male genital tract, affecting 3–5% of full-term male infants and 30–32% of premature male infants. In most cases, the condition resolves during the first few months after delivery; only 0.8% of infants over three months of age still have undescended testicles.

Because of the potentially serious consequences of cryptorchidism, however, doctors do not advise watchful waiting once the child is over six months old. Undescended testicles rarely come down into the scrotum of their own accord after that age.

Cryptorchidism is a frequent occurrence in prune belly syndrome (PBS) and a few other genetic disorders characterized by structural abnormalities of the genitourinary tract.

No variation in the incidence of cryptorchidism among different racial and ethnic groups has been reported.

### ***Testicular torsion***

Most American males suffering from testicular torsion are below age 30, with the majority between the ages of 12 and 18. The peak ages for an acute episode of testicular torsion are the first year of life and age 14. Testicular torsion occurs on the left side of the body slightly more often than on the right side, about 52% versus 48% of cases.

## **Description**

### ***Cryptorchidism***

Some orchiopexies in children are relatively simple procedures; however, others are complicated by the location of the undescended testicle. In general, an orchiopexy for an undescended testicle that lies in front of the scrotum or just above it is a less complicated operation than one done to treat a non-palpable testicle. The procedure is usually done under **general anesthesia**.

If the undescended testis is in the groin area, the surgeon will make a small incision in the groin and a second small incision in the scrotum. The testis is moved downward from the groin without complete separation from the gubernaculum. It is then placed inside a small pouch created by the surgeon between the skin of the scrotum and a layer of muscle in the scrotum called the dartos muscle. The testicle is held in place with sutures that are eventually absorbed by the body.

The Fowler-Stephens technique is often used when the undescended testicle is located high above the scrotum or in the abdomen. It may be done in two stages scheduled several months apart. In the first stage, the surgeon moves the testicle downward and attaches it temporarily to the inside of the thigh. In the second stage, the testicle is transferred into the scrotum itself and sutured into place.

A third type of orchiopexy is called testicular autotransplantation. The surgeon removes the undescended testicle completely from its present location and re-implants it in the scrotum by reattaching its surrounding tissues and blood vessels to nearby blood vessels. This technique minimizes the risk of an inadequate blood supply to the re-implanted testicle.

### ***Testicular torsion***

An orchiopexy done to treat testicular torsion is usually done under general or epidural anesthesia. The surgeon makes an incision in the patient's scrotum and untwists the spermatic cord. The affected testicle is inspected for signs of necrosis, or tissue **death**. If too much tissue has died due to loss of blood supply, the surgeon will remove the entire testicle. If the tissue appears to be healthy, the surgeon sutures the testicle to the wall of the scrotum and then closes the incision. In most cases, the surgeon will also attach the unaffected testicle to the scrotal wall as a preventive measure.

## **Diagnosis/Preparation**

### ***Cryptorchidism***

The diagnosis of cryptorchidism is usually made when a pediatrician examines the newborn baby, although the condition can occur at any time before the boy reaches puberty. The first stage in diagnosis is an external **physical examination** of the child's genitals. If either testicle does not appear to be in the scrotum, the doctor will palpate, or touch, the groin area and abdomen to determine whether a testicle can be felt in any of those locations. If the testicle can be felt, the doctor will decide on the basis of its location whether it is an undescended testicle, a so-called ectopic testicle, or a retractile testicle. An ectopic testicle is one that has developed in a location outside the normal path of development in the inguinal canal. Ectopic testicles are most often discovered along the inner part of the thigh near the groin, at the base of the penis, or below the scrotum in the perineum (the area between the scrotum and the rectum). A retractile testicle is one that is readily pulled back out of the scrotum by an overly sensitive reflex called the cremasteric reflex; it is not a genuinely undescended testicle. It is important for the doctor to distinguish a retractile testicle from genuine cryptorchidism because retractile testicles do not need surgical treatment. At this point in the diagnostic workup, a general pediatrician will often consult a specialist in pediatric urology.

In about 20% of male infants with cryptorchidism, the missing testicle cannot be felt at all. It is



known as a non-palpable testicle. The child may be given a hormone challenge test to help determine whether the testicle is located in the abdomen or whether it has failed to develop fully. If the testosterone level in the blood rises in response to the test, the doctor knows that there is a testis present somewhere in the child's body. In other cases, the testis has atrophied, or shriveled up due to an inadequate blood supply before birth. If neither testicle can be felt, the child should be examined further for evidence of intersexuality. The doctor may order an **ultrasound** to check for the presence of a uterus, particularly if the child's external genitals are ambiguous in appearance.

Surgery is the next step in searching for a non-palpable testicle. The surgeon may perform either an open inguinal procedure or a laparoscopic approach. In an open inguinal exploration, the surgeon makes an incision in the child's groin; if nothing is found, the incision may be extended into the lower abdomen. In a laparoscopic approach, the surgeon uses an instrument that looks like a small telescope with a light attached in order to see inside the groin or the abdominal cavity through a much smaller incision. If the surgeon is able to find the testicle, he or she may then proceed directly to perform an orchiopexy.

### *Testicular torsion*

Testicular torsion is usually diagnosed in the emergency room. The doctor will usually suspect testicular torsion on the basis of sudden onset of severe pain on one side of the scrotum; it is unusual for pain to develop gradually in this disorder. The patient's history often indicates recent hard physical work, vigorous **exercise**, or trauma to the genital area; however, testicular torsion can also occur without any apparent reason. Other symptoms may include swelling of the scrotum, blood in the semen, nausea and vomiting, pain in the abdomen, and fever. A few patients feel the need to urinate frequently. When the doctor examines the patient's scrotum, the affected testicle is usually enlarged and is painful when the doctor touches it. It usually lies higher in the scrotum than the unaffected testicle and may be lying in a horizontal position.

Since testicular torsion is a medical emergency, most doctors will not risk permanent damage to the testicle by taking the time to perform imaging studies. If the diagnosis is unclear, however, the doctor may order a radionuclide scan or a color Doppler ultrasound to determine whether the blood flow to the testicle has been cut off. The patient will be given a mild pain medication and referred to a urologist for surgery as soon as possible.

## Aftercare

### *Cryptorchidism*

Aftercare in children depends partly on the complexity of the procedure. If the child has an uncomplicated orchiopexy, he can usually go home the same day. If the surgeon had to make an incision in the abdomen to find a non-palpable testicle before performing the orchiopexy, the child may remain in the hospital for two to three days. The doctor will usually prescribe a pain medication for the first few days after the procedure.

After the child returns home, he should not bathe until the day after surgery. In addition, he should not ride a bicycle, climb trees, or do anything else that requires straddling for two to three weeks. An older boy should avoid sports or rough games that might result in injury to the genitals until he has a post-surgical checkup.

Most surgeons will schedule the child for a checkup one or two weeks after the orchiopexy, with a second checkup three months later.

### *Testicular torsion*

Aftercare is similar to that for orchiopexy in a child. The area around the incision should be washed very gently the next day and a clean dressing applied. Medication will be prescribed for postoperative pain. The patient is advised to rest at home for several days after surgery, to remain in bed as much as possible, to drink extra fluids, and to elevate the scrotum on a small pillow to ease the discomfort. Vigorous physical and sexual activity should be avoided until the pain and swelling go away.

## Risks

### *Cryptorchidism*

The risks of orchiopexy in treating cryptorchidism include:

- infection of the incision
- bleeding
- damage to the blood vessels and other structures in the spermatic cord, leading to eventual loss of the testicle
- failure of the testicle to remain in the scrotum (This problem can be repaired by a second operation.)
- difficulty urinating for a few days after surgery

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A pediatric surgeon or pediatric urologist is the specialist most likely to perform an orchiopexy in an infant or small child. In an adult patient, the procedure is usually performed by a urologist after referral from the patient's primary physician or the emergency care physician.

An orchiopexy can be performed in the surgical unit of a children's hospital or an ambulatory surgical center. Most orchiopexies in adults are performed as outpatient procedures.

### *Testicular torsion*

The risks of orchiopexy as a treatment for testicular torsion include:

- infection of the incision
- bleeding
- loss of blood circulation in the testicle leading to loss of the testicle
- reaction to anesthesia

### Normal results

In a normal orchiopexy, the testicle remains in the scrotum without re-ascending. If the procedure has been successful, there is no damage to the blood vessels supplying the testicle, no loss of fertility, and no recurrence of torsion.

### Morbidity and mortality rates

#### *Cryptorchidism*

Orchiopexy is most likely to be successful in children when the undescended testicle is relatively close to the scrotum. The rate of failure for orchiopexy performed as a treatment for cryptorchidism is 8% if the testicle lies just above the scrotum; 10–20% if the testicle is located in the inguinal canal; and 25% if the testicle lies within the abdomen.

#### *Testicular torsion*

The mortality rate for orchiopexy in adults is very low because almost all patients are young males in good health. The procedure has a 99% rate of success in saving the testicle when the diagnosis is made promptly and treated within six hours. After 12 hours, however,

## QUESTIONS TO ASK THE DOCTOR

- How often have you treated a child for cryptorchidism?
- What are the chances that the treatment will be successful?
- What should I tell my son about the operation?
- Are there likely to be any long-term aftereffects?

the rate of success in saving the testicle drops to 2%. The average rate of testicular atrophy following orchiopexy for testicular torsion is about 27%.

### Alternatives

#### *Cryptorchidism*

Hormonal therapy using gonadotropins to stimulate the production of more testosterone is effective in some children in causing the testes to descend into the scrotum without surgery. This approach, however, is usually successful only with undescended testes that are already close to the scrotum; its rate of success ranges from 10–50%. Undescended testes that are located higher almost never respond to hormonal therapy. In addition, treatment with hormones has several undesirable side effects, including aggressive behavior.

Some surgeons will, however, prescribe hormonal treatment before an orchiopexy in order to increase the size of the undescended testis and make it easier to identify during surgery.

#### *Testicular torsion*

Pain caused by testicular torsion can be relieved temporarily by manual detorsion. To perform this maneuver, the doctor stands at the patient's feet and gently rotates the affected testicle toward the outside of the patient's body in a sidewise direction. Manual detorsion is effective in relieving pain in 30–70% of patients; however, it is not considered an alternative to orchiopexy in preventing a recurrence of the torsion or loss of the testicle.

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- American Board of Urology (ABU). 2216 Ivy Road, Suite 210, Charlottesville, VA 22903. (434) 979-0059. <http://www.abu.org>.
- National Organization for Rare Disorders (NORD). 55 Kenosia Avenue, P. O. Box 1968, Danbury, CT 06813-1968. (203) 744-0100. <http://www.rarediseases.org>.
- Prune Belly Syndrome Network. P. O. Box 2125, Evansville, IN 47728-0125. <http://www.prunebelly.org>.

Rebecca Frey, PhD

## Orthopedic surgery

### Definition

Orthopedic (sometimes spelled orthopaedic) surgery is an operation performed by a medical specialist such as an orthopedist or orthopedic surgeon, who is trained to assess and treat problems that develop in the bones, joints, and ligaments of the human body.

### Purpose

Orthopedic surgery addresses and attempts to correct problems that arise in the skeleton and its attachments, the ligaments and tendons. It may also include some problems of the nervous system, such as those that arise from injury of the spine. These problems can occur at birth, through injury, or as the result of aging. They may be acute, as in an accident or injury, or chronic, as in many problems related to aging.

Orthopedics comes from two Greek words, *ortho*, meaning straight, and *pais*, meaning child. Originally, orthopedic surgeons treated skeletal deformities in children, using braces to straighten the child's bones. With the development of anesthesia and an understanding of the importance of **aseptic technique** in surgery, orthopedic surgeons extended their role to include surgery involving the bones and related nerves and connective tissue.

The terms orthopedic surgeon and orthopedist are used interchangeably today to indicate a medical doctor with special training and certification in orthopedics.

Many orthopedic surgeons maintain a general practice, while some specialize in one particular aspect of orthopedics such as **hand surgery**, joint replacements, or disorders of the spine. Orthopedists treat both acute and chronic disorders. Some orthopedic surgeons specialize in trauma medicine and can be found in emergency rooms and trauma centers, treating injuries. Others find their work overlapping with plastic surgeons, geriatric specialists, pediatricians, or podiatrists (foot care specialists). A rapidly growing area of orthopedics is sports medicine, and many sports medicine doctors are board certified in orthopedic surgery.

### Demographics

The American Academy of Orthopedic Surgeons reports that in January 2008, there are 31,309 members within all categories of orthopedic surgeons in the United States.

## KEY TERMS

**Arthroplasty**—The surgical reconstruction or replacement of a joint.

**Prosthesis**—A synthetic replacement for a missing part of the body such as a knee or a hip.

**Range of motion**—The normal extent of movement (flexion and extension) of a joint.

## Description

The range of treatments provided by orthopedists is extensive. They include procedures such as **traction**, **amputation**, hand reconstruction, **spinal fusion**, and joint replacements. They also treat strains and sprains, broken bones, and dislocations. Some specific procedures performed by orthopedic surgeons are listed as separate entries in this book, including **arthroplasty**, **arthroscopic surgery**, **bone grafting**, **fasciotomy**, **fracture repair**, **kneecap removal**, and traction.

In general, orthopedists are employed by hospitals, medical centers, trauma centers, or free-standing surgical centers where they work closely with a **surgical team**, including an anesthesiologist and surgical nurse. Orthopedic surgery can be performed under general, regional, or **local anesthesia**.

Much of the work of an orthopedic surgeon involves adding foreign material to the body in the form of screws, wires, pins, tongs, and prosthetics to hold damaged bones in their proper alignment or to replace damaged bone or connective tissue. Great improvements have been made in the development of artificial limbs and joints, and in the materials available to repair damage to bones and connective tissue. As developments occur in the fields of metallurgy and plastics, changes will take place in orthopedic surgery that will allow surgeons to more nearly duplicate the natural functions of bones, joints, and ligaments, and to more accurately restore damaged parts to their original ranges of motion.

## Diagnosis/Preparation

Persons are usually referred to an orthopedic surgeon by a primary care physician, emergency room physician, or other doctor. Prior to any surgery, candidates undergo extensive testing to determine appropriate corrective procedures. Tests may include x rays, computed tomography (CT) scans, **magnetic resonance imaging** (MRI), myelograms, diagnostic arthroplasty, and blood tests. The orthopedist will determine the

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Orthopedic surgery is performed by a physician with specialized training in orthopedic surgery. It is most commonly performed in operating room of a hospital. Very minor procedures such as setting a broken bone may be performed in a professional office or an emergency room of a hospital.

history of the disorder and any treatments that were previously tried. A period of rest to the injured part may be recommended before surgery is undertaken.

Surgical candidates undergo standard blood and urine tests before surgery and, for major procedures, may be given an **electrocardiogram** or other diagnostic tests prior to the operation. Individuals may choose to donate some of their own blood to be held in reserve for their use in major surgery such as **knee replacement**, during which heavy bleeding is common.

## Aftercare

Rehabilitation from orthopedic injuries can require long periods of time. Rehabilitation is usually physically and mentally taxing. Orthopedic surgeons will work closely with physical therapists to ensure that patients receive treatment that will enhance the range of motion and return function to all affected body parts.

## Risks

As with any surgery, there is always the risk of excessive bleeding, infection, and allergic reaction to anesthesia. Risks specifically associated with orthopedic surgery include inflammation at the site where foreign materials (pins, prostheses, or wires) are introduced into the body, infection as the result of surgery, and damage to nerves or to the spinal cord.

## Normal results

Thousands of people have successful orthopedic surgery each year to recover from injuries or to restore lost function. The degree of success in individual recoveries depends on an individual's age and general health, the medical problem being treated, and a person's willingness to comply with rehabilitative therapy after the surgery.



## QUESTIONS TO ASK THE DOCTOR

- What tests will be performed prior to surgery?
- How will the procedure affect daily activities after recovery?
- Where will the surgery be performed?
- What form of anesthesia will be used?
- What will be the resulting appearance and level of function after surgery?
- Is the surgeon board certified by the American Academy of Orthopedic Surgeons?
- How many similar procedures has the surgeon performed?
- What is the surgeon's complication rate?

Abnormal results from orthopedic surgery include persistent pain, swelling, redness, drainage or bleeding in the surgical area, surgical wound infection resulting in slow healing, and incomplete restoration of pre-surgical function.

### Morbidity and mortality rates

Mortality from orthopedic surgical procedures is not common. The most common causes for mortality are adverse reactions to anesthetic agents or drugs used to control pain, post-surgical clot formation in the veins, and post-surgical heart attacks or strokes.

### Alternatives

For the removal of diseased, non-functional, or non-vital tissue, there is no alternative to orthopedic surgery. Alternatives to orthopedic surgery depend on the condition being treated. Medications, acupuncture, or hypnosis are used to relieve pain. Radiation is an occasional alternative for shrinking growths. Chemotherapy may be used to treat bone cancer. Some foreign bodies may remain in the body without harm.

### Resources

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### ORGANIZATIONS

- American Academy of Orthopedic Surgeons. 6300 North River Road Rosemont, IL 60018 4262. (847) 823 7186 or (800) 346 2267. <http://www.aaos.org/wordhtml/home2.htm>.
- American College of Sports Medicine. 401 West Michigan Street, Indianapolis, IN 46202 3233 (Mailing Address: P.O. Box 1440, Indianapolis, IN 46206 1440). (317) 637 9200, Fax: (317) 634 7817. <http://www.acsm.org>.
- American College of Surgeons. 633 North Saint Claire Street, Chicago, IL 60611. (312) 202 5000. <http://www.facs.org/>.
- American Society for Bone and Mineral Research 2025 M Street, NW, Suite 800, Washington, DC 20036 3309. (202) 367 1161. <http://www.asbmr.org/>.
- Orthopedic Trauma Association. 6300 N. River Road, Suite 727, Rosemont, IL 60018 4226. (847) 698 1631. <http://www.ota.org/links.htm>.

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Orthopedic x rays see **Bone x rays**

Orthotopic transplantation see **Liver transplantation**

Osteotomy, hip see **Hip osteotomy**

Osteotomy, knee see **Knee osteotomy**

Otolaryngologic surgery see **Ear, nose, and throat surgery**

## Otoplasty

### Definition

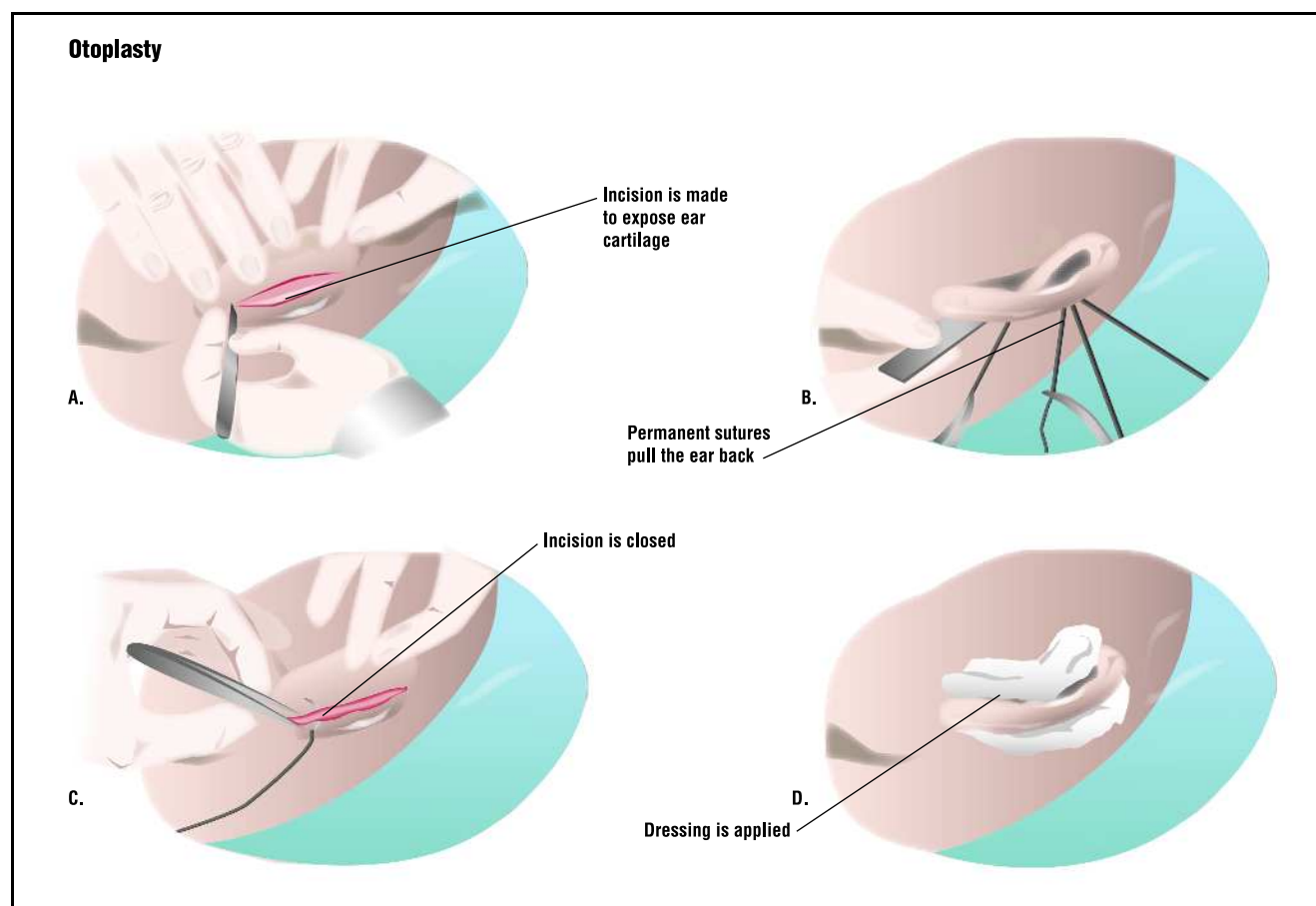
Otoplasty refers to a group of **plastic surgery** procedures done to correct deformities of or disfiguring injuries to the external ear. It is the only type of plastic surgery that is performed more often in children than adults.

### Purpose

Otoplastic surgery may be done for the following reasons:

- To reconstruct an external ear in children who are born with a partially or completely missing auricle (the visible part of the external ear). This type of birth defect is called microtia; it occurs in such disorders as hemifacial microsomia and Treacher Collins syndrome. Most cases of microtia, however, involve only one ear.
- To correct the appearance of protruding or prominent ears. This procedure is also known as setback otoplasty or pinback otoplasty.
- To correct major disparities in the size or shape of a patient's ears.
- To reshape deformed ears. One congenital type of deformity is known as Stahl's ear, which is characterized by a pointed upper edge produced by the flattening of the ear rim and folding of the cartilage. Stahl's deformity is also known as Vulcan ear or Spock ear because it resembles the ears of the well-known *Star Trek* character.
- To repair or reconstruct the auricle after traumatic injuries or cancer surgery.

Otoplasty is considered reconstructive rather than **cosmetic surgery**. Consequently, it is often covered by health insurance. People who are considering



During an otoplasty, an incision is made in the back of the ear, exposing cartilage (A). Permanent sutures in the cartilage pull the ear back closer to the skull (B). The incision is closed (C), and dressings are applied (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

otoplasty for themselves or their children should check with their insurance carrier about coverage. The average surgeon's fee for an otoplasty in the United States in 2001 was \$3,114.

Otoplasty is not done to correct hearing difficulties related to the structures of the middle and inner ear. Hearing problems are treated surgically by otolaryngologists (physicians who specialize in ear, nose, and throat procedures).

### Demographics

Statistics for congenital deformities of the external ear are difficult to obtain because the causes are so diverse. Such genetic disorders as Treacher Collins syndrome and hemifacial microsomia affect between one in 3,500 and one in 10,000 children. In addition, microtia has been associated with certain medications taken during pregnancy—particularly anticonvulsants, which are drugs given to treat epilepsy, and isotretinoin, a drug prescribed for severe acne.

Stahl's deformity is found more often among Asian Americans than among Caucasian or African Americans. As of 2003, it is thought to be a hereditary disorder.

Setback or pinback otoplasty is the most frequently performed procedure for reconstruction of prominent or protruding ears. According to the American Society of Plastic Surgeons, 30,137 setback otoplasties were performed in the United States in 2006. There are no exact statistics on the incidence of protruding ears in the general population, although about 8% of patients treated for this deformity have a family history of it. Large or protruding ears appear to be equally common in males and females; however, it is easier for girls and women to avoid social discomfort by styling their hair to cover their ears. This factor may explain why a slight majority (53%) of setback otoplasties is done on boys. Although most setback otoplasties are performed in children between the ages of four and 14, the second largest group of patients in this category is women in their 20s and 30s.

The most common cause of trauma requiring otoplasty is human and animal bites. Although exact figures are not known because many bite cases are not reported, a large percentage of dog and human bites cause wounds on the head and neck. With regard to human bites, the single most common injury requiring medical treatment is auricular avulsion, or tearing of the external ear. In the United States, 93% of patients treated for ear injuries caused by human bites are males between the ages of 15 and 25. Most cases of auricular avulsion in children, however, are

## KEY TERMS

**Auricle**—The portion of the external ear that is not contained inside the head. It is also called the pinna.

**Avulsion**—A type of injury caused by ripping or tearing. Most ear injuries requiring otoplasty are avulsion injuries.

**Concha**—The hollow shell-shaped portion of the external ear.

**Congenital**—Present at the time of birth.

**Ear molding**—A non-surgical method for treating ear deformities shortly after birth with the application of a mold held in place by tape and surgical glue.

**Hematoma**—A localized collection of blood in an organ or tissue due to broken blood vessels.

**Hemifacial microsomia (HFM)**—A term used to describe a group of complex birth defects characterized by underdevelopment of one side of the face.

**Microtia**—The partial or complete absence of the auricle of the ear.

**Pinna**—Another name for the auricle; the visible portion of the external ear.

**Setback otoplasty**—A surgical procedure done to reduce the size or improve the appearance of large or protruding ears; it is also known as pinback otoplasty.

**Stahl's deformity**—A congenital deformity of the ear characterized by a flattened rim and pointed upper edge caused by a fold in the cartilage; it is also known as Vulcan ear or Spock ear.

**Treacher Collins syndrome**—A disorder that affects facial development and hearing, thought to be caused by a gene mutation on human chromosome 5. Treacher Collins syndrome is sometimes called mandibulofacial dysostosis.

caused by dog bites, which are likely to cause crushing as well as tearing of the tissues.

### Description

Otoplasty in children is performed under **general anesthesia**; in adults, it may be done under either general anesthesia or **local anesthesia** with sedation. Most otoplasties take about two to three hours to complete. Many plastic surgeons prefer to use absorbable sutures when performing an otoplasty in order to minimize the risk of disturbing the shape of the ear by removing **stitches** later.

### *Otoplasty for microtia*

Otoplasty for microtia requires a series of three or four separate operations. In the first operation, a piece of cartilage is removed from the child's rib cage on the side opposite the affected ear, so that the surgeon can use the natural curve of the cartilage in fashioning the new ear. The surgeon works from a template derived from photographs and computer models when he or she carves the cartilage into the desired shape. The cartilage is then carefully positioned under the skin on the side of the face. The skin will shape itself to fit the cartilage framework of the new ear. The second and third operations are done to shape the ear lobe and to raise the new ear into its final position.

### *Otoplasty for protruding ears*

There is no universally accepted single technique for performing a setback otoplasty. Variations in the procedure are due partly to the different causes of ear protrusion. The patient's ear may have a large concha (the shell-like hollow of the external ear); the angle of the fold in the ear cartilage may cause the ear to protrude; or the ear lobe may be unusually large.

After the patient has been anesthetized, the surgeon makes an incision behind the ear in the fold of skin where the ear meets the head. In one technique, the surgeon exposes the ear cartilage beneath the skin and reshapes it or removes a small piece. The cartilage is bent back toward the head and secured in place with non-removable sutures. Removal of cartilage is sometimes referred to as a conchal resection.

Another procedure for protruding ears involves the removal of skin and suturing the cartilage back on itself. This technique reshapes the ear without the need to remove cartilage; it is sometimes called a cartilage-sparing otoplasty.

After the surgeon has finished reshaping the ear and carefully drying the area, the incision is closed. The surgeon covers the ear with a cotton dressing moistened with mineral oil or other soft dressing.

## Diagnosis/Preparation

### *Congenital abnormalities of the ear*

Diagnosis of microtia is made by the obstetrician or pediatrician at the time of the child's birth. The diagnosis of prominent or protruding ears, however, is somewhat more complex because the deformity is a matter of shape and proportion rather than the absence or major malformation of a body part. The head of a newborn infant is larger in proportion to its body than is the case in adults, and as a result, the

shape of the ears may not concern the parents until the child is two to three years old.

Otoplasty to correct microtia is usually started when the child is at least five years old. The surgeon must remove a portion of rib cartilage in order to construct a framework for the missing ear, and children younger than five may not have enough cartilage. In addition, it is easier for the surgeon to use the child's normal ear as a model for the size and shape of the reconstructed ear when the child is five to seven years old. Otoplasty for microtia is preceded by consultations between the surgeon and the child's parents. Following the diagnosis, a comprehensive treatment plan is made that includes long-term psychosocial as well as surgical follow-up. The reconstruction of a missing ear must be done in several stages because the surgeon must allow for changes in the proportions of the child's face and skull as he or she matures as well as attempt to make the new ear look as normal as possible.

There continues to be some debate among plastic surgeons concerning the best age for performing a setback otoplasty. Many recommend the operation when the child is between five and seven years old. One reason is that the human ear has attained 85–90% of its adult size by this age, and therefore the surgeon can estimate the final size and shape of the ear with considerable accuracy. In addition, the cartilage in the ear is still relatively soft and easier for the surgeon to reshape. Another reason for performing an otoplasty in children in the early elementary school years is psychological; name-calling and teasing by peers can be emotionally destructive for children in this age bracket. On the other hand, some surgeons have reported performing setback otoplasties on children as young as nine months with no disturbances in the growth of the ear or recurrence of the problem.

Preparation for otoplasty in children should include an assessment of the child's feelings about the procedure. Some surgeons consider opposition on the child's part to be a contraindication for surgery, as well as unrealistic expectations on the part of the parents. In general, a positive attitude is associated with faster recovery and better overall results.

Preparation for otoplasty in adults includes a **physical examination** and standard blood tests. Patients are usually advised to discontinue taking **aspirin** and any other medications that thin the blood for two weeks prior to surgery. Plastic surgeons strongly urge adult patients to quit smoking before the surgery, because smoking delays and complicates the healing process. Adult patients are also asked to shower and shampoo



their hair thoroughly on the morning of the procedure. Men should have a haircut or trim a day or two before surgery; women should braid or pin their hair close to the head.

### *Trauma*

Avulsion injuries caused by bites, thermal or chemical burns resulting from industrial accidents, and other traumatic injuries of the auricle are diagnosed by emergency physicians.

Plastic surgery for traumatic injuries of the auricle is preceded by thorough cleansing of the wound and **debridement** of damaged tissue. It is important to treat ear injuries promptly because the ears are not well supplied with blood vessels. This characteristic makes it easier for infection to develop in parts of the auricle where the skin has been torn open or crushed. In some cases, plastic surgery is postponed for a few days and the patient is given oral penicillin to prevent infection.

### *Aftercare*

After an otoplasty, the patient's head is wrapped with a turban-type bandage that is worn for four to five days following surgery. The patient is instructed to wear a ski-type headband over the ears continuously for about a month after the turban is removed, and then at night for an additional two months. Warm compresses should be applied to the ears two to three times a day for two weeks after the turban is removed.

Patients should follow the surgeon's instructions about washing their hair, and avoid holding hot-air blow dryers too close to the ear.

Patients should also avoid contact sports for at least three months after otoplasty. An anti-inflammatory medication (Kenalog) can be applied to the ear in the event of abnormal scar formation.

### *Risks*

Some risks associated with otoplasties are common to all operations performed under general anesthesia. They include bleeding or infection of the incision; numbness or loss of feeling in the area around the incision; and a reaction to the anesthesia.

Specific risks associated with otoplasties include the following:

- Formation of abnormal scar tissue. This complication can usually be corrected later; plastic surgeons advise waiting at least six months for revision surgery.
- Hematoma, which is a collection of blood within a body organ or tissue caused by leakage from broken

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Otoplasties for microtia and prominent or deformed ears are specialized procedures performed only by qualified plastic surgeons. Plastic surgeons are doctors who have completed three years of general surgical training, followed by two to three years of specialized training in plastic surgery. There are, however, relatively few plastic surgeons who perform otoplasties for microtia.

Ear molding as an alternative to surgery is performed by a plastic surgeon as an outpatient or office procedure.

Traumatic injuries of the external ear are treated initially by an emergency physician, trauma surgeon, or plastic surgeon; in most cases, an otolaryngologist is consulted to determine whether the inner structures of the ear have also been injured. Revision plastic surgery may be performed later to remove scar tissue.

blood vessels. In the case of the ear, a hematoma can damage the results of plastic surgery because it creates tension and pressure that distort the final shape of the ear. Careful drying of the ear at the end of the procedure and application of a pressure bandage can reduce the risk of a hematoma. In the event that one develops, it is treated by reopening the incision and draining the collected blood.

- Distortion of the shape of the ear caused by over-correction of deformed features.
- Reappearance of ear protrusion (in setback otoplasty). This complication is most likely to occur in the first six months after surgery.

### *Normal results*

The normal result of an otoplasty is a reconstructed or reshaped ear that resembles a normal ear (or the patient's other ear) more closely. In a setback otoplasty, the normal result is an ear that lies closer to the patient's head without an overcorrected, "pinned-back" look.

### *Morbidity and mortality rates*

The mortality rate in otoplasty is extremely low and is almost always associated with anesthesia reactions. The most common complication reported is

## QUESTIONS TO ASK THE DOCTOR

- How long will it take for the ear to assume its final shape?
- How much change in the shape of the ear can be reasonably expected?
- Would my child benefit from ear molding rather than surgery?
- How many otoplasties have you performed?

asymmetrical ears (18.4%), followed by skin irritation (9.8%); increased sensitivity to cold (7.5%); soreness when the ear is touched (5.7%); abnormal shape to the ear (4.4%); loss of feeling in the ear (3.9%); bleeding (2.6%); and hematoma (0.4%).

### Alternatives

Some ear deformities in children, including protruding ears and Stahl's deformity, can be treated with ear molding in the early weeks of life, when the cartilage in the ear can be reshaped by the application of splints and Steri-Strips. One technique involves making a mold in the shape desired for the child's ear from dental compound and attaching it to the ear with methylmethacrylate **glue**. The ear and the mold are held in place with surgical tape and covered with a tubular bandage or ear wrap for reinforcement. The mold and tape must be worn constantly for six weeks, with a change of dressing every two weeks. Ear molding is reported to be about 85% effective when it is started within six weeks after the baby's birth. It costs less than surgery—about \$600—and is considerably less painful. The chief disadvantage of ear molding is its ineffectiveness in treating ear deformities characterized by the absence of skin and cartilage rather than distorted shape.

There are no effective alternatives to otoplasty in treating ear deformities or injuries in adults; however, some plastic surgeons use custom-made silicone molds to help maintain the position of the ears in adult patients for several weeks after surgery.

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American Society of Plastic Surgeons (ASPS). 444 East Algonquin Road, Arlington Heights, IL 60005. (847) 228-9900. [www.plasticsurgery.org](http://www.plasticsurgery.org).

FACES: The National Craniofacial Association. P. O. Box 11082, Chattanooga, TN 37401. (800) 332-2373. [www.facescranio.org](http://www.facescranio.org).

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Otosclerosis surgery see **Stapedectomy**

# Outpatient surgery

## Definition

Outpatient surgery, also referred to as ambulatory surgery, is defined by the American Hospital Association (AHA) as “a surgical operation, whether major or minor, performed on patients who do not remain in the hospital overnight.” Outpatient surgery may be performed in inpatient operating suites, outpatient surgery suites, or procedure rooms within an outpatient care facility. Patients may go home after being released following the procedure and time spent in the **recovery room**.

## Purpose

Mounting pressure to keep hospitalization costs down and improved technology have increased the frequency of outpatient surgery, with shorter medical procedure duration, fewer complications, and lower cost. As of 2006, about 53% of all surgical procedures in the United States are performed on an outpatient basis.

According to the Agency for Healthcare Research and Quality, about 90% of outpatient surgeries in the United States are performed to treat an illness or disorder; the remaining 10% are diagnostic procedures.

## Description

Due to improved pain control, advanced medical techniques—including those that reduce recovery time—and cost-cutting considerations, more and more surgeries are being performed on an outpatient basis. Surgeries suited to a nonhospital setting generally are those with a low percentage of postoperative complications, which would require serious attention by a physician or nurse. Outpatient surgery continues to mushroom: in 1984, roughly 400,000 outpatient surgeries were performed; by 2000, the number had risen to 8.3 million; and from 1993 to 2001, the number of freestanding **ambulatory surgery centers** in the United States increased by 150%. A 2002 study reported that 65% of all surgical procedures did not involve a hospital stay; this proportion is expected to increase to 75% by 2015. These statistics also reflect the fact that many patients (especially children) prefer to recover at home or in a familiar setting.

With increased technological advances in instruments such as the arthroscope and laparoscope, more physicians are performing surgery in their offices or in other outpatient settings, primarily ambulatory clinics and surgical centers, or surgicenters. Among the most

## KEY TERMS

**Ambulatory surgery**—Surgery done on an outpatient basis; the patient goes home the same day.

**Ambulatory surgery center**—An outpatient facility with at least two operating rooms, either connected or not connected to a hospital.

**Outpatient procedures**—Surgeries that are performed on an outpatient basis, involving less recovery time and fewer expected complications.

frequently performed outpatient surgeries are tonsillectomies, arthroscopy, **cosmetic surgery**, removal of cataracts, gynecological, urological and orthopedic procedures, wound and hernia repairs, and gallbladder removals. Even such procedures as microscopically controlled surgery under **local anesthesia** for skin cancer have been recommended on an outpatient basis.

## Preparation

While many outpatient surgeries are covered by insurance plans, many are not. Candidates for such surgeries should check in advance with their insurance carrier concerning whether their procedures are covered on an outpatient basis. **Medicare** and **Medicaid** patients should also check whether these programs will cover the cost of their surgeries.

Preparing for outpatient surgery varies, of course, with the surgical procedure to be performed. There are, however, guidelines common to most outpatient surgeries. Patients should be in good health before undergoing ambulatory surgery. Colds, fever, chills, or flu symptoms are all reasons to postpone a procedure, and surgical candidates should notify their primary health care physicians if such conditions exist.

Patients should check with their physician for all information covering preparation for outpatient procedures. A near-universal requirement is to have a family member or friend take charge of delivering the patient to surgery, either to wait there or to arrive in time to pick up the patient on release from recovery. The evening before, a light meal is recommended to preoperative patients, with no alcohol taken for a full day before surgery. Nothing is to be taken by mouth after midnight of the day preceding surgery. Smokers should stop or cut back on smoking prior to surgery. Loose-fitting clothing is recommended, and patients should bring along enough money to cover postoperative prescription drugs.

This same information applies if the outpatient is a child. If children are permitted clear liquids on the day of outpatient surgery, parents will be told when the child must stop taking them. Surgery will be cancelled or delayed if these requirements are not met.

## Results

The benefits of outpatient surgery include lower medical costs, tighter scheduling—because patients are not subject to the potential delays encountered in hospital operating rooms—and what many patients would consider a less stressful environment than a hospital setting. Recovery time spent in one's own home, either with familiar caregivers or home nurses, is a choice many postoperative patients prefer to recuperation in a hospital.

Complications related to surgery occur less than 1% of the time in outpatient settings. However, in terms of patient safety, nonhospital settings are not as closely regulated as are hospitals, so patients should inquire about potential risks concerning outpatient surgery that arise in ambulatory clinics, surgical centers, and physicians' offices. There are guidelines for surgery in outpatient settings, but oversight and enforcement may vary. Patients may wish to find out whether their outpatient center is licensed or certified as a medical facility or is accredited in the states that require this. The latter may be accomplished by contacting the Joint Commission (formerly the Joint Commission for Accreditation of Healthcare Organizations).

Among problems encountered during outpatient surgery are those concerning anesthesia administration, infection, bleeding that calls for a **transfusion**, and respiratory and resuscitation events. Some patients are at higher risk than others of requiring inpatient admission after an outpatient procedure. These include patients over the age of 65; operations lasting longer than 120 minutes; the need for **general anesthesia**; and patients with heart problems, cancer, or vascular disease.

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Ovary and fallopian tube removal see

**Salpingo-oophorectomy**

Ovary removal see **Oophorectomy**

## Oxygen therapy

### Definition

Oxygen may be classified as an element, a gas, and a drug. Oxygen therapy is the administration of oxygen at concentrations greater than that in room air to treat or prevent hypoxemia (not enough oxygen in the blood). Oxygen delivery systems are classified as stationary, portable, or ambulatory. Oxygen can be administered by nasal cannula, mask, and tent. Hyperbaric oxygen therapy involves placing the patient in an airtight chamber with oxygen under pressure.

### Purpose

The body is constantly taking in oxygen and releasing carbon dioxide. If this process is inadequate, oxygen levels in the blood decrease, and the patient may need supplemental oxygen. Oxygen therapy is a



## KEY TERMS

**Arterial blood gas test**—A blood test that measures oxygen and carbon dioxide in the blood.

**Atelectasis**—Partial or complete collapse of the lung, usually due to a blockage of the air passages with fluid, mucus or infection.

**Breathing rate**—The number of breaths per minute.

**Cannula**—Also called nasal cannula. A small, lightweight plastic tube with two hollow prongs that fit just inside the nose. Nasal cannulas are used to supply supplemental oxygen through the nose.

**Cyanosis**—Blue, gray, or dark purple discoloration of the skin caused by a deficiency of oxygen.

**Ductus arteriosus**—A fetal blood vessel that connects the aorta and pulmonary artery.

**Flow meter**—Device for measuring the rate of a gas (especially oxygen) or liquid.

**Hypoxemia**—Oxygen deficiency, defined as an oxygen level less than 60 mm Hg or arterial oxygen saturation of less than 90%. Different values are used for infants and patients with certain lung diseases.

**Oxygenation**—Saturation with oxygen.

**Peak expiratory flow rate**—A test used to measure how fast air can be exhaled from the lungs.

**Pulmonary function tests**—A series of tests that measure how well air is moving in and out of the lungs and carrying oxygen to the bloodstream.

**Pulmonary rehabilitation**—A program that helps patients learn how to breathe easier and improve their quality of life. Pulmonary rehabilitation includes treatment, exercise training, education, and counseling.

**Pulmonologist**—A physician who specializes in caring for people with lung diseases and breathing problems.

**Pulse oximetry**—A non-invasive test in which a device that clips onto the finger measures the oxygen level in the blood.

**Residual volume**—The volume of air remaining in the lungs, measured after a maximum expiration.

**Respiratory failure**—The sudden inability of the lungs to provide normal oxygen delivery or normal carbon dioxide removal.

**Respiratory therapist**—A health care professional who specializes in assessing, treating, and educating people with lung diseases.

**Total lung capacity test**—A test that measures the amount of air in the lungs after a person has breathed in as much as possible.

**Vital capacity**—Maximal breathing capacity; the amount of air that can be expired after a maximum inspiration.

key treatment in respiratory care. The purpose is to increase oxygen saturation in tissues where the saturation levels are too low due to illness or injury. Breathing prescribed oxygen increases the amount of oxygen in the blood, reduces the extra work of the heart, and decreases shortness of breath. Oxygen therapy is frequently ordered in the **home care** setting, as well as in acute (urgent) care facilities.

Some of the conditions oxygen therapy is used to treat include:

- documented hypoxemia
- severe respiratory distress (e.g., acute asthma or pneumonia)
- severe trauma
- chronic obstructive pulmonary disease (COPD, including chronic bronchitis, emphysema, and chronic asthma)
- pulmonary hypertension
- cor pulmonale

- acute myocardial infarction (heart attack)
- short-term therapy, such as postanesthesia recovery

Oxygen may also be used to treat chronic lung disease patients during **exercise**.

Hyperbaric oxygen therapy is used to treat the following conditions:

- gas gangrene
- decompression sickness
- air embolism
- smoke inhalation
- carbon monoxide poisoning
- cerebral hypoxic event

Helium-oxygen therapy is a treatment that may be used for patients with severe airway obstruction. The combination of helium and oxygen, known as heliox, reduces the density of the delivered gas, and has been shown to reduce the effort of breathing and improve ventilation when an airway obstruction is present.

This type of treatment may be used in an emergency room for patients with acute, severe asthma.

## Description

### *Oxygen delivery (other than mechanical ventilators and hyperbaric chambers)*

In the hospital, oxygen is supplied to each patient room via an outlet in the wall. Oxygen is delivered from a central source through a pipeline in the facility. A flow meter attached to the wall outlet accesses the oxygen. A valve regulates the oxygen flow, and attachments may be connected to provide moisture. In the home, the oxygen source is usually a canister or air compressor. Whether in home or hospital, plastic tubing connects the oxygen source to the patient.

Oxygen is most commonly delivered to the patient via a nasal cannula or mask attached to the tubing. The nasal cannula is usually the delivery device of choice since it is well tolerated and doesn't interfere with the patient's ability to communicate, eat, or drink. The concentration of oxygen inhaled depends upon the prescribed flow rate and the ventilatory minute volume (MV).

Another delivery option is transtracheal oxygen therapy, which involves a small flexible catheter inserted in the trachea or windpipe through a tracheostomy tube. In this method, the oxygen bypasses the mouth, nose, and throat, and a humidifier is required at flow rates of 1 liter (2.1 pt) per minute and above. Other oxygen delivery methods include tents and specialized infant oxygen delivery systems.

**TYPES OF OXYGEN DELIVERY SYSTEMS.** The types of oxygen delivery systems include:

- Compressed oxygen—oxygen that is stored as a gas in a tank. A flow meter and regulator are attached to the oxygen tank to adjust oxygen flow. Tanks vary in size from very large to smaller, portable tanks. This system is generally prescribed when oxygen is not needed constantly (e.g., when it is only needed when performing physical activity).
- Liquid oxygen—oxygen that is stored in a large stationary tank that stays in the home. A portable tank is available that can be filled from the stationary tank for trips outside the home. Oxygen is liquid at very cold temperatures. When warmed, liquid oxygen changes to a gas for delivery to the patient.
- Oxygen concentrator—electric oxygen delivery system approximately the size of a large suitcase. The concentrator extracts some of the air from the room, separates the oxygen, and delivers it to the patient via a nasal cannula. A cylinder of oxygen is provided as a

backup in the event of a power failure, and a portable tank is available for trips outside the home. This system is generally prescribed for patients who require constant supplemental oxygen or who must use it when sleeping.

- Oxygen conserving device, such as a demand inspiratory flow system or pulsed-dose oxygen delivery system—uses a sensor to detect when inspiration (inhalation) begins. Oxygen is delivered only upon inspiration, thereby conserving oxygen during exhalation. These systems can be used with either compressed or liquid oxygen systems, but are not appropriate for all patients.

## Preparation

A physician's order is required for oxygen therapy, except in emergency use. The need for supplemental oxygen is determined by inadequate oxygen saturation, indicated in blood gas measurements, pulse oximetry, or clinical observations. The physician will prescribe the specific amount of oxygen needed by the patient. Some patients require supplemental oxygen 24 hours a day, while others may only need treatments during exercise or sleep. No special patient preparation is required to administer oxygen therapy.

### *Patient education*

**SELECTING AN OXYGEN SYSTEM.** A health care provider will meet with the patient to discuss the oxygen systems available. A system recommendation will be made, based on the patient's overall condition and personal needs, as well as the system's ease of use, reliability, cost, range of oxygen delivery, and features. The health care provider can give the patient a list of medical supply companies that stock home oxygen equipment and supplies. The patient can meet with home care representatives from these companies to evaluate the product lines that best fit his or her needs. Patients in the home setting are directed to notify the vendors when replacement oxygen supplies are needed.

**OXYGEN SAFETY.** Patients will receive instructions about the safe use of oxygen in the home. Patients must be advised not to change the flow rate of oxygen unless directed to do so by the physician.

Oxygen supports combustion, therefore no open flame or combustible products should be permitted when oxygen is in use. These include petroleum jelly, oils, and aerosol sprays. A spark from a cigarette, electric razor, or other electrical device could easily ignite oxygen-saturated hair or bedclothes around the patient. Explosion-proof plugs should be used for vaporizers and humidifier attachments. The patient

should be sure to have a functioning smoke detector and fire extinguisher in the home at all times.

Care must be taken with oxygen equipment used in the home or hospital. The oxygen system should be kept clean and dust-free. Cylinders should be kept in carts, or have collars for safe storage. If not stored in a cart, smaller canisters may be laid on the floor. Knocking cylinders together can cause sparks, so bumping them should be avoided. In the home, the oxygen source must be placed at least 6 ft (1.8 m) away from flames or other sources of ignition, such as a lit cigarette. Oxygen tanks should be kept in a well-ventilated area. Oxygen tanks should not be kept in the trunk of a car. “No Smoking—Oxygen in Use” signs should be used to warn visitors not to smoke near the patient.

Special care must be given when administering oxygen to premature infants because of the danger of high oxygen levels causing retinopathy of prematurity, or contributing to the construction of ductus arteriosus. PaO<sub>2</sub> (partial pressure of oxygen) levels greater than 80 mm Hg should be avoided.

Patients who are undergoing a laser **bronchoscopy** should receive concurrent administration of supplemental oxygen to avoid burns to the trachea.

#### *Insurance clearance*

The patient should check with his or her insurance provider to determine if the treatment is covered and what out-of-pocket expenses may be incurred. Oxygen therapy is usually fully or partially covered by most insurance plans, including **Medicare**, when prescribed according to specific guidelines. Usually test results indicating the medical necessity of the supplemental oxygen are needed before insurance clearance is granted.

#### *Travel guidelines*

Traveling with oxygen requires advanced planning. The patient needs to obtain a letter from his or her health care provider that verifies all medications, including oxygen. In addition, a copy of the patient's oxygen prescription must be shown to travel personnel. Home health care companies can help the patient make travel plans, and can arrange for oxygen when the patient arrives at his or her destination. Patients cannot bring or use their own oxygen tanks on an airplane; therefore the patient must leave his or her portable oxygen tank at the airport before boarding. Oxygen suppliers can pick up the oxygen unit from the airport if necessary, or a family member can take it home.

### Aftercare

Once oxygen therapy is initiated, periodic assessment and documentation of oxygen saturation levels is required. Follow-up monitoring includes blood gas measurements and pulse oximetry tests. If the patient is using a mask or a cannula, gauze can be tucked under the tubing to prevent irritation of the cheeks or the skin behind the ears. Water-based lubricants can be used to relieve dryness of the lips and nostrils.

### Risks

Oxygen is not addictive and causes no side effects when used as prescribed. Complications from oxygen therapy used in appropriate situations are infrequent. Respiratory depression, oxygen toxicity, and absorption atelectasis are the most serious complications of oxygen overuse.

A physician should be notified and emergency services may be required if the following symptoms develop:

- frequent headaches
- anxiety
- cyanotic (blue) lips or fingernails
- drowsiness
- confusion
- restlessness
- slow, shallow, difficult, or irregular breathing

Oxygen delivery equipment may present other problems. Perforation of the nasal septum as a result of using a nasal cannula and non-humidified oxygen has been reported. In addition, bacterial contamination of nebulizer and humidification systems can occur, possibly leading to the spread of pneumonia. High-flow systems that employ heated humidifiers and aerosol generators, especially when used by patients with artificial airways, also pose a risk of infection.

### Normal results

A normal result is a patient that demonstrates adequate oxygenation through pulse oximetry, blood gas tests, and clinical observation. Signs and symptoms of inadequate oxygenation include cyanosis, drowsiness, confusion, restlessness, anxiety, or slow, shallow, difficult, or irregular breathing. Patients with obstructive airway disease may exhibit “aerophagia” (air hunger) as they work to pull air into the lungs. In cases of carbon monoxide inhalation, the oxygen saturation can be falsely elevated.

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- American Association for Respiratory Care. 11030 Ables Lane, Dallas, Texas 75229. (972) 243 2272. E mail: [info@aacrc.org](mailto:info@aacrc.org). <http://www.aarc.org>.
- American College of Chest Physicians. 3300 Dundee Road, Northbrook, Illinois 60062 2348. (847) 498 1400. <http://www.chestnet.org>.

American Lung Association and American Thoracic Society. 1740 Broadway, New York, NY 10019 4374. (800) LUNG USA or (800) 586 4872. <http://www.lungusa.org>.

National Heart, Lung and Blood Institute. Information Center. P.O. Box 30105, Bethesda, Maryland 20824. (301) 251 2222. <http://www.nhlbi.nih.gov/nhlbi/>.

National Jewish Medical and Research Center. Lung Line. 14090 Jackson Street, Denver, Colorado 80206. <http://www.nationaljewish.org>.

### OTHER

Daily Lung. <http://www.dailylung.com>. A full feature magazine covering lung disease and related health topics.

National Lung Health Education Program. <http://www.nlhep.org>.

Pulmonary Paper. P.O. Box 877, Ormond Beach, Florida 32175. (800) 950 3698. <http://www.pulmonarypaper.org>. Not for profit newsletter supporting people with chronic lung problems.

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Oxytocin see **Uterine stimulants**





# P

Pacemaker implantation see **Pacemakers**

## Pacemakers

### Definition

A pacemaker is a surgically implanted electronic device that regulates a cardiac arrhythmia.

Pacemakers are most frequently prescribed when the heartbeat decreases under 60 beats per minute at rest (severe symptomatic bradycardia). They are also used in some cases to slow a fast heart rate over 120 beats per minute at rest (tachycardia).

### Demographics

The population for pacemaker implant is not limited by age, sex, or race. Over 100,000 pacemakers are implanted per year in the United States. The occurrence is more frequent in the elderly with over 85% of implants received by those over age 65. A history of myocardial infarction (heart attack), congenital defect, or cardiac transplant also increases the likelihood of pacemaker implant.

### Description

Approximately 500,000 Americans have an implantable permanent pacemaker device. A pacemaker implantation is performed under **local anesthesia** in a hospital by a surgeon assisted by a cardiologist. An insulated wire called a lead is inserted into an incision above the collarbone and guided through a large vein into the chambers of the heart. Depending on the configuration of the pacemaker and the clinical needs of the patient, as many as three leads may be used in a pacing system. Current pacemakers have a double, or bipolar, electrode attached to the end of each lead. The electrodes deliver an electrical charge to the heart to regulate

heartbeat. They are positioned on the areas of the heart that require stimulation. The leads are then attached to the pacemaker device, which is implanted under the skin of the patient's chest.

Patients undergoing surgical pacemaker implantation usually stay in the hospital overnight. Once the procedure is complete, the patient's **vital signs** are monitored and a **chest x ray** is taken to ensure that the pacemaker and leads are properly positioned.

Modern pacemakers have sophisticated programming capabilities and are extremely compact. The smallest weigh less than 13 grams (under half an ounce) and are the size of two stacked silver dollars. The actual pacing device contains a pulse generator, circuitry programmed to monitor heart rate and deliver stimulation, and a lithium iodide battery. Battery life typically ranges from seven to 15 years, depending on the number of leads the pacemaker is configured with and how much energy the pacemaker uses. When a new battery is required, the unit can be exchanged in a simple outpatient procedure.

A temporary pacing system is sometimes recommended for patients who are experiencing irregular heartbeats as a result of a recent heart attack or other acute medical condition. The implantation procedure for the pacemaker leads is similar to that for a permanent pacing system, but the actual pacemaker unit housing the pulse generator remains outside the patient's body. Temporary pacing systems may be replaced with a permanent device at a later date.

### Diagnosis/Preparation

Patients being considered for pacemaker implantation will undergo a full battery of cardiac tests, including an **electrocardiogram** (ECG), electrophysiological study, or both, to fully evaluate the bradycardia or tachycardia.

The symptoms of fatigue and lightheadedness that are characteristic of bradycardia can also be caused by

## KEY TERMS

**Electrocardiogram (ECG)**—A recording of the electrical activity of the heart. An ECG uses externally attached electrodes to detect the electrical signals of the heart.

**Electrophysiological study**—A test that monitors the electrical activity of the heart in order to diagnose arrhythmia. An electrophysiological study measures electrical signals through a cardiac catheter that is inserted into an artery in the leg and guided up into the atrium and ventricle of the heart.

**Embolism**—A blood clot, air bubble, or clot of foreign material that blocks the flow of blood in an artery. When an embolism blocks the blood supply to a tissue or organ, the tissue the artery feeds dies (infarction). Without immediate and appropriate treatment, an embolism can be fatal.

**Magnetic resonance imaging (MRI)**—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

a number of other medical conditions, including anemia. Certain prescription medications can also slow the heart rate. A doctor should take a complete medical history and perform a full physical work-up to rule out all non-cardiac causes of bradycardia.

Patients are advised to abstain from eating six to eight hours before the surgical procedure. The patient is usually given a sedative to help him or her relax for the procedure. An intravenous (IV) line will also be inserted into a vein in the patient's arm before the procedure begins in case medication or blood products are required during the insertion.

### Aftercare

After an implant without complications the patient can expect a hospital stay of one to five post-procedure days. Pacemaker patients should schedule a follow-up visit with their cardiologist approximately six weeks after the surgery. During this visit, the doctor will make any necessary adjustments to the settings of the pacemaker. Pacemakers are programmed externally with a handheld electromagnetic device. Pacemaker batteries must be checked regularly. Some pacing systems allow patients to monitor battery life through a special telephone monitoring service that can read pacemaker signals.

## WHO PERFORMS THIS PROCEDURE AND WHERE IS IT PERFORMED?

Pacemaker implants are performed by a cardiologist who has completed medical school and an additional internship and residency program. Additional training as an electrophysiologist may be acquired by the physician during the residency program. Specific training by the pacemaker manufacturer may also be acquired. Hospitals performing these procedures have access to cardiac catheterization facilities or operating rooms equipped with portable fluoroscopy units.

Patients with cardiac pacemakers should not undergo a **magnetic resonance imaging (MRI)** procedure. Devices that emit electromagnetic waves (including magnets) may alter pacemaker programming or functioning. A 1997 study found that cellular phones often interfere with pacemaker programming and cause irregular heart rhythm. However, advances in pacemaker design and materials have greatly reduced the risk of pacemaker interference from electromagnetic fields.

### Risks

Because pacemaker implantation is an invasive surgical procedure, internal bleeding, infection, hemorrhage, and embolism are all possible complications. Infection is more common in patients with temporary pacing systems. Antibiotic therapy given as a precautionary measure can reduce the risk of pacemaker infection. If infection does occur, the entire pacing system may have to be removed.

The placing of the leads and electrodes during the implantation procedure also presents certain risks for the patient. The lead or electrode could perforate the heart or cause scarring or other damage. The electrodes can also cause involuntary stimulation of nearby skeletal muscles.

A complication known as pacemaker syndrome develops in approximately 7% of pacemaker patients with single-chamber pacing systems. The syndrome is characterized by the low blood pressure and dizziness that are symptomatic of bradycardia. It can usually be corrected by the implantation of a dual-chamber pacing system.

## QUESTIONS TO ASK THE DOCTOR

- How many pacemaker implants has the physician performed?
- What type of pacemaker will be implanted, univentricular or biventricular, and how many of the specific procedure has the physician performed?
- How long will the expected hospital stay be?
- What precautions should be taken in the weeks following discharge from the hospital?
- What precautions will need to be taken in day to day activities following pacemaker implant?
- When can normal daily, such as driving, exercise and work, activities be initiated?
- What will indicate that the pacemaker is failing and when should emergency care be sought?
- How long will the battery function and when should treatment to replace the device be sought?
- Is there special documentation I will need for air travel during security screenings?
- Will there be notification of manufacturer recalls?

### Normal results

Pacemakers that are properly implanted and programmed can correct a patient's arrhythmia and resolve related symptoms.

### Morbidity and mortality rates

In the United States, patients experience complications in 3.3% and 3.8% of cases, with those over 65 years of age demonstrating a slightly higher complication rate of 6.1%. The most common complications include lead dislodgement, pneumothorax (collapsed lung), and cardiac perforation. The risk of **death** is less than 0.5% throughout the course of the hospital stay.

### Resources

#### BOOKS

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Packed cell volume see **Hematocrit**

Packed red blood cell volume see **Hematocrit**

## Pain management

### Definition

Pain itself is defined by the International Association for the Study of Pain (IASP) as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage." Thus, pain management encompasses all interventions used to understand and ease pain, and if possible to alleviate the cause of the pain.

### Purpose

Pain serves to alert a person to potential or actual damage to the body. The definition of damage is quite broad: pain can arise from injury as well as disease. After the message is received and interpreted, further pain can be counterproductive. Pain can have a negative impact on a person's quality of life and impede recovery from illness or injury, thus contributing to escalating health care costs. Unrelieved pain can become a syndrome in its own right and cause a downward spiral in a person's health and emotional outlook. Managing pain properly facilitates recovery, prevents additional health complications, and improves an individual's quality of life.

Yet the experiencing of pain is a completely unique occurrence for each person, a complex combination of several factors other than the pain itself. It is influenced by:

- Ethnic and cultural values. In some cultures, tolerating pain is related to showing strength and endurance. In others, pain is considered punishment for misdeeds.
- Age. Many people have been taught that grownups never cry. On the other hand, in some cultures, the



elderly are allowed to complain freely about pain and discomfort.

- Anxiety and stress. This factor is related to being in a strange or unfamiliar place such as a hospital, and the fear of the unknown consequences of the pain and the condition causing it, which can all combined to make pain feel more severe. For patients being treated for pain, knowing the duration of activity of an analgesic leads to anxiety about the return of pain when the drug wears off. This anxiety can make the pain more severe. In addition, patients who interpret their pain as meaning that their disease is recurring or getting worse often experience pain as more severe.
- Fatigue and depression. It is known that pain in itself can actually cause emotional depression. Fatigue from lack of sleep or the illness itself also contributes to depressed feelings.

### Precautions

The perception of pain is an individual experience. Healthcare providers play an important role in understanding their patients' pain. All too often, both physicians and nurses have been found to incorrectly assess the severity of pain. A study reported in the *Journal of Advanced Nursing* evaluated nurses' perceptions of a select group of white American and Mexican-American women patients' pain following gallbladder surgery. Objective assessments of each patient's pain showed little difference between the perceived severities for each group. Yet, the nurses involved in the study consistently rated all patients' pain as less than the patients reported, and with equal consistency, believed that better-educated women born in the United States were suffering more than less-educated Mexican-American women. Nurses from a northern European background were more apt to minimize the severity of pain than nurses from eastern and southern Europe or Africa. The study indicated how healthcare staff, and especially nursing staff, need to be aware of how their own background and experience contributes to how they perceive a person's pain.

Some patient populations are particularly susceptible to inadequate pain management. These include cancer patients; children; trauma victims receiving treatment in hospital emergency departments; and the elderly in **nursing homes**.

### Description

Before considering pain management, a review of pain definitions and mechanisms may be useful. Pain is the means by which the peripheral nervous system

## KEY TERMS

**Acute**—Referring to pain in response to injury or other stimulus that resolves when the injury heals or the stimulus is removed.

**Central nervous system (CNS)**—The part of the nervous system that includes the brain and the spinal cord.

**Chronic**—Referring to pain that endures beyond the term of an injury or painful stimulus. Can also refer to cancer pain, pain from a chronic or degenerative disease, and pain from an unidentified cause.

**Iatrogenic**—Resulting from the activity of the physician.

**Neuropathy**—Nerve damage.

**Neurotransmitter**—Chemicals within the nervous system that transmit information from or between nerve cells.

**Nociceptor**—A nerve cell that is capable of sensing pain and transmitting a pain signal.

**Nonpharmacological**—Referring to therapy that does not involve drugs.

**Parasympathetic nervous system**—That part of the autonomic nervous system consisting of nerves that arise from the cranial and sacral regions and function in opposition to the sympathetic nervous system.

**Peripheral nervous system (PNS)**—Nerves that are outside of the brain and spinal cord.

**Pharmacological**—Referring to therapy that relies on drugs.

**Stimulus**—A factor capable of eliciting a response in a nerve.

**Sympathetic nervous system**—That portion of the autonomic nervous system consisting of nerves that originate in the thoracic and lumbar spinal cord and function in opposition to the parasympathetic nervous system.

(PNS) warns the central nervous system (CNS) of injury or potential injury to the body. The CNS comprises the brain and spinal cord, and the PNS is composed of the nerves that stem from and lead into the CNS. PNS includes all nerves throughout the body, except the brain and spinal cord. Pain is sometimes categorized by its site of origin, either cutaneous (originating in the skin, or subcutaneous tissue, such as a shaving nick or paper cut), deep somatic pain (arising

from bone, ligaments and tendons, nerves, or veins and arteries), or visceral (appearing as a result of stimulation of pain receptor nerves around such organs as the brain, lungs, or stomach and intestines).

A pain message is transmitted to the CNS by special PNS nerve cells called nociceptors, which are distributed throughout the body and respond to different stimuli depending on their location. For example, nociceptors that extend from the skin are stimulated by such sensations as pressure, temperature, and chemical changes.

When a nociceptor is stimulated, neurotransmitters are released within the cell. Neurotransmitters are chemicals found within the nervous system that facilitate nerve cell communication. The nociceptor transmits its signal to nerve cells within the spinal cord, which conveys the pain message to the thalamus, a specific region in the brain.

Once the brain has received and processed the pain message and coordinated an appropriate response, pain has served its purpose. The body uses natural pain-killers called endorphins to derail further pain messages from the same source. However, these natural pain-killers may not adequately dampen a continuing pain message. Also, depending on how the brain has processed the pain information, certain hormones such as prostaglandins may be released. These hormones enhance the pain message and play a role in immune system responses to injury, such as inflammation. Certain neurotransmitters, especially substance P and calcitonin gene-related peptide, actively enhance the pain message at the injury site and within the spinal cord.

Pain is generally divided into two additional categories: acute and chronic. Nociceptive pain, or the pain that is transmitted by nociceptors, is typically called acute pain. This kind of pain is associated with injury, headaches, disease, and many other conditions. Response to acute pain is made by the sympathetic nervous system (the nerves responsible for the fight-or-flight response of the body). It normally resolves once the condition that precipitated it is resolved.

There are some disorders that produce pain that does not resolve following the disorder. Even after healing or a cure has been achieved, the brain continues to perceive pain. In this situation, the pain may be considered chronic. Chronic pain is within the province of the parasympathetic nervous system, and the changeover occurs as the body attempts to adapt to the pain. The time limit used to define chronic pain typically ranges from three to six months, although some healthcare professionals prefer a more flexible definition and consider chronic pain as pain that

endures beyond a normal healing time. The pain associated with cancer, persistent and degenerative conditions, and neuropathy, or nerve damage, is included in the chronic category. Also, unremitting pain that lacks an identifiable physical cause such as the majority of cases of low back pain may be considered chronic. The underlying biochemistry of chronic pain appears to be different from that of acute nociceptive pain.

It has been hypothesized that uninterrupted and unrelenting pain can induce changes in the spinal cord. In the past, severing a nerve's connection to the CNS has treated intractable pain. However, the lack of any sensory information being relayed by that nerve can cause pain transmission in the spinal cord to go into overdrive, as evidenced by the phantom limb pain experienced by amputees. Evidence is accumulating that unrelenting pain or the complete lack of nerve signals increases the number of pain receptors in the spinal cord. Nerve cells in the spinal cord may also begin secreting pain-amplifying neurotransmitters independent of actual pain signals from the body. Immune chemicals, primarily cytokines, may play a prominent role in such changes.

### *Managing pain*

Considering the different causes and types of pain, as well as its nature and intensity, management usually requires a multidisciplinary approach. The elements of this approach include treating the underlying cause of pain, pharmacological and non-pharmacological therapies, and some invasive (surgical) procedures.

Treating the cause of pain underlies the basic strategy of pain management. Injuries are repaired, diseases are diagnosed, and certain encounters with pain can be anticipated and treated prophylactically (by prevention). However, there are no guarantees of immediate relief from pain. Recovery can be impeded by pain and quality of life can be damaged. Therefore, pharmacological and other therapies have developed over time to address these aspects of disease and injury.

**PHARMACOLOGICAL OPTIONS.** General guidelines developed by the World Health Organization (WHO) have been developed for pain management. These guidelines operate upon the three-step ladder approach, including:

- Mild pain is alleviated with acetaminophen or a non-steroidal anti-inflammatory drug (NSAID). NSAIDs and acetaminophen are available as over-the-counter (OTC) and prescription medications, and are frequently the initial pharmacological treatment for pain. These drugs can also be used as adjuncts to the

other drug therapies that might require a doctor's prescription. NSAIDs include aspirin, ibuprofen (Motrin, Advil, Nuprin), naproxen sodium (Aleve), and ketoprofen (Orudis KT). These drugs are used to treat pain from inflammation and work by blocking production of pain-enhancing neurotransmitters. Acetaminophen is also effective against pain, but its ability to reduce inflammation is limited. NSAIDs and acetaminophen are effective for most forms of acute (sharp, but of a short duration) pain.

- Mild to moderate pain is eased with a milder opioid medication, plus acetaminophen or NSAIDs. Opioids include both drugs derived from the opium poppy, such as morphine and codeine, and synthetic drugs based on the structure of opium. This drug class includes drugs such as oxycodone, methadone, and meperidine (Demerol). They provide pain relief by binding to specific opioid receptors in the brain and spinal cord. One drawback of opioids, however, is that they frequently cause constipation because they slow down the rhythmic muscular contractions of the intestines that push food along during the process of digestion.
- Moderate to severe pain is treated with stronger opioid drugs, plus acetaminophen or NSAIDs. Morphine is sometimes referred to as the gold standard of palliative care as it is not expensive; can be given by starting with smaller doses and gradually increased; and is highly effective over a long period of time. It can also be given by a number of different routes, including by mouth, rectally, or by injection.

Although antidepressant drugs were developed to treat depression, it has been discovered that they are also effective in combating chronic headaches, cancer pain, and pain associated with nerve damage. Antidepressants that have been shown to have analgesic (pain-reducing) properties include amitriptyline (Elavil), trazodone (Desyrel), and imipramine (Tofranil). Anticonvulsant drugs share a similar background with antidepressants. Developed to treat epilepsy, anticonvulsants were found to relieve pain as well. Drugs such as phenytoin (Dilantin) and carbamazepine (Tegretol) are prescribed to treat the pain associated with nerve damage.

In some cases, chronic pain caused by complications of diabetes or cancer can be eased by administering local anesthetics. The most commonly used are mexiletine (Mexitol) and a lidocaine patch.

**Corticosteroids** are another class of drugs commonly given to manage chronic pain caused by arthritis or other diseases affecting the muscles and joints; they may also be given to control nausea. Dexamethasone

(Decadron) and prednisone are the most commonly used corticosteroids in pain management. They work by reducing inflammation and suppressing the immune system.

Close monitoring of the effects of pain medications is required in order to assure that adequate amounts of medication are given to produce the desired pain relief. When a person is comfortable with a certain dosage of medication, oncologists typically convert to a long-acting version of that medication. Transdermal fentanyl patches (Duragesic) are a common example of a long-acting opioid drug often used for cancer pain management. A patch containing the drug is applied to the skin and continues to deliver the drug to the person for an average of three days. Pumps are also available that provide an opioid medication upon demand when the person is experiencing pain. By pressing a button, they can release a set dose of medication into an intravenous solution or an implanted catheter. Another mode of administration involves implanted catheters that deliver pain medication directly to the spinal cord. Because these pumps offer the patient some degree of control over the amount of analgesic administered, the system, commonly called **patient-controlled analgesia (PCA)**, reduces the level of anxiety about availability of pain medication. Delivering drugs in this way can reduce side effects and increase the effectiveness of the drug. Research is underway to develop toxic substances that act selectively on nerve cells that carry pain messages to the brain. These substances would kill the selected cells and stop transmission of the pain message.

**NONPHARMACOLOGICAL OPTIONS.** Pain treatment options that do not use drugs are often used as adjuncts to, rather than replacements for, drug therapy. One of the benefits of nondrug therapies is that an individual can take a more active role in pain management. Such relaxation techniques as yoga and meditation are used to focus the brain elsewhere than on the pain, decrease muscle tension, and reduce stress. Tension and stress can also be reduced through **biofeedback**, in which an individual consciously attempts to modify skin temperature, muscle tension, blood pressure, and heart rate.

Hypnosis is another nonpharmacological option for pain relief. Although doctors do not yet fully understand how hypnosis works, it is used successfully in some patients to manage pain related to childbirth, oral surgery, burn treatment, and other procedures that require the patient to remain conscious.

Participating in normal activities and exercising can also help control pain levels. Through physical

therapy, an individual learns beneficial exercises for reducing stress, strengthening muscles, and staying fit. Regular **exercise** has been linked to production of endorphins, the body's natural painkillers.

Acupuncture involves the insertion of small needles into the skin at key points. Acupressure uses these same key points, but involves applying pressure rather than inserting needles. Both of these methods may work by prompting the body to release endorphins. Applying heat or being massaged are very relaxing and help reduce stress. Transcutaneous electrical nerve stimulation (TENS) applies a small electric current to certain parts of nerves, potentially interrupting pain signals and inducing release of endorphins. To be effective, use of TENS should be medically supervised.

**INVASIVE PROCEDURES.** There are three types of invasive procedures that may be used to manage or treat pain: anatomic, augmentative, and ablative. These procedures involve surgery, and certain guidelines should be followed before carrying out a procedure with permanent effects. First, the cause of the pain must be clearly identified. Next, surgery should be done only if noninvasive procedures are ineffective. Third, any psychological issues should be addressed. Finally, there should be a reasonable expectation of success.

Anatomic procedures involve correcting the injury or removing the cause of pain. Relatively common anatomic procedures are decompression surgeries such as repairing a herniated disk in the lower back or relieving the nerve compression related to carpal tunnel syndrome. Another anatomic procedure is neurolysis, also called a nerve block, which involves destroying a portion of a peripheral nerve.

Augmentative procedures include electrical stimulation or direct application of drugs to the nerves that are transmitting the pain signals. Electrical stimulation works on the same principle as TENS. In this procedure, instead of applying the current across the skin, electrodes are implanted to stimulate peripheral nerves or nerves in the spinal cord. Augmentative procedures also include implanted drug-delivery systems. In these systems, catheters are implanted in the spine to allow direct delivery of drugs to the CNS.

Ablative procedures are characterized by severing a nerve and disconnecting it from the CNS. However, this method may not address potential alterations within the spinal cord. These changes perpetuate pain messages and do not cease, even when the connection between the sensory nerve and the CNS is severed. With growing understanding of neuropathic pain and development of less invasive procedures, ablative procedures are used less frequently. However,

they do have applications in select cases of peripheral neuropathy, cancer pain, and other disorders.

## Preparation

Prior to beginning management, the patient's pain should be thoroughly evaluated, including a psychosocial as well as a physical assessment. Pain scales or questionnaires can be administered by a member of the healthcare team, although there is no single questionnaire that is universally accepted as of 2007. Some questionnaires are verbal, while others use pictures or drawings to help the patient describe the pain. Some questionnaires are filled out by the patient, while others may be given to relatives or friends to complete. It is often necessary to ask other family members to complete a pain questionnaire if the patient is cognitively impaired.

In spite of their limitations, questionnaires and self-report forms do allow healthcare workers to better understand the pain being suffered by the patient. Evaluation also includes physical examinations and diagnostic tests to determine the underlying physical causes of the pain. Some evaluations require assessments from several viewpoints, including neurology, psychiatry and psychology, and physical therapy. If the pain is caused by a medical procedure, management consists of anticipating the type and intensity of associated pain and managing it preemptively.

Nurses or physicians often take what is called a pain history. This history will help to provide important information that can help health care providers to better manage the patient's pain. A typical pain history includes the following questions:

- Where is the pain located?
- On a scale of 1 to 10, with 1 indicating the least pain, how would the person rate the pain being experienced?
- What does the pain feel like?
- When did (or does) the pain start?
- How long has the person had it?
- Is the person sometimes free of pain?
- Is the pain constant, or is it episodic?
- Does the person know of anything that triggers the pain or makes it worse?
- Does the person have other symptoms (nausea, dizziness, blurred vision, etc.) during or after the pain?
- What pain medications or other measures has the person found to help in easing the pain?
- How does the pain affect the person's ability to carry on normal activities?
- What does it mean to the person that he or she is experiencing pain?



## Aftercare

An assessment by nursing staff as well as other healthcare providers should be made to determine the effectiveness of the pain management interventions employed. There are objective, measurable signs and symptoms of pain that can be looked for. The goal of good pain management is the absence of these signs. Signs of acute pain include:

- rise in pulse and blood pressure
- more rapid breathing
- perspiring profusely, clammy skin
- taut muscles
- more tense appearance, fast speech, very alert
- unusually pale skin
- dilated pupils of the eye

Signs of chronic pain include:

- lower pulse and blood pressure
- changeable breathing pattern
- warm, dry skin
- nausea and vomiting
- slow or monotone speech
- inability or difficulty in getting out of bed and performing activities of daily living (ADLs)
- constricted pupils of the eye

When these signs are absent and the patient appears to be comfortable, healthcare providers can consider their interventions to have been successful. It is also important to document interventions used, and which ones were successful.

## Risks

Owing to toxicity over the long term, some drugs can only be used for acute pain or as adjuncts in chronic pain management. NSAIDs have the well-known side effect of causing gastrointestinal bleeding, and long-term use of **acetaminophen** has been linked to kidney and liver damage. Other drugs, especially narcotics, have such serious side effects as constipation, drowsiness, and nausea. Serious side effects can also accompany pharmacological therapies; mood swings, confusion, bone thinning, cataract formation, increased blood pressure, and other problems may discourage or prevent use of some **analgesics**.

Nonpharmacological therapies carry little or no risks. However, individuals recovering from serious illness or injury should consult with the health care providers or physical therapists before making use of adjunct therapies. Invasive procedures carry risks similar to other surgical procedures, such as infection,

reaction to anesthesia, and iatrogenic (injury as a result of treatment) injury.

A traditional concern about narcotics use has been the risk of promoting addiction. As narcotic use continues over time, the body becomes accustomed to the drug and adjusts normal functions to accommodate to its presence. Therefore, to elicit the same level of action, it is necessary to increase dosage over time. As dosage increases, an individual may become physically dependent on narcotic drugs.

However, physical dependence is different from psychological addiction. Physical dependence is characterized by discomfort if drug administration suddenly stops, while psychological addiction is characterized by an overpowering craving for the drug for reasons other than pain relief. Psychological addiction is a very real and necessary concern in some instances, but it should not interfere with a genuine need for narcotic pain relief. However, caution must be taken with people who have a history of addictive behavior.

## Normal results

Effective application of pain management techniques reduces or eliminates acute or chronic pain. This treatment can improve an individual's quality of life and aid in recovery from injury and disease.

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Pain relievers see **Analgesics**

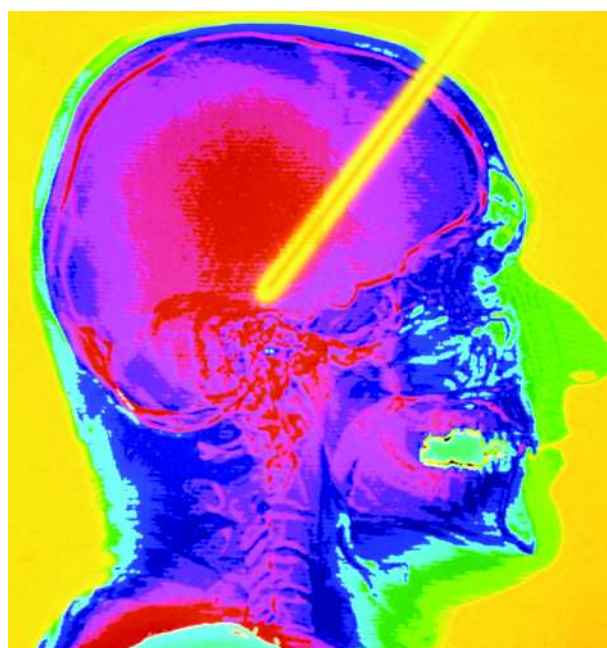
## Pallidotomy

### Definition

Pallidotomy is the destruction of a small region of the brain, the globus pallidus internus, in order to treat some of the symptoms of Parkinson's disease.

### Purpose

The symptoms of Parkinson's disease (PD) include rigidity, slowed movements, and tremor, along with postural instability and a variety of non-motor symptoms (i.e., symptoms not involving movement). These symptoms are due to degeneration of a small portion of the brain called the substantia nigra, the cells of which secrete the chemical dopamine that influences cells in another brain region called the globus pallidus internus



**A CT scan of a surgical probe entering a patient's brain.** (John Greim / Photo Researchers, Inc.)

(GPi). Together with other brain regions, these two structures take part in complex control loops that govern certain aspects of movement and, when substantia nigra cells degenerate, these loops are disrupted and movements become unregulated, producing the symptoms of Parkinson's disease.

The effects of dopamine on the brain can be mimicked by the drug levodopa; levodopa therapy is the mainstay of PD treatment in its early stages. Unfortunately, levodopa becomes less effective over time, and also produces unwanted and uncontrolled movements called dyskinesias. This may occur after five to 10 years or more of successful levodopa treatment. Once a patient can no longer be treated effectively with levodopa, surgery is considered as a management option. Pallidotomy is one of the main surgical options for treatment of advanced PD.

The effect of dopamine on the cells of the GPi is to suppress them by preventing them from firing. Pallidotomy mimics this action by permanently destroying the GPi cells. It may seem odd that the treatment for degeneration of one brain area is to destroy another, but in the absence of dopamine, the GPi cells are overactive, and therefore, eliminating them is an appropriate treatment.

The GPi has two halves that control movements on opposite sides: right controls left, left controls right. Unilateral (one-sided) pallidotomy may be used

if symptoms are markedly worse on one side or the other, or if the risks from bilateral (two-sided) pallidotomy are judged to be too great.

## Demographics

Parkinson's disease affects approximately one million Americans. The peak incidence is approximately at age 62, but young-onset PD can occur as early as age 40. Because young-onset patients live with their disease for so many more years, they are more likely to become candidates for surgery than older-onset patients. In addition, younger patients tend to do better with surgery and suffer fewer adverse effects from the surgery. Approximately 5% of older PD patients receive one form or another of PD surgery; many more develop the symptoms for which surgery may be effective, but either develop them at an advanced age, making surgery inadvisable, or decide the risks of surgery are not worth the potential benefit, or do not choose surgery for some other reason.

## Description

Pallidotomy requires the insertion of a long needle-like probe deep into the brain through a hole in the top of the skull. In order to precisely locate the GPi target, and to ensure the probe is precisely placed in the target, a "stereotactic frame" is used. This device is a rigid frame attached to the patient's head, providing an immobile three-dimensional coordinate system, which can be used to precisely track the location of the GPi and the movement of the probe.

For unilateral pallidotomy, a single "burr hole" is made in the top of the skull; bilateral pallidotomy requires two holes. A strong topical anesthetic is used to numb the shaved area before this hole is drilled. Since there are no pain receptors in the brain, there is no need for deeper anesthetic. In addition, the patient must remain awake in order to report any sensory changes during the surgery. The lesion made in the GPi is very close to the optic tract that carries visual information from the eyes to the rear of the brain. Visual changes may indicate the probe is too close to this region.

Once the burr hole is made, the surgeon inserts a microelectrode probe, which is used to more precisely locate the GPi. Electrical stimulation of the brain through the electrode can help determine exactly which structure is being stimulated. This is harmless, but may cause twitching, light flashes, or other sensations. A contrast dye may also be injected into the spinal fluid, which allows the surgeon to visualize the brain's structure using one or more imaging techniques. During the procedure, the patient will be asked to make

various movements to assist in determining the location of the electrode.

When the proper target is located, the electrode tip is briefly heated, carefully destroying the surrounding tissue to about the size of a pearl. If bilateral pallidotomy is being performed, the localizing and lesioning will be repeated on the other side.

## Diagnosis/Preparation

Pallidotomy is performed in patients with Parkinson's disease who are still responsive to levodopa, but who have developed disabling drug treatment complications known as motor fluctuations, including rapid wearing off of drug effect, unpredictable "off states" (times of low levodopa levels in the blood), and disabling dyskinesias. Those who are very elderly, demented, or with other significant medical conditions that would be compromised by surgery are usually not candidates for pallidotomy.

The surgical candidate should discuss all the surgical options with the neurologist before deciding on pallidotomy. A full understanding of the risks and potential benefits must be understood before consenting to the surgery.

The patient will undergo a variety of medical tests, and one or more types of neuroimaging procedures, including **magnetic resonance imaging (MRI)**, computed tomography (CT) scanning, **angiography** (imaging the brain's blood vessels), and **ventriculography** (imaging the brain's ventricles). On the day of the surgery, the stereotactic frame will be fixed to the patient's head. First, a local anesthetic is applied at the four sites where the frame's pins contact the head; there may nonetheless be some initial discomfort. A final MRI is done with the frame in place to help set the coordinates of the GPi in relation to the frame.

The patient will receive a mild sedative to ease the anxiety of the procedure.

## Aftercare

The procedure requires several hours. Some centers perform pallidotomy as an outpatient procedure, sending the patient home the same day. Most centers keep the patient overnight or longer for observation. Patients will feel improved movement immediately. Medications may be adjusted somewhat to accommodate the changes in symptoms.

## Risks

The key to successful outcome in pallidotomy is extremely precise placement of the electrode. While

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Pallidotomy is performed in the hospital by a neurosurgeon, in coordination with the patient's neurologist.

there are several controversies in the field of PD surgery, all experts agree that risks are reduced in procedures performed by the most experienced neurosurgeons.

Hemorrhage in the brain is a possible complication, as is infection. There are small but significant risks of damage to the optic tract, which can cause visual deficits. Speech impairments may also occur, including difficulty retrieving words and slurred speech. Some cognitively fragile patients may become even more impaired after surgery.

### Normal results

Pallidotomy improves the motor ability of patients, especially during "off" periods. Studies show the procedure generally improves tremor, rigidity, and slowed movements by 25–60%. Dyskinesias typically improve by 75% or more. Improvements from unilateral pallidotomy are primarily on the side opposite the surgery. Balance does not improve, nor do non-motor symptoms such as drooling, constipation, and orthostatic hypotension (lightheadness on standing).

### Morbidity and mortality rates

Among the best surgeons, the risk of serious morbidity or mortality is 1–2%. Hemorrhage may occur in 2–6%, visual field deficits in 0–6%, and weakness in 2–8%. Most patients gain weight after surgery.

### Alternatives

Patients whose symptoms are well managed by drugs are not recommended for surgery, and significant effort will usually be made to adjust medications to control symptoms before surgery is considered.

Thalamotomy, surgery to the thalamus, was recommended in the past to control tremor. It is rarely performed today, and few centers would consider thalamotomy for any patient unless tremor was the only troubling and uncontrolled symptom.

Deep-brain stimulation (DBS) of the GPi is an alternative treatment in widespread use, as is DBS of another brain region, the subthalamic nucleus. Both

## QUESTIONS TO ASK THE DOCTOR

- How many pallidotomies has the neurosurgeon performed?
- What is the surgeon's own rate of serious complications?
- Would deep brain stimulation of the subthalamic nucleus be appropriate for me?
- How will my medications change after the operation?

procedures use permanently implanted, programmable electrodes to deliver a very small, continuous electric current to the target region. This has the same effect as a lesion, but is adjustable. DBS of the subthalamic nucleus typically produces better symptomatic results than either DBS to the GPi or pallidotomy. However, both forms of DBS carry the risk of long-term complications from the implanted hardware, as well as other risks.

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#### ORGANIZATIONS

National Parkinson's Disease Foundation. <http://www.npf.org>.

WE MOVE. <http://www.wemove.org>.

Richard Robinson

Pancreas removal see **Pancreatectomy**

## Pancreas transplantation

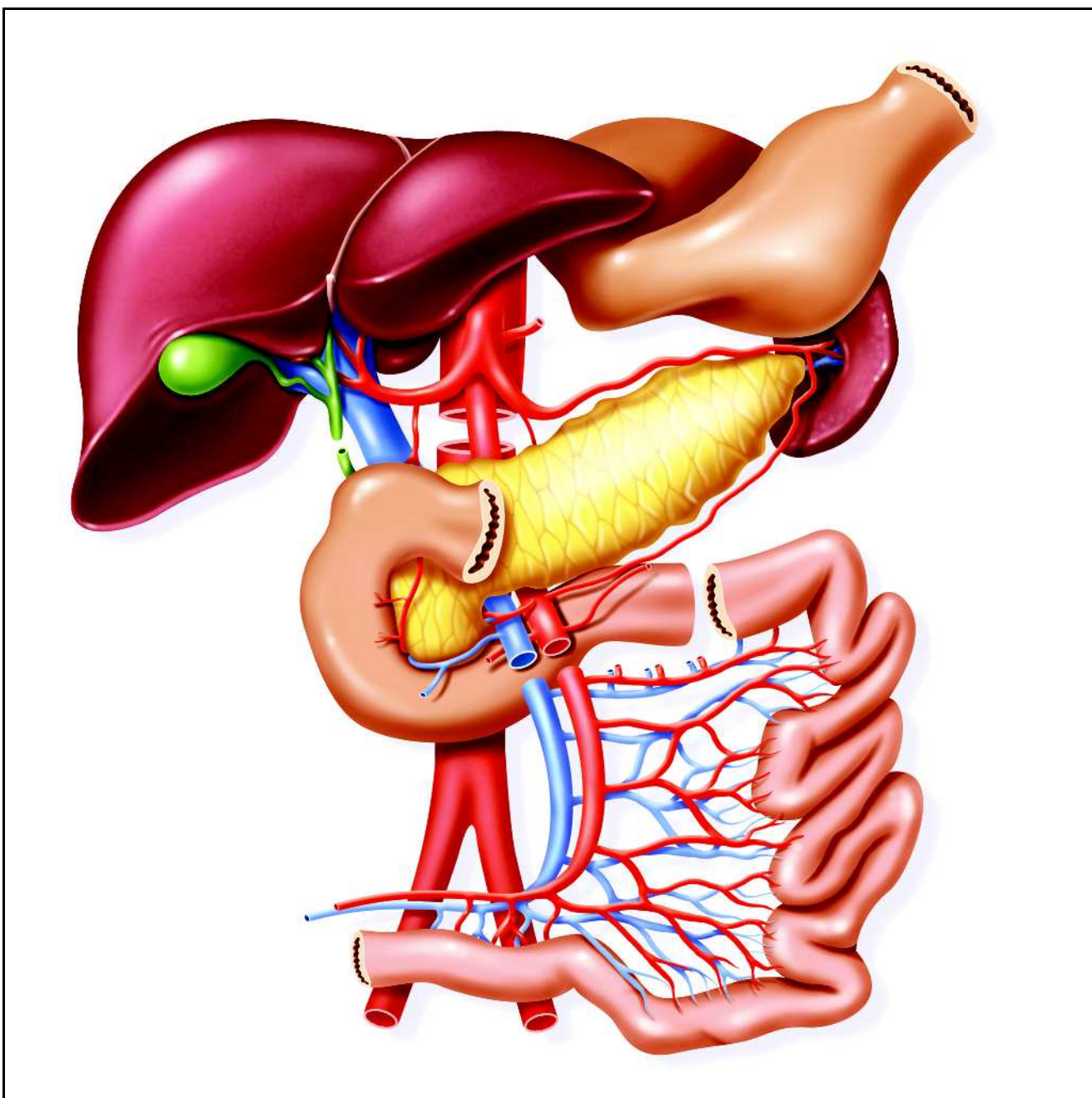
### Definition

Pancreas transplantation is a surgical procedure in which a diseased pancreas is replaced with a healthy pancreas that has been obtained from an immunologically compatible cadaver or living donor.

### Purpose

The pancreas secretes insulin that regulates glucose (blood sugar) metabolism. Patients with type I





**The pancreas transplantation procedure.** (BSIP/Phototake. Reproduced by permission.)

diabetes have experienced partial or complete damage to the insulin-producing beta cells of the pancreas. Consequently, they are unable to generate sufficient insulin to control blood glucose levels. Long-term uncontrolled high blood glucose levels can cause damage to every system of the body, so type I patients must inject insulin to do the work of the beta cells. Pancreas transplantation allows the body to once again make

and secrete its own insulin, and establishes insulin independence for these individuals.

### Demographics

It is estimated that over one million people in the United States have type 1 diabetes mellitus (also called insulin-dependant diabetes or juvenile diabetes). Among

these individuals, the best candidates for pancreas transplantation are typically:

- between the ages of 20 and 40
- those who have extreme difficulty regulating their glucose levels with insulin therapy (a condition called brittle diabetes)
- those who have few secondary complications of diabetes
- those who are in good cardiovascular health

A pancreas-only transplant is an uncommon procedure, with only 163 procedures occurring in the United States in 2001. More common is the combined kidney-pancreas transplant, which was performed on 885 patients the same year. An additional 305 patients received a PAK, or pancreas after kidney transplant, according to the United Network for Organ Sharing (UNOS).

### Description

Once a donor pancreas is located and tissue typing deems it compatible, the patient is contacted and prepared for surgery. Blood tests, a **chest x ray**, and an **electrocardiogram** (ECG) are performed and an intravenous (IV) line is started for fluid and medication administration. Once the transplant procedure is ready to start, **general anesthesia** is administered.

The surgeon makes an incision under the ribs and locates the pancreas and duodenum. The pancreas and duodenum (part of the small intestine) are removed. The new pancreas and duodenum are then connected to the patient's duodenum, and the blood vessels are sutured together to restore blood flow to the new pancreas. The patient's original pancreas is left in place.

Replacing the duodenum allows the pancreas to drain into the gastrointestinal system. The transplant can also be done creating bladder drainage. Bladder drainage makes it easier to monitor organ rejection because pancreatic secretions can be measured in the patient's urine. Once the new pancreas is in place, the abdomen and skin are sutured closed. This surgery is often done at the same time as kidney **transplant surgery**.

### Diagnosis/Preparation

After the patient and doctor have decided on a pancreas transplant, a complete immunological study is performed to match the patient to a donor. An extensive medical history and **physical examination** is performed, including radiological exams, blood and urine tests, and psychological evaluation. Once the patient is approved for transplant, he or she will be placed on the United Network for Organ Sharing

## KEY TERMS

**Cadaver organ**—A pancreas, kidney, or other organ from a brain-dead organ donor.

**Duodenum**—The section of the small intestine immediately after the stomach.

(UNOS) Organ Center waiting list. The timing of surgery depends on the availability of a donated living or cadaver organ.

### Aftercare

Patients receiving a pancreas transplantation are monitored closely for organ rejection. The average hospital stay is three weeks, and it takes about six months to recover from surgery. Patients will take **immunosuppressant drugs** for the rest of their lives.

### Risks

Diabetes and poor kidney function greatly increase the risk of complications from anesthesia during surgery. Organ rejection, excessive bleeding, and infection are other major risks associated with this surgery.

The reason simultaneous kidney-pancreas transplants and pancreas after kidney transplants are performed more frequently than pancreas only transplants is the relative risk of immunosuppressant drugs in people with diabetes. People with type I diabetes are already at risk for autoimmune problems, are more prone to infections, and have a complicated medical history that makes suppressing the immune system unadvisable.

On the other hand, diabetes is also the number one cause of chronic kidney failure, or end-stage renal disease (ESRD), which makes this group more likely to eventually require a kidney transplant for survival. In those patients with diabetes who will receive or are already receiving immunosuppressive treatment for a life-saving kidney transplant, a pancreas transplant can return their ability to self-produce insulin.

Patients with type I diabetes considering pancreas transplantation alone must weigh the risks and benefits of the procedure and decide with their doctors whether life-long treatment with immunosuppressive drugs is preferable to life-long insulin dependence.

### Normal results

In a successful transplant, the pancreas begins producing insulin, bringing the regulation of glucose

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A pancreas transplant is performed by a transplant surgeon in one of over 200 UNOS-approved hospitals nationwide. The patient must go through an evaluation procedure at his or her hospital of choice to get on the UNOS national waiting list and the UNOS Organ Center's UNet database.

back under control. Natural availability of insulin prevents the development of additional complications associated with diabetes, including kidney damage, vision loss, and nerve damage. Many patients report an improved quality of life.

### Morbidity and mortality rates

In their 2002 Annual Report, the Organ Procurement and Transplant Network (OPTN) reported that the patient survival rate for pancreas transplant alone was 98.6% after one year and 86% after three years. Survival rates for pancreas-kidney transplant recipients were 95.1% after one year and 89.2% after three years.

### Alternatives

Innovations in islet cell transplants, a procedure that involves transplanting a culture of the insulin-producing islet cells of a healthy pancreas to a patient with type I diabetes, have increased the frequency of this procedure. The Edmonton Protocol, a type of islet cell transplant developed in 1999 by Dr. James Shapiro at the University of Alberta (Canada), uses a unique immunosuppressant drug regimen that has dramatically improved success rates of the islet transplant procedure. As of early 2003, the Edmonton Protocol was still considered investigational in the United States, and a number of clinical trials were ongoing.

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## QUESTIONS TO ASK THE DOCTOR

- How many pancreas or pancreas-kidney transplants have both you and the hospital performed?
- What are your success rates? How about those of the hospital?
- Who will be on my transplant team?
- Can I get on the waiting list at more than one hospital?
- What type of immunosuppressive drugs will I be on post-transplant?
- How long will my recovery period be?

### ORGANIZATIONS

American Diabetes Association. 1701 North Beauregard Street, Alexandria, VA 22311. (800) 342 2383. <http://www.diabetes.org>.

United Network for Organ Sharing (UNOS). 700 North 4th St., Richmond, VA 23219. (888) 894 6361. <http://www.transplantliving.org>.

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## Pancreatectomy

### Definition

A pancreatectomy is the surgical removal of the pancreas. A pancreatectomy may be total, in which case the entire organ is removed, usually along with the spleen, gallbladder, common bile duct, and portions of the small intestine and stomach. A pancreatectomy may also be distal, meaning that only the body and tail of the pancreas are removed, leaving the head of the organ attached. When the duodenum is removed along with all or part of the pancreas, the procedure is called a pancreaticoduodenectomy, which surgeons sometimes refer to as "Whipple's procedure." Pancreaticoduodenectomies are increasingly used to treat a variety of malignant and benign diseases of the pancreas. This procedure often involves removal of the regional lymph nodes as well.

### Purpose

A pancreatectomy is the most effective treatment for cancer of the pancreas, an abdominal organ that

## KEY TERMS

**Chemotherapy**—A cancer treatment that uses synthetic drugs to destroy the tumor either by inhibiting the growth of the cancerous cells or by killing the cancer cells.

**Computed tomography (CT) scan**—An imaging technique that creates a series of pictures of areas inside the body, taken from different angles. The pictures are created by a computer linked to an x-ray machine.

**Endoscopic retrograde cholangiopancreatography (ERCP)**—A procedure to x-ray the ducts (tubes) that carry bile from the liver to the gallbladder and from the gallbladder to the small intestine.

**Laparoscopy**—In this procedure, a laparoscope (a thin, lighted tube) is inserted through an incision in the abdominal wall to determine if the cancer is within the pancreas only or has spread to nearby tissues and if it can be removed by surgery later. Tissue samples may be removed for biopsy.

**Magnetic resonance imaging (MRI)**—A procedure in which a magnet linked to a computer is used to create detailed pictures of areas inside the body.

**Pancreas**—A large gland located on the back wall of the abdomen, extending from the duodenum (first part of the small intestine) to the spleen. The pancreas produces enzymes essential for digestion, and

the hormones insulin and glucagon, which play a role in diabetes.

**Pancreaticoduodenectomy**—Removal of all or part of the pancreas along with the duodenum. Also known as “Whipple’s procedure” or “Whipple’s operation.”

**Pancreatitis**—Inflammation of the pancreas, either acute (sudden and episodic) or chronic, usually caused by excessive alcohol intake or gallbladder disease.

**Positron emission tomography (PET) scan**—An imaging system that creates a picture showing the location of tumor cells in the body. A substance called radionuclide dye is injected into a vein, and the PET scanner rotates around the body to create the picture. Malignant tumor cells show up brighter in the picture because they are more active and take up more dye than normal cells.

**Radiation therapy**—A treatment using high energy radiation from x-ray machines, cobalt, radium, or other sources.

**Ultrasonogram**—A procedure where high-frequency sound waves that cannot be heard by human ears are bounced off internal organs and tissues. These sound waves produce a pattern of echoes which are then used by the computer to create sonograms, or pictures of areas inside the body.

secretes digestive enzymes, insulin, and other hormones. The thickest part of the pancreas near the duodenum (a part of the small intestine) is called the head, the middle part is called the body, and the thinnest part adjacent to the spleen is called the tail.

While surgical removal of tumors in the pancreas is the preferred treatment, it is only possible in the 10–15% of patients who are diagnosed early enough for a potential cure. Patients who are considered suitable for surgery usually have small tumors in the head of the pancreas (close to the duodenum, or first part of the small intestine), have jaundice as their initial symptom, and have no evidence of metastatic disease (spread of cancer to other sites). The stage of the cancer will determine whether the pancreatectomy to be performed should be total or distal.

A partial pancreatectomy may be indicated when the pancreas has been severely injured by trauma, especially injury to the body and tail of the pancreas. While such surgery removes normal pancreatic tissue as well, the long-term consequences of this surgery are

minimal, with virtually no effects on the production of insulin, digestive enzymes, and other hormones.

Chronic pancreatitis is another condition for which a pancreatectomy is occasionally performed. Chronic pancreatitis—or continuing inflammation of the pancreas that results in permanent damage to this organ—can develop from long-standing, recurring episodes of acute (periodic) pancreatitis. This painful condition usually results from alcohol abuse or the presence of gallstones. In most patients with the alcohol-induced disease, the pancreas is widely involved, therefore, surgical correction is almost impossible.

### Description

A pancreatectomy can be performed through an open surgery technique, in which case one large incision is made, or it can be performed laparoscopically, in which case the surgeon makes four small incisions to insert tube-like **surgical instruments**. The abdomen is filled with gas, usually carbon dioxide, to help the surgeon view the abdominal cavity. A camera is



inserted through one of the tubes and displays images on a monitor in the **operating room**. Other instruments are placed through the additional tubes. The laparoscopic approach allows the surgeon to work inside the patient's abdomen without making a large incision.

If the pancreatectomy is partial, the surgeon clamps and cuts the blood vessels, and the pancreas is stapled and divided for removal. If the disease affects the splenic artery or vein, the spleen is also removed.

If the pancreatectomy is total, the surgeon removes the entire pancreas and attached organs. He or she starts by dividing and detaching the end of the stomach. This part of the stomach leads to the small intestine, where the pancreas and bile duct both attach. In the next step, he removes the pancreas along with the connected section of the small intestine. The common bile duct and the gallbladder are also removed. To reconnect the intestinal tract, the stomach and the bile duct are then connected to the small intestine.

During a pancreatectomy procedure, several tubes are also inserted for **postoperative care**. To prevent tissue fluid from accumulating in the operated site, a temporary drain leading out of the body is inserted, as well as a **gastrostomy** or g-tube leading out of the stomach in order to help prevent nausea and vomiting. A jejunostomy or j-tube may also be inserted into the small intestine as a pathway for supplementary feeding.

### Diagnosis/Preparation

Patients with symptoms of a pancreatic disorder undergo a number of tests before surgery is even considered. These can include ultrasonography, x-ray examinations, computed tomography scans (CT scan), and **endoscopic retrograde cholangiopancreatography** (ERCP), a specialized imaging technique to visualize the ducts that carry bile from the liver to the gallbladder. Tests may also include **angiography**, another imaging technique used to visualize the arteries feeding the pancreas, and needle aspiration cytology, in which cells are drawn from areas suspected to contain cancer. Such tests are required to establish a correct diagnosis for the pancreatic disorder and in the planning the surgery.

Since many patients with pancreatic cancer are undernourished, appropriate nutritional support, sometimes by tube feedings, may be required prior to surgery.

Some patients with pancreatic cancer deemed suitable for a pancreatectomy will also undergo chemotherapy and/or radiation therapy. This treatment is aimed at shrinking the tumor, which will improve the chances for successful surgical removal. Sometimes,

patients who are not initially considered surgical candidates may respond so well to chemoradiation that surgical treatment becomes possible. Radiation therapy may also be applied during the surgery (intraoperatively) to improve the patient's chances of survival, but this treatment is not yet in routine use. Some studies have shown that intraoperative radiation therapy extends survival by several months.

Patients undergoing distal pancreatectomy that involves removal of the spleen may receive preoperative medication to decrease the risk of infection.

### Aftercare

Pancreatectomy is major surgery. Therefore, extended hospitalization is usually required with an average hospital stay of two to three weeks.

Some pancreatic cancer patients may also receive combined chemotherapy and radiation therapy after surgery. This additional treatment has been clearly shown to enhance survival rates.

After surgery, patients experience pain in the abdomen and are prescribed pain medication. Follow-up exams are required to monitor the patient's recovery and remove implanted tubes.

A total pancreatectomy leads to a condition called pancreatic insufficiency, because food can no longer be normally processed with the enzymes normally produced by the pancreas. Insulin secretion is likewise no longer possible. These conditions are treated with pancreatic enzyme replacement therapy, which supplies digestive enzymes; and with insulin injections. In some case, distal pancreatectomies may also lead to pancreatic insufficiency, depending on the patient's general health condition before surgery and on the extent of pancreatic tissue removal.

### Risks

There is a fairly high risk of complications associated with any pancreatectomy procedure. A recent Johns Hopkins study documented complications in 41% of cases. The most devastating complication is postoperative bleeding, which increases the mortality risk to 20–50%. In cases of postoperative bleeding, the patient may be returned to surgery to find the source of hemorrhage, or may undergo other procedures to stop the bleeding.

One of the most common complications from a pancreaticoduodenectomy is delayed gastric emptying, a condition in which food and liquids are slow to leave the stomach. This complication occurred in 19% of patients in the Johns Hopkins study. To manage

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A pancreatectomy is performed by a surgeon trained in gastroenterology, the branch of medicine that deals with the diseases of the digestive tract. An anesthesiologist is responsible for administering anesthesia and the operation is performed in a hospital setting, with an oncologist on the treatment team if pancreatic cancer motivated the procedure.

this problem, many surgeons insert feeding tubes at the original operation site, through which nutrients can be fed directly into the patient's intestines. This procedure, called enteral nutrition, maintains the patient's nutrition if the stomach is slow to recover normal function. Certain medications, called promotility agents, can help move the nutritional contents through the gastrointestinal tract.

The other most common complication is pancreatic anastomotic leak. This is a leak in the connection that the surgeon makes between the remainder of the pancreas and the other structures in the abdomen. Most surgeons handle the potential for this problem by checking the connection during surgery.

### Normal results

After a total pancreatectomy, the body loses the ability to secrete insulin, enzymes, and other substances; therefore, the patient has to take supplements for the rest of his or her life.

Patients usually resume normal activities within a month after surgery, although they are asked to avoid heavy lifting for six to eight weeks and not to drive as long as they take narcotic medication.

When a pancreatectomy is performed for chronic pancreatitis, the majority of patients obtain some relief from pain. Some studies report that one-half to three-quarters of patients become free of pain.

### Morbidity and mortality rates

The mortality rate for pancreatectomy has decreased in recent years to 5–10%, depending on the extent of the surgery and the experience of the surgeon. A study of 650 patients at Johns Hopkins Medical Institution, Baltimore, found that only nine patients, or 1.4%, died from complications related to surgery.

## QUESTIONS TO ASK THE DOCTOR

- What do I need to do before surgery?
- What type of anesthesia will be used?
- How long will it take to recover from the surgery?
- When can I expect to return to work and/or resume normal activities?
- What are the risks associated with a pancreatectomy?
- How many pancreatectomies do you perform in a year?
- Will there be a scar?

Unfortunately, pancreatic cancer is the most lethal form of gastrointestinal malignancy. However, for a highly selective group of patients, a pancreatectomy offers a chance for cure, especially when performed by experienced surgeons. The overall five-year survival rate for patients who undergo pancreatectomy for pancreatic cancer is about 10%; patients who undergo pancreaticoduodenectomy have a 4–5% survival at five years. The risk for tumor recurrence is thought to be unaffected by whether the patient undergoes a total pancreatectomy or a pancreaticoduodenectomy, but is increased when the tumor is larger than 1.2 in (3 cm) and the cancer has spread to the lymph nodes or surrounding tissue.

### Alternatives

Depending on the medical condition, a **pancreas transplantation** may be considered as an alternative for some patients.

### Resources

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#### ORGANIZATIONS

- American College of Gastroenterology. 4900 B South 31st St., Arlington, VA 22206. (703) 820 7400. <http://www.acg.gi.org>.
- American Gastroenterological Association (AGA). 4930 Del Ray Avenue, Bethesda, MD 20814. (301) 654 2055. <http://www.gastro.org>.
- National Cancer Institute (NCI). NCI Public Inquiries Office, Suite 3036A, 6116 Executive Boulevard, MSC8322 Bethesda, MD 20892 8322. (800) 422 6237. <http://www.cancer.gov>.

#### OTHER

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## Paracentesis

### Definition

Paracentesis is a minimally invasive procedure that uses a needle to remove fluid from the abdomen.

### Purpose

There are two reasons to take fluid out of the abdomen. One is to analyze it for diagnostic purposes; the other is to relieve pressure. Liquid that accumulates in the abdomen is called ascites. Ascites seeps out of organs for several reasons related either to disease in the organ or fluid pressures that are changing.

#### Liver disease

All the blood flowing through the intestines passes through the liver on its way back to the heart. When progressive disease such as alcohol damage or hepatitis destroys enough liver tissue, the scarring that results shrinks the liver and constricts blood flow. Such scarring of the liver is called cirrhosis. Pressure builds in the intestinal blood circulation, slowing flow and pushing fluid into surrounding tissues. Slowly the

## KEY TERMS

**Ascites**—Fluid in the abdomen.

**Ectopic pregnancy**—A pregnancy occurring outside the womb that often ruptures and requires surgical removal.

**Hepatitis**—An inflammation of the liver.

fluid accumulates in areas with the lowest pressure and greatest capacity. The free space around abdominal organs receives the greatest amount. This space is called the peritoneal space because it is enclosed by a thin membrane called the peritoneum. The peritoneum wraps around nearly every organ in the abdomen, providing many folds and spaces for the fluid to gather.

### Infections

Peritonitis is an infection of the peritoneum that can develop in several ways. Many abdominal organs contain germs that do not occur elsewhere in the body. If they spill their contents into the peritoneum, infection is the result. Infection changes the dynamics of body fluids, causing them to seep into tissues and spaces. The gall bladder, the stomach, any part of the intestine, and most especially the appendix—all cause peritonitis when they leak or rupture. Tuberculosis can infect many organs in the body; it is not confined to the lungs. Tuberculous peritonitis causes ascites.

### Other inflammations

Peritoneal fluid is not just produced by infections. An inflamed pancreas, called pancreatitis, can cause a massive sterile peritonitis when it leaks its digestive enzymes into the abdomen.

### Cancer

Any cancer that begins in or spreads to the abdomen can leak fluid. One particular tumor of the ovary that leaks fluid and results in fluid accumulation is called Meigs' syndrome.

### Kidney disease

Since the kidneys are intimately involved with the body's fluid balance, diseases of the kidney often cause excessive fluid to accumulate. Nephrosis and nephrotic syndrome are the general terms for diseases that

cause the kidneys to retain water and promote its movement into body tissues and spaces.

### Heart failure

The ultimate source of fluid pressure in the body is the heart, whose pumping generates blood pressure. All other pressures in the body are related to blood pressure. As the heart starts to fail, blood backs up, waiting to be pumped. This increases pressure in the veins leading to the heart, particularly below the it where gravity is also pulling blood down. The extra fluid from heart failure is first noticed in the feet and ankles, where gravitational effects are most evident. In the abdomen, the liver swells first, then it and other abdominal organs start to leak.

### Pleural fluid

The other major body cavity (besides the abdomen) is the chest. The tissue in the chest corresponding to the peritoneum is called the pleura, and the space contained within the pleura, between the ribs and the lungs, is called the pleural space. Fluid is often found in both cavities, and fluid from one cavity can find its way into the other.

Fluid that accumulates in the abdomen creates abnormal pressures on organs in the abdomen. Digestion is hindered; blood flow is slowed. Pressure upward on the chest from fluid-filled organs compromises breathing. The kidneys function poorly in the presence of such external pressures and may even fail.

### Description

During paracentesis, special needles puncture the abdominal wall, being careful not to hit internal organs. If fluid is needed only for analysis, less than 7 oz (200 ml) are removed. If pressure relief is an additional goal, many quarts may be removed. Rapid removal of large amounts of fluid can cause blood pressure to drop suddenly. For this reason, the physician will often leave a tube in place so that fluid can be removed slowly, giving the system time to adapt.

A related procedure called culdocentesis removes ascitic fluid from the very bottom of the abdominal cavity through the back of the vagina. This is used most often to diagnose female genital disorders like ectopic pregnancy, which may bleed or exude fluid into the peritoneal space.

Fluid is sent to the laboratory for testing, where cancer and blood cells can be detected, infections identified, and chemical analysis can direct further investigations.

### Aftercare

An adhesive bandage and perhaps a single stitch close the insertion site. Nothing more is required.

### Risks

Risks are negligible. It is remotely possible that an organ could be punctured and bleed or that an infection could be introduced.

### Normal results

A diagnosis of the cause and/or relief from accumulated fluid pressure are the expected results. Fluid will continue to accumulate until the cause is corrected. Repeated procedures may be needed.

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Paralytic ileus see **Intestinal obstruction repair**

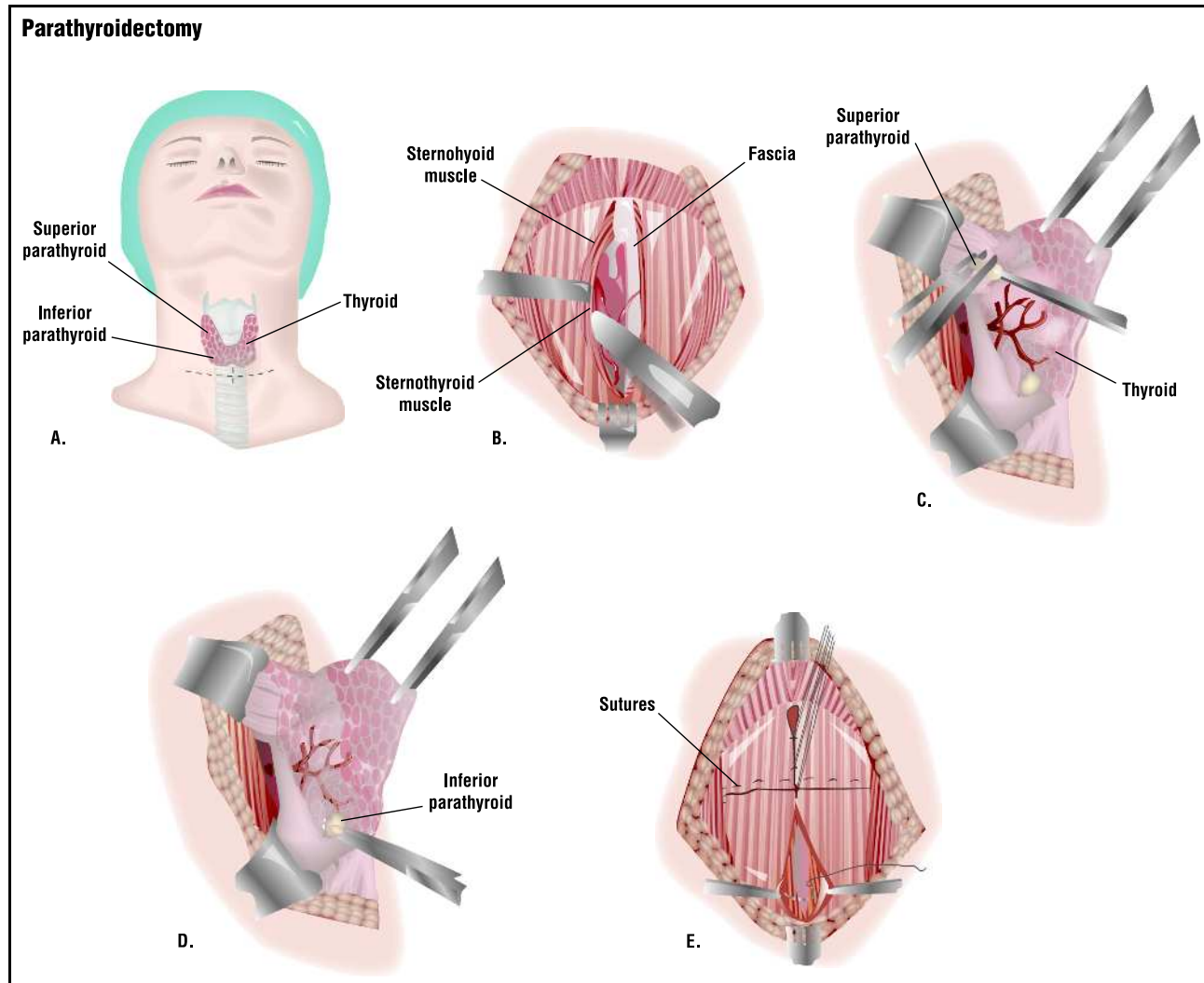
Parathyroid gland removal see **Parathyroidectomy**

## Parathyroidectomy

### Definition

Parathyroidectomy is the removal of one or more parathyroid glands. A person usually has four parathyroid glands, although the exact number may vary from three to seven. The glands are located in the neck, in front of the Adam's apple, and are closely linked to





The parathyroid gland is accessed through an incision in the neck (A). Muscles and connecting tissues, or fascia, are cut open (B). The thyroid gland is exposed, and the superior (C) and inferior parathyroid glands are removed (D). The muscle layers are stitched, and the wound closed (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

the thyroid gland. The parathyroid glands regulate the balance of calcium in the body.

is approximately twice that of males. The incidence of parathyroidectomy rises after age 40.

### Purpose

Parathyroidectomy is usually performed to treat hyperparathyroidism (abnormal over-functioning of the parathyroid glands).

### Demographics

The number of parathyroidectomy procedures has risen due to routine measurement of calcium in the blood. Incidence rates vary between 25 and 50 per 100,000 persons. The number of procedures in females

### Description

The operation begins when an anesthesiologist administers **general anesthesia**. The surgeon makes an incision in the front of the neck where a tight-fitting necklace would rest. All of the parathyroid glands are identified. The surgeon then identifies the diseased gland or glands, and confirms the diagnosis by sending a piece of the gland(s) to the pathology department for immediate microscopic examination. The diseased glands are then removed, and the incision is closed and covered with a dressing.

## KEY TERMS

**Anesthesiologist**—A physician who specializes in anesthetizing persons for operations or other medical procedures.

**Ectopic parathyroid tissue**—Parathyroid tissue located in an abnormal place.

**Hyperparathyroidism**—Abnormal over-functioning of the parathyroid glands.

**Hypoparathyroidism**—Abnormal under-functioning of the parathyroid glands.

**Otolaryngologist**—A surgeon who treats people with abnormalities in the head and neck regions of the body.

**Recurrent laryngeal nerve**—A nerve that lies very near the parathyroid glands, and serves the larynx or voice box.

Parathyroidectomy patients usually stay overnight in the hospital after the operation. Some patients remain hospitalized for one or two additional days.

## Diagnosis/Preparation

Prior to the operation, the diagnosis of hyperparathyroidism should be confirmed using lab tests. Occasionally, physicians order computed tomography scans (**CT scans**), **ultrasound** exams, or **magnetic resonance imaging** (MRI) tests to determine the total number of parathyroid glands, and their location prior to the procedure.

Parathyroidectomy should only be performed when other non-operative methods have failed to control a person's hyperparathyroidism.

Preparation is similar to other surgical procedures requiring general anesthetic. The patient is not allowed any food or drink by mouth after midnight the night before surgery. He or she should ask the physician for specific directions regarding preparation for surgery, including food, drink, and medication intake.

## Aftercare

The incision should be watched for signs of infection. In general, no special **wound care** is required.

The calcium level is monitored during the first 48 hours after the operation by obtaining frequent blood samples for laboratory analysis.

Most individuals require only two or three days of hospitalization to recover from the operation. They

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Parathyroidectomy is an operation performed most commonly by a general surgeon, or occasionally by an otolaryngologist, in the operating room of a hospital.

can usually resume most of their normal activities within one to two weeks.

## Risks

The major risk of parathyroidectomy is injury to the recurrent laryngeal nerve (a nerve that lies very near the parathyroid glands and serves the larynx or voice box). If this nerve is injured, the voice may become hoarse or weak.

Occasionally, too much parathyroid tissue is removed, and a person may develop hypoparathyroidism (under-functioning of the parathyroid glands). If this occurs, he or she will require daily calcium supplements.

In some cases, the surgeon is unable to locate all of the parathyroid glands, and cannot remove them in one procedure. A fifth or sixth gland may be located in an aberrant place such as the chest (ectopic parathyroid). If this occurs, the hyperparathyroidism may not be corrected with one operation, and a second procedure may be required to find all of the patient's remaining parathyroid gland tissue.

## Normal results

The surgery progresses normally if the diseased parathyroid glands are located and removed from the neck region.

## Morbidity and mortality rates

Hematoma formation (collection of blood under the incision) is a possible complication of any operative procedure. However, in procedures that involve the neck it is of particular concern because a rapidly enlarging hematoma can obstruct the airway.

Infection of the surgical incision may occur, as it may in any operative procedure, but this is uncommon in parathyroidectomy.

Before the function of the parathyroid gland was understood, people undergoing a **thyroidectomy** often

## QUESTIONS TO ASK THE DOCTOR

- What type of physician performs the surgery?
- Is the surgeon board certified in head and neck surgery?
- How many parathyroidectomy procedures has the surgeon performed?
- What is the surgeon's complication rate?
- Is there an alternative to surgery?
- What is the risk of complication?
- How will the body's function change after the surgery?

died due to the lack of calcium in their blood caused by removal of the parathyroid glands. This is not a problem today.

### Alternatives

There is no safe or reliable alternative to removal of the parathyroid glands for the treatment of hyperparathyroidism. Oral phosphates can lower serum calcium levels, but the long-term use of this approach is not well understood.

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American College of Surgeons. 633 North St. Clair Street, Chicago, IL 60611 32311. (312) 202 5000, fax: (312) 202 5001. <http://www.facs.org>, E mail: [postmaster@facs.org](mailto:postmaster@facs.org).

American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464 5000. <http://www.ama-assn.org>.

American Academy of Otolaryngology Head and Neck Surgery. One Prince St., Alexandria, VA 22314 3357. (703) 836 4444. <http://www.entnet.org/index2.cfm>.

American Osteopathic College of Otolaryngology Head and Neck Surgery. 405 W. Grand Avenue, Dayton, OH 45405. (937) 222 8820 or (800) 455 9404, fax (937) 222 8840. Email: [info@aocohns.org](mailto:info@aocohns.org).

Association of Thyroid Surgeons. 717 Buena Vista St., Ventura, CA 93001. Fax: (509) 479 8678. [info@thyroidsurgery.org](mailto:info@thyroidsurgery.org).

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Paravaginal surgery see **Needle bladder neck suspension**

## Parentage testing

### Definition

Parentage testing (previously called paternity testing) refers to a variety of DNA tests used in an attempt to verify whether someone could possibly be the mother

or the father of a particular child. Parentage testing has two possible results: an individual can be definitively excluded as the parent, or an individual can be defined as having some degree of probability of being the parent.

In fact, neither paternity nor maternity can actually be definitively demonstrated through current tests. Instead, these tests provide information that a particular individual cannot be excluded as the child's parent. A mathematical model is then utilized to determine an estimate of the probability that, based on the results of the testing, a particular individual IS that child's parent. The probability is called the parentage index, and it uses DNA results, as well as situational information (where the alleged parent was at the time of the child's conception, comparison of the alleged parent's and the child's physical appearance) to generate a percent chance of parentage.

The first step in parentage testing involves collecting some type of DNA sample from the child in question, the known parent, and the alleged parent. Any type of biological tissue can be used for this testing. Most commonly, a testing sample is obtained either through a buccal (inside of the cheek) swab, or through blood testing. DNA is the genetic material stored inside the nucleus of every cell within the human body. The DNA can be extracted from the nucleus of the cells which have been procured in the testing sample for each individual. Laboratory testing then evaluates the known parent's DNA, and compares this to the child's DNA. The DNA of each individual is sequenced, and DNA sequences that match the known relationship are excluded. The remaining DNA sequences are then compared to DNA sequences of the alleged parent. This gives the examiners information on the probability that this individual is or is not capable of having parented the child, up to a probability of over 99.9%.

### Purpose

This test is performed to exclude the possibility that a particular individual could be the biological mother or father of a baby or child, or to provide evidence of probability that the individual might be the biological mother or father of a baby or child. These tests are often run when a mother is uncertain of her baby's paternity, to clarify child support issues, to clarify issues that may come up relative to an adoption, or in forensic medicine (medicine pertaining to a crime).

### Precautions

Parentage testing is not effected by illness, medications, activity level or diet. However, the test results can be affected by a recent blood transfusion. Therefore, if

## KEY TERMS

**Buccal**—The interior surface of the cheek.

**DNA**—Deoxyribonucleic acid; the substance within the nucleus of all human cells in which the genetic information is stored.

**Maternity**—Refers to the mother.

**Paternity**—Refers to the father.

blood is being used for the DNA testing, 90 days should elapse between a blood transfusion and parentage testing.

Patients who are taking anticoagulant medications should inform their healthcare practitioner prior to a blood draw, since this may increase their chance of bleeding or bruising after a blood test.

### Description

While blood testing is frequently performed for parentage testing, other types of tissue may be used to provide DNA samples appropriate for testing. This includes a buccal (inside of the cheek) swab, in which a cotton-swab like instrument is used to scrape a few of the cells from the inside of the cheek. In some cases, other types of biological tissue, bone, or teeth may be used for testing.

This test may be performed using blood drawn from a vein (usually one in the forearm), generally by a nurse or phlebotomist (an individual who has been trained to draw blood). A tourniquet is applied to the arm above the area where the needle stick will be performed. The site of the needle stick is cleaned with antiseptic, and the needle is inserted. The blood is collected in vacuum tubes. After collection, the needle is withdrawn, and pressure is kept on the blood draw site to stop any bleeding and decrease bruising. A bandage is then applied. Alternatively, a finger stick can be used to draw just a few drops of blood from a finger tip.

Because the results of parentage testing are frequently utilized in court or as evidence in legal decisions, there are very careful regulations on the way the samples are drawn, labeled, stored, and transported. It is crucial that the chain-of-custody of all samples is clearly delineated, and that all packaging is tamper-free and appropriately labeled. Individuals who are involved in the actual parentage case are restrained from being involved in the actual acts of either collecting or transporting the DNA-containing samples.



## Preparation

There are no restrictions on diet or physical activity, either before or after the testing.

## Aftercare

There is no aftercare necessary following a buccal swab.

As with any blood tests, discomfort, bruising, and/or a very small amount of bleeding is common at the puncture site. Immediately after the needle is withdrawn, it is helpful to put pressure on the puncture site until the bleeding has stopped. This decreases the chance of significant bruising. Warm packs may relieve minor discomfort. Some individuals may feel briefly woozy after a blood test, and they should be encouraged to lie down and rest until they feel better.

## Risks

Neither a buccal swab nor basic blood tests carry any significant risk.

## Results

One possible outcome of parentage testing is exclusion of the possibility that an individual has any chance whatsoever of being able to be genetically related as a parent to the child in question—this is referred to as a zero-percent probability. Positive proof of parentage can approach 99.9% probability that a particular individual could be a particular child's parent.

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### ORGANIZATIONS

American Association of Clinical Chemistry. 1850 K St., N.W. Suite 625, Washington, DC 20006. <http://www.aacc.org>.

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Parkinson's surgery see **Deep brain stimulation**

Parotid gland removal see **Parotidectomy**

# Parotidectomy

## Definition

Parotidectomy is the removal of the parotid gland, a salivary gland near the ear.

## Purpose

The parotid gland is the largest of the salivary glands. There are two parotid glands, one on each side of the face, just below and to the front of the ear. A duct through which saliva is secreted runs from each gland to the inside of the cheek.

The main purpose of parotidectomy is to remove abnormal growths (neoplasms) that occur in the parotid gland. Parotid gland neoplasms may be benign (approximately 80%) or malignant. Tumors may spread from other areas of the body, entering the parotid gland by way of the lymphatic system.

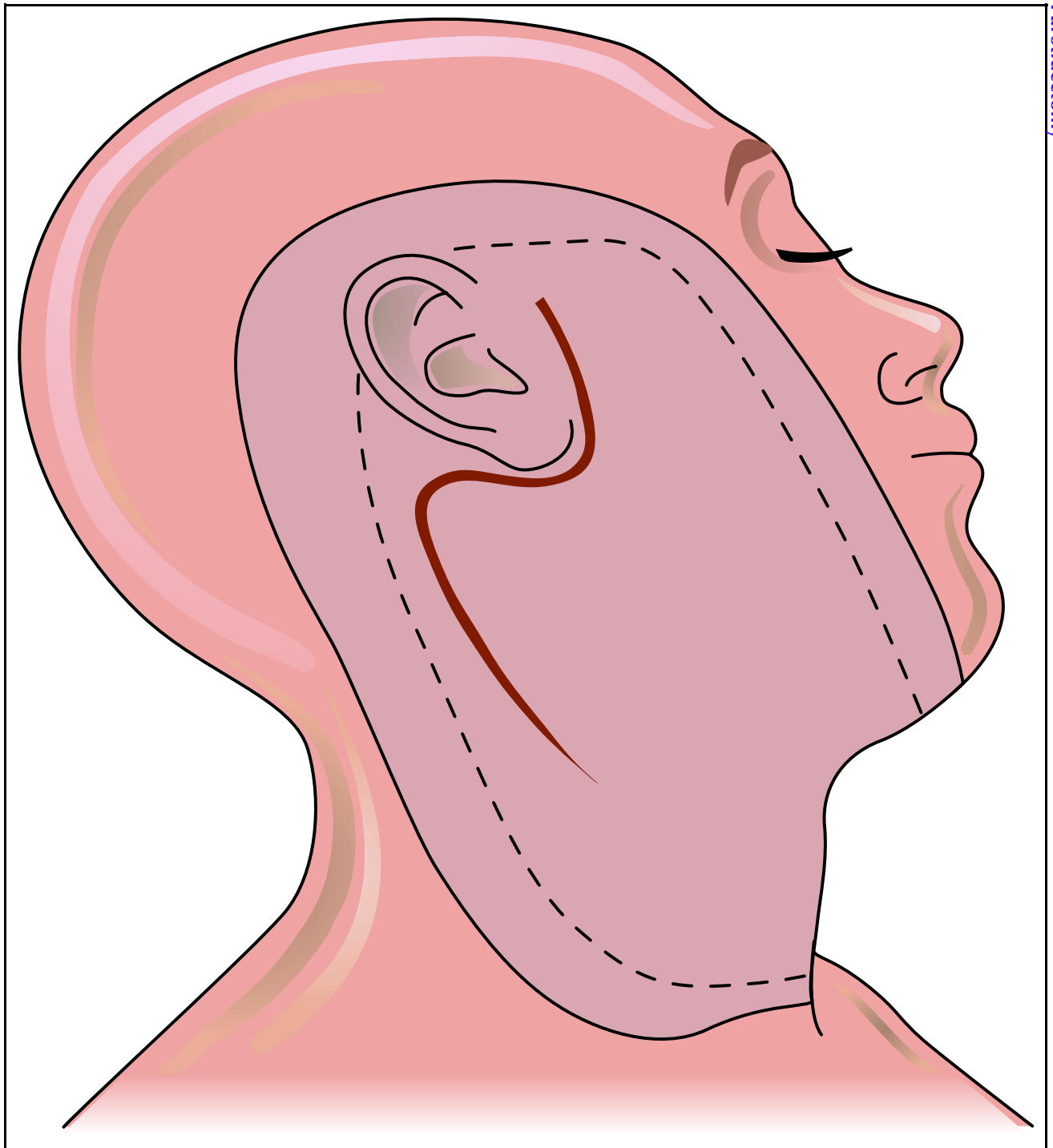
## Demographics

Benign parotid gland growths usually appear after the age of 40. Malignant growths most often affect women over the age of 60, while benign tumors affect both sexes equally. Cancer of the salivary glands accounts for only 1% of all cancers, and 7% of all head and neck cancers.

## Description

During surgery, two different areas of the parotid gland are identified: the superficial lobe and the deep lobe. Superficial parotidectomy removes just the superficial lobe, while total parotidectomy removes both lobes.

The patient is first placed under **general anesthesia** to ensure that no pain is experienced and that all muscles remain relaxed. An incision is made directly to the front or back of the ear and down the jaw line. The skin is folded back to expose the parotid gland. The various facial nerves are identified and protected during the surgery so as to avoid permanent facial paralysis or numbness. A superficial or total parotidectomy is then performed, depending on the type and location of the tumor. If the tumor has spread to involve the facial nerve, the operation is expanded to include parts of the bone behind the ear (mastoid) to remove as much tumor as possible. Before the incision is closed, a drain is inserted into the area to collect any leaking saliva, if a superficial parotidectomy was performed. The procedure typically takes from two to five hours to complete, depending on the extent of surgery and the skill of the surgeon.



Parotidectomy is a surgical procedure performed to remove cancerous tumors in the parotid gland, a salivary gland near the ear. Among the tumors seen in the parotid gland are lymphoma, melanoma, and squamous cell carcinoma. The illustration above shows the facial incision sites for this procedure. (Illustration by Electronic Illustrators Group. Cengage Learning, Gale.)

### Diagnosis/Preparation

A complete **physical examination** and medical history is performed, as are diagnostic tests to help

the surgeon better plan for the surgery. Some tests that may be performed include computed tomography (CT) scan, **magnetic resonance imaging** (MRI),

## KEY TERMS

**Fistula**—An abnormal opening or duct through tissue that results from injury, disease, or other trauma.

**Salivary glands**—Three pairs of glands that secrete into the mouth and aid digestion.

and fine-needle aspiration biopsy (using a thin needle to withdraw fluid and cells from the growth).

## Aftercare

After surgery, the patient will remain in the hospital for one to three days. The incision site will be watched closely for signs of infection and heavy bleeding (hemorrhage). The incision site should be kept clean and dry until it is completely healed. If the patient has difficulty smiling, winking, or drinking fluids, the physician should be contacted immediately. These are signs of facial nerve damage.

## Risks

There are a number of complications that are associated with parotidectomy. Facial nerve paralysis after minor surgery should be minimal. After major surgery, a graft is attempted to restore nerve function to facial muscles. Salivary fistulas can occur when saliva collects in the incision site or drains through the incision. Recurrence of cancer is the single most important consideration for patients who have undergone parotidectomy. Long-term survival rates are largely dependent on the tumor type and the stage of tumor development at the time of the operation.

Other risks include hematoma (collection of blood under the skin) and infection. The most common long-term complication of parotidectomy is redness and sweating in the cheek, known as Frey's syndrome. Rarely, paralysis may extend throughout all the branches of the facial nervous system.

## Normal results

Although some facial numbness or weakness is normal immediately following parotidectomy, these symptoms usually subside within a few months, with most patients regaining full function within one year. Return of a benign tumor is very rare.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Parotidectomy is performed in a hospital operating room, usually by an otolaryngologist, a medical doctor who specializes in the treatment of diseases that affect the ear, nose, throat, and other structures of the head and neck.

## Morbidity and mortality rates

There is a 25–50% risk of temporary facial weakness following parotidectomy, and a 1–2% risk of permanent weakness. Frey's syndrome may be experienced by up to 90% of patients to some extent and causes perspiration on that side of the face with eating. There is very little or no risk of mortality associated with the surgery. The survival rate of malignant parotid gland tumors depends on their size, location, extension, and if metastasis has occurred. The 10-year survival rate ranges from 32% to 83%.

## Alternatives

A benign parotid neoplasm may be managed expectantly (i.e., adhering to a period of watchful waiting) so that the growth is of a larger size before it is removed (the risk of facial nerve damage increases with each subsequent parotidectomy). There is generally no alternative to surgical treatment of parotid gland neoplasms, although radiation therapy may be recommended after the procedure in the case of malignant tumors.

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### ORGANIZATIONS

American Academy of Otolaryngology. One Prince St., Alexandria, VA 22314 3357. (703) 836 4444. <http://www.entnet.org>.

## QUESTIONS TO ASK THE DOCTOR

- Why is a parotidectomy being recommended?
- How many parotidectomies do you perform each year?
- What is your rate of complications?
- What diagnostic tests will be performed prior to surgery?
- Will a superficial or total parotidectomy be performed?

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## Partial thromboplastin time

### Definition

The partial thromboplastin time (PTT) test is a blood test that is done to investigate bleeding disorders and to monitor patients taking an anticlotting drug (heparin).

### Purpose

#### Diagnosis

Blood clotting (coagulation) depends on the action of substances in the blood called clotting factors. Measuring the partial thromboplastin time helps to assess which specific clotting factors may be missing or defective.

#### Monitoring

Certain surgical procedures and diseases cause blood clots to form within blood vessels. Heparin is used to treat these clots. The PTT test can be used to

monitor the effect of heparin on a patient's coagulation system.

### Precautions

Certain medications besides heparin can affect the results of the PPT test. These include antihistamines, vitamin C (ascorbic acid), **aspirin**, and chlorpromazine (Thorazine).

### Description

When a body tissue is injured and begins to bleed, it starts a sequence of clotting factor activities called the coagulation cascade, which leads to the formation of a blood clot. The cascade has three pathways: extrinsic, intrinsic, and common. Many of the thirteen known clotting factors in human blood are shared by both pathways; several are found in only one. The PTT test evaluates the factors found in the intrinsic and common pathways. It is usually done in combination with other tests, such as the prothrombin test, which evaluate the factors of the extrinsic pathway. The combination of tests narrows the list of possible missing or defective factors.

Heparin prevents clotting by blocking certain factors in the intrinsic pathway. The PTT test allows a doctor to check that there is enough heparin in the blood to prevent clotting, but not so much as to cause bleeding. The test is done before the first dose of heparin or whenever the dosage level is changed; and again when the heparin has reached a constant level in the blood. The PTT test is repeated at scheduled intervals.

The PTT test uses blood to which a chemical has been added to prevent clotting before the test begins. About 5 mL of blood are drawn from a vein in the patient's inner elbow region. Collection of the sample takes only a few minutes. The blood is spun in a centrifuge, which separates the pale yellow liquid part of blood (plasma) from the cells. Calcium and activating substances are added to the plasma to start the intrinsic pathway of the coagulation cascade. The partial thromboplastin time is the time it takes for a clot to form, measured in seconds.

The test can be done without activators, but they are usually added to shorten the clotting time, making the test more useful for monitoring heparin levels. When activators are used, the test is called activated partial thromboplastin time or APTT.

Test results can be obtained in less than one hour. The test is usually covered by insurance.



## Preparation

The doctor should check to see if the patient is taking any of the medications that may influence the test results. If the patient is on heparin therapy, the blood sample is drawn one hour before the next dose of heparin.

## Aftercare

Aftercare includes routine care of the puncture site. In addition, patients on heparin therapy must be watched for signs of spontaneous bleeding. The patient should not be left alone until the doctor or nurse is sure that bleeding has stopped. Patients should also be advised to watch for bleeding gums, bruising easily, and other signs of clotting problems; to avoid activities that might cause minor cuts or bruises; and to avoid using aspirin.

## Risks

The patient may develop a bruise or swelling around the puncture site, which can be treated with moist warm compresses. People with coagulation problems may bleed for a longer period than normal.

## Normal results

Normal results vary based on the method and activators used. Normal APTT results are usually between 25–40 seconds; PTT results are between 60–70 seconds. APTT results for a patient on heparin should be 1.5–2.5 times normal values. An APTT longer than 100 seconds indicates spontaneous bleeding.

## Abnormal results

Increased levels in a person with a bleeding disorder indicate a clotting factor may be missing or defective. Further tests are done to identify the factor involved. Liver disease decreases production of factors, increasing the PTT.

Low levels in a patient on heparin indicate too little heparin is in the blood to prevent clots. High levels indicate too much heparin is present, placing the person at risk of excessive bleeding.

## Morbidity and mortality rates

Morbidity rates are excessively miniscule. The most common problems are minor bleeding and bruising. Since neither are reportable events, morbidity can only be estimated. Mortality is essentially zero.

## KEY TERMS

**Activated partial thromboplastin time**—Partial thromboplastin time test that uses activators to shorten the clotting time, making it more useful for heparin monitoring.

**Clotting factors**—Substances in the blood that act in sequence to stop bleeding by forming a clot.

**Coagulation**—The process of blood clotting.

**Coagulation cascade**—The sequence of biochemical activities, involving clotting factors, that stop bleeding by forming a clot.

**Common pathway**—The pathway that results from the merging of the extrinsic and intrinsic pathways. The common pathway includes the final steps before a clot is formed.

**Extrinsic pathway**—One of three pathways in the coagulation cascade.

**Heparin**—A medication that prevents blood clots.

**Intrinsic pathway**—One of three pathways in the coagulation cascade.

**Partial thromboplastin time**—A test that checks the clotting factors of the intrinsic pathway.

**Plasma**—The fluid part of blood, as distinguished from blood cells.

## Alternatives Resources

There are no alternatives to a partial thromboplastin time.

## Precautions

The only precaution needed is to clean the venipuncture site with alcohol.

## Side effects

The most common side effects of a partial thromboplastin time test are minor bleeding and bruising.

## Resources

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Patella removal see **Kneecap removal**

Patent ductus arteriosus repair see **Heart surgery for congenital defects**

## Patent urachus repair

### Definition

Patent urachus repair is surgery to correct a urachus (a tube that connects the fetal bladder to the umbilical cord) that fails to close after birth.

### Purpose

A patent urachus is an anomaly, and repair is recommended for these defects occurring at birth.

### Demographics

The condition occurs three times more often in male infants than in females.

### Description

As fetal development progresses, the urachus, a tube that can measure from 1.2–3.9 in (3–10 cm) long and 0.3–0.4 in (8–10 mm) in diameter, forms, extending from the front dome of the bladder to the umbilicus. Following birth, the tube, adjacent to the umbilical ligaments, closes and itself becomes ligament. Should this closure fail, it may result in several types of urachal remnants. If the urachus remains completely open, it is known as a patent urachus. This type of abnormality makes up 50% of all urachal anomalies.

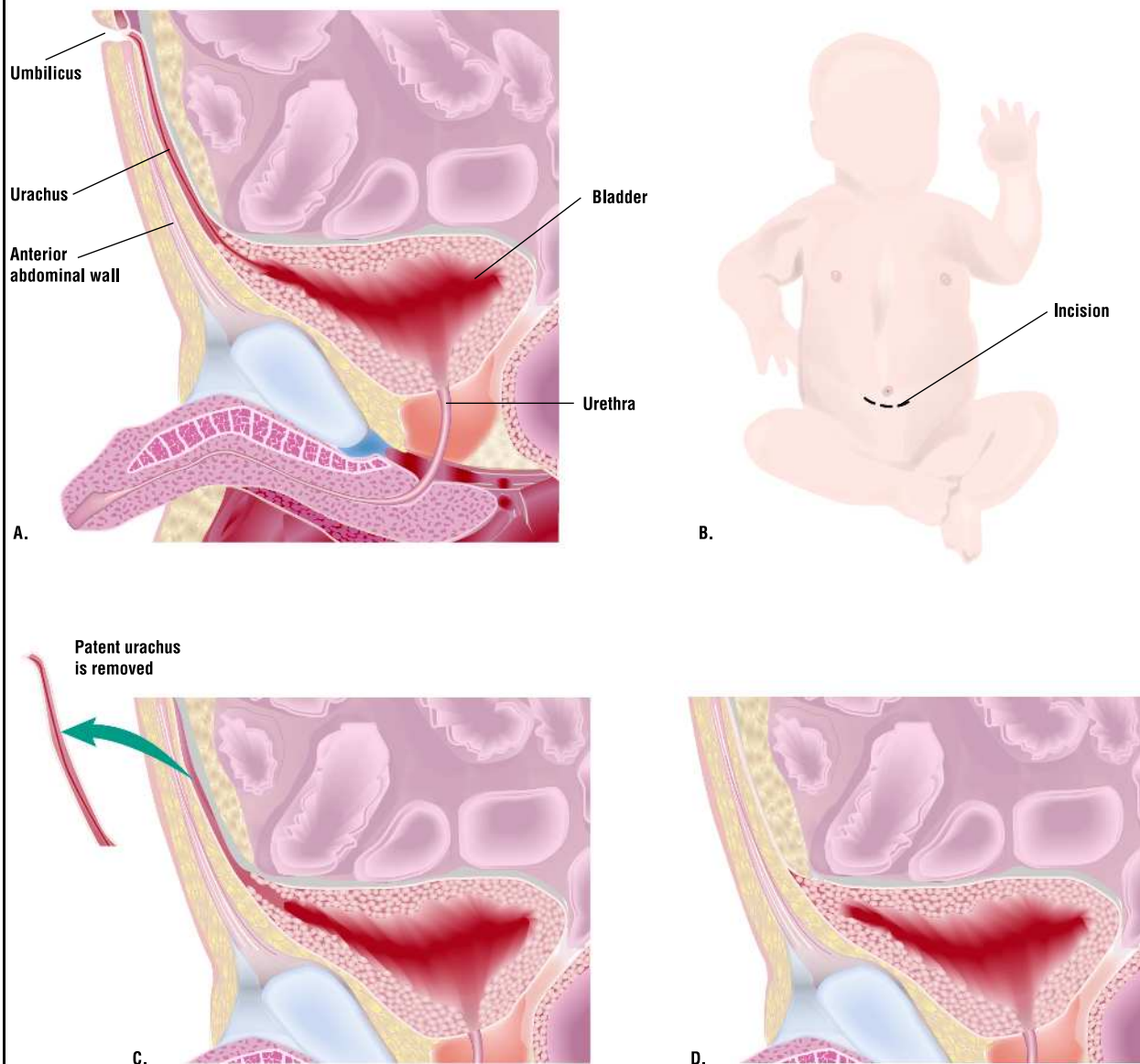
If the urachus remains open all the way to the bladder, there is the danger that bacteria will enter the bladder through the open tube and cause infection. For this reason, the patent urachus of the infant must be removed.

### Diagnosis/Preparation

This anomaly occurs as an isolated event or in association with prune-belly syndrome, in which there is continuous drainage of urine from the umbilicus. If urine freely discharges through the umbilicus, the patent urachus is rarely found. It should be suspected, however, if a local cord is enlarged and affected with edema, or is slow to slough normally. The condition customarily is diagnosed in infants.

The child is given a general anesthetic, after which an incision is made in the lower abdomen.

## Patent urachus repair



A patent urachus is an abnormal opening from the bladder to the umbilicus, which is retained from fetal life (A). To repair it, an incision is made in the baby's abdomen (B). The patent urachus is removed (C), and the opening to the bladder is closed (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

### Aftercare

Surgery for patent urachus repair may require several days' hospitalization, during which infants can be fed as normal.

### Risks

Risks are the same as for those patients receiving any anesthesia: a reaction to medication and/or

breathing problems. There is also the risk of bladder infection or bladder leaks. In the latter case, a catheter is put in place until the bladder heals.

### Normal results

The outcomes of patent urachus repair in infants are excellent, as a rule, and most children recover rapidly.

## KEY TERMS

**Adenocarcinoma**—A malignant tumor that originates in the membranous tissue that serves as the covering of a gland.

**Anterolateral**—Situated in front and to the side.

**Patency**—The state of being open or unblocked.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Patent urachus repair is performed by the pediatric surgeon in a hospital setting.

## Morbidity and mortality rates

Patent urachal anomalies do not usually cause significant morbidity or mortality. However, adenocarcinoma has been reported in adults with urachal remnants, presumably from chronic inflammation and infection. Patency is noted in only 2% of adults.

## Alternatives

Sometimes more conservative treatment than surgery is advised, with radical excision reserved for persistent or recurring cases. Because the urachus may not completely close at birth, but may close within the first few months of the infant's life, observation may be advised before moving forward with surgery.

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Nancy McKenzie, PhD

## QUESTIONS TO ASK THE DOCTOR

- Is it advisable to put off surgery during the first few months of the child's life and see if the urachus will close on its own?
- What effects will surgery have on a newborn?

## Patient-controlled analgesia

### Definition

Patient-controlled analgesia (PCA) is a means for the patient to self-administer **analgesics** (pain medications) intravenously by using a computerized pump, which introduces specific doses into an intravenous line.

### Purpose

The purpose of PCA is improved pain control. The patient receives immediate delivery of pain medication without the need for a nurse to administer it. The patient controls when the medication is given. More importantly, PCA uses more frequent but smaller doses of medication, and thus provides more even levels of medication within the patient's body. Syringe-injected **pain management** by a nurse requires larger doses of medication given less frequently. Larger doses peak shortly after administration, often causing undesirable side effects such as nausea and difficulty in breathing. Their pain-suppressing effects also often wear off before the next dose is scheduled.

### Description

PCA uses a computerized pump, which is controlled by the patient through a hand-held button that is connected to the machine. The pump usually delivers medications in small regular doses, and it can be programmed to issue a large initial dose and then a steady, even flow. The PCA pump can deliver medicine into a vein (intravenously, the most common method), under the skin (subcutaneously), or between the dura mater and the skull (epidurally).

When the patient feels the need for medication, the patient presses a button similar to a nurse call button. When this button is pressed, some sound (usually a beep) is heard, indicating that the pump is working properly and that the button was pressed correctly. The pump delivers the medication through an intravenous line, a plastic tube connected to a needle



## KEY TERMS

**Analgesia**—A medicine that relieves pain.

**Epidural**—Between the vertebrae and the dura mater of the spinal cord. Analgesia is introduced into this space anywhere along the spinal column.

**Intravenous**—Within a vein, usually meaning something introduced into a vein such as an injection.

**Lockout time**—The minimum amount of time (usually expressed in minutes) after one dose of pain medication on demand is given before the patient is allowed to receive the next dose on demand.

**Opioid**—A synthetic drug resembling opium or alkaloids of opium.

**Respiratory depression**—Decreased rate (number of breaths per minute) and depth (how much air is inhaled with each breath) of breathing.

**Subcutaneous**—Under the skin, as in an injection under the skin.

inserted into a vein. Glucose and other medications can also be administered through intravenous lines, along with analgesics.

The medications most commonly used in PCA pumps are synthetic, opium-like pain-relievers (opioids), usually morphine and meperidine (Demerol).

The pump may be set to deliver a larger initial dose of the prescribed drug. The health-care provider sets the pump to deliver a specified dose, determined by the physician, on demand with a lockout time (for example, 1 mg of morphine on demand, but not more frequently than one dose every six minutes). If the patient presses the button before six minutes have elapsed, the pump will not dispense the medication. The pump also generates a record that the health personnel can access. An around-the-clock, even dose may also be set. The practitioner sets a total limit for an hour (or any other period) that takes into account the initial dose, the demand doses, and the around-the-clock doses. The pump's internal computer calculates all these amounts, makes a record of the requests it received and those it refused, and also keeps inventory of the medication being administered, which warns the staff when the supply is getting low.

An example of how a nurse might program the pump might be for a patient who has a prescription for

a maximum of 11 mg of morphine an hour. The nurse sets the machine to deliver 1 mg at the beginning of the hour, and 1 mg on demand with a six-minute lockout. There are 10 six-minute periods in an hour, so the patient can request and receive 10 mg over that hour.

Using a PCA pump requires that the patient understand how the system works and has the physical strength to press the button. Therefore, PCA should not be offered to patients who are confused, unresponsive, or paralyzed. Patients with neurologic disease or head injuries in whom narcotics would mask neurologic changes are not eligible for PCA. Patients with poor kidney or lung function are usually not good candidates for PCA, unless they are monitored very closely.

PCA may be used by children as young as seven years old. It has proven safe and successful in such children in the control of postoperative pain, sickle-cell pain, and pain associated with bone-marrow transplantation. In all cases, the child should manage the PCA pump himself or herself. As morphine can slow breathing in young patients, the blood oxygen levels of children must be closely monitored.

In addition, PCA has been found safe for nursing mothers after a **cesarean section**. Very small amounts of morphine do pass into the milk of breastfeeding mothers, but it has not proved harmful to infants.

## Preparation

When preparing for PCA, the nurse must assess the patient to determine whether PCA is appropriate and then must set the total dose and the timing of the doses as prescribed by the physician. Since there is only a small amount of drug administered (3,000 doses at 10 mg each weigh less than 1 oz total), it is not sufficient fluid to keep the tubing and the needle from clogging and the contents from coagulating. Therefore, the drug must be put in a solution (flush solution) that will flow through the tube and needle easily, and permit rapid administration. The flush solution also keeps the line open for administration of other medications or in case the patient has a reaction to the pain medications. For example, a patient may have a reaction to morphine and would need counteractive medication immediately. The flush solution can also keep the patient from becoming dehydrated. In addition, many painkillers that are prescribed (such as morphine sulfate) are solid crystals at room temperature and need to be dissolved in some fluid to be absorbed by the body.

When entering the settings into the PCA system, the nurse must pay close attention to the physician's orders to ensure that the correct medication is used, that the concentration of the drug in the flushing solution is correct, that the dose of the drug itself is correct, that the lockout time is appropriate, and that the total hourly limit is properly entered into the pump's computerized controls. To eliminate the risk of incorrect programming, many institutions have adopted policies that require verification by a registered nurse (RN) for all programming. That is, everything must be checked by two nurses, and both must sign the written record.

Another important aspect of PCA is patient education. The settings on the PCA pump must be explained to patients so that they understand how and when medications will be available. The nurse should observe patients as they first start using the button, should ensure that the equipment is functioning properly, and be clear that the patients understand their role in the process and are carrying it out correctly.

Whenever opium-like painkillers are administered to the elderly patient, it must be remembered that older adults may be more susceptible to the side effects of narcotics because the heart, liver, and kidneys of the elderly function less efficiently than those of younger patients. The elderly may also clear the narcotic out of their system at a slower pace. If the pump's timing device is calibrated for a younger person's rate of elimination, the elderly patient could accidentally receive an overdose. Doses for such elderly patients should be calculated more conservatively.

### Normal results

The goal of patient-controlled analgesia is managed pain control, enhanced by a stable and constant level of the pain medication in the body. The patient is able to rest better and breathe more deeply. Since the patient is comfortable, he or she is more able to participate in activities that would enhance recovery. PCA also gives the patient in the hospital some control in an unfamiliar and uncomfortable situation. When administered properly, and with watchful assessment by health-care providers, PCA can be a safe alternative to traditional methods of relieving pain.

Interestingly enough, studies have shown that when patients control their pain medication, most use less medication overall than patients who have nurse-administered painkillers.

### Risks

Problems that may occur with PCA include allergic reactions to the medications and adverse side effects such as nausea, a dangerous drop in the rate and effectiveness of breathing, and excessive sedation. The PCA device must be monitored frequently to prevent tampering. Even sophisticated devices that monitor themselves and sound an alarm should be checked often, since no machine is perfect. Ineffective pain control must be assessed to determine whether the problem stems from inadequate dosage or from inability, or unwillingness, of the patient to carry out his or her own pain management.

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Patient charts see **Medical charts**

## Patient confidentiality

### Definition

Confidentiality is the right of an individual to have personal, identifiable medical information kept private. Such information should be available only to the physician of record and other health care and insurance personnel as necessary. As of 2003, patient confidentiality was protected by federal statute.

### Purpose

The passage of federal regulations (the Health Insurance Portability and Accountability Act of 1996) was prompted by the need to ensure privacy and protection of personal records and data in an environment of electronic medical records and third-party insurance payers.

### Description

Patient confidentiality means that personal and medical information given to a health care provider will not be disclosed to others unless the individual has given specific permission for such release.

Because the disclosure of personal information could cause professional or personal problems, patients rely on physicians to keep their medical information private. It is rare for medical records to remain completely sealed, however. The most benign breach of confidentiality takes place when clinicians share medical information as case studies. When this data is published in professional journals the identity of the patient is never divulged, and all identifying data is either eliminated or changed. If this confidentiality is breached in any way, patients may have the right to sue.

The greatest threat to medical privacy, however, occurs because most medical bills are paid by some form of health insurance, either private or public. This makes it difficult, if not impossible, to keep information truly confidential. Health records are routinely viewed not only by physicians and their staffs, but by the employees of insurance companies, medical laboratories, public health departments, researchers, and many others. If an employer provides health insurance, the employer and designated employees may have access to employee files.

The Health Insurance Portability and Accountability Act (HIPAA) of 1996 requires all professionals and organizations to guard the privacy of their patients and customers. Individuals must provide written consent for any and all releases of medical or

## KEY TERMS

**HIPAA**—Health Insurance Portability and Accountability Act of 1996.

**Joint Commission on Accreditation of Healthcare Organizations (JCAHO)**—The accrediting organization that evaluates virtually all U.S. health care organizations and programs. Accreditation is maintained with onsite surveys every three years; laboratories are surveyed every two years.

health-related information. Employees at all levels are required to maintain confidentiality. Similar policies have been in place for some time. This was a requirement of the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) to maintain accreditation. All confidentiality releases must identify the types of information that can be released, the people or groups that have been permitted access to the information, and limit the length of time for which the release is valid.

Before the enactment of HIPAA, despite having voluntary safeguards, patient confidentiality had eroded with the almost-complete dominance of health-maintenance organizations and other types of third-party payers. Confidentiality is essential for a good relationship between patient and practitioner, whose duty to keep information private stems from the Hippocratic Oath. If personal information is disseminated without the patient's permission, it can erode confidence in the medical profession and expose health care professionals to legal action.

Physicians are increasingly being sued by patients whose information has been released without their permission. Even though the plaintiffs do not always prevail, the costs of legal action are burdensome to both sides.

Each state and the federal government have enacted laws to protect the confidentiality of health care information generally, with particular attention paid to information about communicable diseases and mental health. For example, through the 1960s substance and alcohol abuse were treated as mental illnesses, with patient confidentiality determined by the laws in each state, since at the time the state was responsible for mental health care and treatment.

In the early 1970s, however, the rising numbers of those needing substance abuse treatment came to the attention of the federal government, because drug-related activity, including the treatment for substance

abuse, could be the basis for criminal prosecution on a federal level. Congress concluded that this might stop individuals needing treatment from seeking it. HIPAA was enacted to provide a strict confidentiality law and limit disclosure of information that could reveal a patient's identity.

Confusion ensued when practitioners who were treating substance abusers were required to follow two practices for patient confidentiality. One set of requirements was mandated by the state. The federal government dictated the other. With the varying degrees of protection provided by state mental health laws, the confusion increased. While all states specify exceptions to confidentiality, few have spelled out the necessary elements of valid consent for disclosure of mental health information. Some states presently allow disclosure of the following types of mental health information without patient consent:

- to other treatment providers
- to health care services payers or other sources of financial assistance to the patient
- to third parties that the mental health professional feels might be endangered by the patient
- to researchers
- to agencies charged with oversight of the health care system or the system's practitioners
- to families under certain circumstances
- to law enforcement officials under certain circumstances
- to public health officials

Prior to 2003, providers had become increasingly concerned that these exceptions are not addressed uniformly, particularly when providers and payers conducted business across state lines. This resulted in open-ended disclosures that specify neither the parties to whom disclosure is to be made nor the specific information allowed to be revealed. Since 2003, implementation of HIPAA requirements have rectified this problem.

Both the ethical and the legal principles of confidentiality are rooted in a set of values regarding the relationship between caregiver and patient. It is essential that a patient trust a caregiver so that a warm and accepting relationship may develop. This is particularly true in a mental health treatment.

### Normal results

The Health Insurance Portability and Accountability Act of 1996 was enacted to address the issue of patient confidentiality. Full implementation of HIPAA regulations began in April 2003. If individuals and organizations having patient data adhere to the

requirements of HIPAA, patient confidentiality will be enhanced.

HIPAA provides a uniform set of guidelines that apply to all providers and organizations. HIPAA requirements are not affected by state boundaries.

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- American College of Physicians. 190 N Independence Mall West, Philadelphia, PA 19106-1572. (800) 523-1546, ext. 2600. (215) 351-2600. <http://www.acponline.org>.
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- National Patient Advocate Foundation. 725 15th St. NW, 10th Floor, Washington, DC 20005. Phone: (202) 347-8009, Fax: (202) 347-5579. <http://www.npaf.org>. <action@npaf.org>.



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## Patient rights

### Definition

Patient rights encompass legal and ethical issues in the provider-patient relationship, including a person's right to privacy, the right to quality medical care without prejudice, the right to make informed decisions about care and treatment options, and the right to refuse treatment.

### Purpose

The purpose of delineating patient rights is to ensure the ethical treatment of persons receiving medical or other professional health care services. Without exception, all persons in all settings are entitled to receive ethical treatment.

### Description

Many issues comprise the rights of patients in the medical system, including a person's ability to sue a health plan provider; access to emergency and specialty care, diagnostic testing, and prescription medication without prejudice; confidentiality and protection of patient medical information; and continuity of care.

Health care reform led to an emergence of health maintenance organizations (HMOs) and other managed health care plans. The rapid change in medical care moved health care decision making from medical professionals to business entities, a move many consider to be detrimental to the health care industry in general.

Establishing a patient's bill of rights has been the response to this concern. The Bipartisan Patient Protection Act of 2001 has been signed into law.

At issue, besides basic rights of care and privacy, is the education of patients concerning what to expect of their health care facility and its providers. These basic rights include the right to:

- participate in the development and implementation in the plan of care
- be treated with respect and dignity
- be informed about condition, treatment options, and the possible results and side effects of treatment
- refuse treatment in accordance with the law, and receive information about the consequences of refusal
- quality health care without discrimination because of race, creed, gender, religion, national origin, or source of payment
- privacy and confidentiality, which includes access to medical records upon request
- personal safety
- know the identity of the person treating the patient, as well as any relationship between professionals and agencies involved in the treatment
- informed consent for all procedures
- information, including the medical records by the patient or by the patient's legally authorized representative and hospital charges, except for Medicaid and general assistance
- consultation and communication
- complain or compliment without the fear of retaliation or compromise of access or quality of care

Patients are expected to meet a fair share of responsibility by following the plan of care, providing complete and accurate health information, and communicating comprehension of instructions on procedures and treatment. The patient is further responsible for consequences of refusal of treatment, of not following the rules and regulations of a hospital, and of not being considerate of others' rights. The patient is also responsible for providing assurance that financial obligations of care are met.

The American Hospital Association provides an informal bill of rights for patients who are hospitalized, which informs patients that they have the right to refuse any procedure or medication that is prescribed, and that states that full information should be provided by the attending physician if the patient has expressed doubts or concerns.

Persons United Limiting Substandards and Errors in Health Care (PULSE), a non-profit organization concerned with patient education and improving communication within the health care system, encourages the partnership of health care professionals and patients. A patient who is educated about his or her own medical condition can work together with health care providers regarding treatment decisions.

New federal privacy rules, beyond the proposed patient bill of rights, give patients additional control over private medical information. Patients have the right to examine their own medical records and to amend them if necessary. In practice, medical personnel have often been reluctant to part with patient records, even when requested by the patients themselves. While health care providers and patients assume that medical records are private, the widespread use of computer transmissions opens the potential for seriously compromising **patient confidentiality**. Regulations recently imposed by the federal government are aimed at protecting patient records by creating limits on the methods in which medical information is shared. Direct authorization from a patient must be gained before information may be released. Criminal and civil penalties may be imposed for a privacy violation. Intentional disclosure of private information can bring a \$50,000 fine and a one-year prison term. Penalties for selling medical information are higher. These rules became enforceable in 2003.

## Alternatives

Not all individuals or organizations agree with the new regulations. Some complain that they are too restrictive, while others maintain that they are not restrictive enough. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) cites complexity and cost factors as major problems, and that the full extent of the impact caused by the ruling was not adequately considered when it passed in 2003. The government estimated that it will cost taxpayers \$17.6 billion over 10 years to comply with the privacy regulations. Critics of the regulations imply that the cost will be more than triple the estimate, and that billable hours for attorneys specializing in the complexities of the regulations will skyrocket, thus resulting in even higher costs of patient care.

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PCA see **Patient-controlled analgesia**

PCNL see **Nephrolithotomy, percutaneous**

PCV see **Hematocrit**

## Pectus excavatum repair

### Definition

Pectus excavatum repair, also called “funnel chest repair” or “chest deformity repair,” is a type of surgery performed to correct pectus excavatum, a deformity of the front of the chest wall with depression of the breastbone (sternum) and rib (costal) cartilages. It is sometimes associated with Marfan or Poland syndrome.

### Purpose

The chest consists of the rib cage and sternum, which protect the upper-abdominal cavity and its contents. Pectus excavatum, also called “funnel chest” or “depressed sternum” is a deformity that is usually diagnosed shortly after birth. In some people, it is not visible until they are older. The exact cause is not known, but it is believed to be due to overgrowth of the rib cartilage connected to the sternum, which connects to the sternum being pushed backward toward the spine. Most people have no symptoms, but if the breastbone is pushed back far enough, heart and lung function may be affected. The purpose of pectus excavatum repair surgery is to correct the deformity to improve physical appearance, posture, and breathing.

### Demographics

In the United States, pectus excavatum is the most common chest wall deformity observed in children, occurring more commonly in boys than in girls. Pectus excavatum tends to run in families. The funnel chest usually progresses as the child grows, often showing a

## KEY TERMS

**Marfan syndrome**—A condition occasionally associated with chest wall deformities, in which the patients have a characteristic tall, thin appearance, and cardiac and great vessel abnormalities.

**Pectus carinatum**—A chest wall deformity characterized by a protrusion of the sternum.

**Pectus excavatum**—A chest wall deformity in which the chest wall takes on a sunken appearance.

**Poland syndrome**—A condition associated with chest wall deformities in which varying degrees of underdevelopment of one side of the chest and arm may occur.

**Sternum**—The breastbone. It connects to ribs one through seven on either side of the chest.

dramatic deterioration during the puberty growth spurt.

Pectus excavatum repair is technically easiest to perform in preadolescent children, and the recovery is faster. However, almost half of the patients undergoing the operation are teenagers. Repair is rarely performed on children under eight years of age. In recent years, a large number of adults over the age of 21 years have undergone repair with equally good results as those observed with children.

### Description

Pectus excavatum repair is always performed with the patient under **general anesthesia**. An epidural catheter is inserted for the management of pain after the operation. The surgeon makes two incisions over the sternum, on either side of the chest, for insertion of a curved steel bar or strut under the sternum. He or she proceeds to remove the deformed cartilages. The rib lining is left in place to allow renewed cartilage growth. The sternum is then repositioned, and the metal strut is placed behind it and brought out through the muscles and skin for future attachment to a brace, which will stay in place six to 12 weeks. The metal strut is fixed to the ribs on either side, and the incisions are closed and dressed. A small steel grooved plate may be used at the end of the bar to help stabilize and fix the bar to the rib. A blood **transfusion** is not required during surgery. The surgeon may insert a temporary chest tube to re-expand the lung if the lining of the lung is entered.

A variety of surgical procedures are available to repair pectus excavatum.

### *Nuss procedure*

A common technique is the Nuss procedure, developed in 1987 by Dr. Donald Nuss, a pediatric surgeon at Children's Hospital of the The King's Daughters and Eastern Virginia Medical School in Norfolk, Virginia. The procedure is minimally invasive, and results in very little blood loss and short recovery times.

### *Leonard procedure*

Another surgical approach that drastically reduces the time required for surgery is the Leonard procedure, developed by Dr. Alfred Leonard, a Minneapolis thoracic and pediatric surgeon. This operation does not violate the chest, and is combined with a bracing technique.

## Diagnosis/Preparation

A pediatrician diagnoses pectus excavatum after observing a child when he or she inhales, exhales, and rests. The pediatrician also calculates the depth of the chest from front to back using x rays of the chest to determine whether the diameter is shorter than average, as is the case with funnel chest. The heart is usually larger and displaced to the left. The pediatrician also evaluates lung capacity using **exercise** tests and lung scans that can reveal mismatched lungs.

Other diagnostic tests may include:

- Electrocardiogram (ECG or EKG). This test records the electrical activity of the heart, and shows abnormal rhythms (arrhythmias or dysrhythmias).
- Echocardiogram (echo). This test evaluates the structure and function of the heart by using sound waves recorded on an electronic sensor that yields a moving picture of the heart and its valves.

Before surgery, a bone density test is performed to ensure that the patient does not have soft bones that would deform again right after the surgery. After a complete **health history** is taken, a patient whose condition is considered severe enough to warrant surgery is sent for a CT scan and further evaluation of his or her pulmonary function.

Because of the great variability of pectus excavatum among those who have it, custom-made bars (or braces) must be used. The brace is a light vest to which the deformity-correcting wire will be attached at surgery. Patients are fitted with the brace prior to surgery.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Pectus excavatum repair is performed in a hospital by experienced thoracic surgeons who specialize in pectus excavatum repair.

## Aftercare

Usual recovery time in the hospital is four to five days. Attention is paid to post-operative **pain management**. The patient is encouraged to breathe deeply, and receives assistance with movement (to avoid dislodging the bar). After discharge, the patient slowly resumes a normal, but restricted, activity level. Most children are able to return to school in two to three weeks, with exercise restrictions for six weeks (no physical education classes, heavy lifting, or athletics).

The pectus excavatum support bar is removed under general anesthesia two to four years after insertion, usually on an outpatient basis. In most cases, patients are able to leave the hospital within one to two hours after bar removal.

## Risks

Risks associated with pectus excavatum repair include those normally associated with the administration of anesthesia (such as adverse reactions to medications and breathing problems), and risks associated with any surgery (such as bleeding and infection). Specific pectus excavatum surgery risks may include lung collapse (pneumothorax) and the recurrence of the funnel chest. Bar displacement may occasionally require repositioning.

## Normal results

Pectus excavatum repair, in almost all instances, restores the ability of patients to participate in full activities, even strenuous activities and athletics. Also, there is a marked improvement in the patient's self image.

## Morbidity and mortality rates

According to the National Institutes of Health (NIH), excellent results (95–98%) are reported over a lengthy follow-up time of 25 years. Long-term follow-up (over 15 years) shows that the Nuss procedure provides excellent results with less than 5% recurrence of the deformity after the bar is removed.



## QUESTIONS TO ASK THE DOCTOR

- Can exercises correct pectus excavatum?
- How is pectus excavatum surgery performed?
- Should everyone with pectus excavatum have surgery?
- What surgical procedures does the doctor use?
- How many pectus excavatum surgeries does the physician perform each year?

### Alternatives

Mild cases of pectus excavatum may respond to an exercise and posture physiotherapy program. Many patients with rounded shoulders and a slouching posture have benefited from these techniques, with or without additional surgical correction. However, body-building exercises usually result in worsening of cosmetic appearance due to the enhancement of the pectoral muscles.

### Resources

#### BOOKS

- Pearson, F. G. *Thoracic Surgery*. Philadelphia: W. B. Saunders Co., 2002.
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- Genc, A., and O. Mutaf. "Polytetrafluoroethylene Bars in Stabilizing the Reconstructed Sternum for Pectus Excavatum Operations in Children." *Chest* 110 (July 2002): 54-7.
- Hebra, A., B. Swoveland, M. Egbert, E.P. Tagge, K. Georgeson, H.B. Othersen, and D. Nuss. "Outcome Analysis of Minimally Invasive Repair of Pectus Excavatum: Review of 251 Cases." *Journal of Pediatric Surgery* 35 (2000): 252-7.
- Jacobs, J. P., J.A. Quintessenza, V.O. Morell, L.M. Botero, H.M. van Gelder, and C. I. Tchervenkov. "Minimally Invasive Endoscopic Repair of Pectus Excavatum." *European Journal of Cardiothoracic Surgery* 21 (2002): 869-83.

#### ORGANIZATIONS

- American Pediatric Surgical Association (APSA). 60 Revere Drive, Suite 500, Northbrook, IL 60062. (847) 480 9576. [www.eapsa.org](http://www.eapsa.org).

Southern Thoracic Surgical Association. 633 N. Saint Clair St., Suite 2320, Chicago, IL, 60611 3658. (800) 685 7872. [www.stsa.org/](http://www.stsa.org/).

#### OTHER

"Pectus Excavatum Repair." *BestHealth*. [www.besthealth.com/surgery/PectusExcavatumRepair\\_1.html](http://www.besthealth.com/surgery/PectusExcavatumRepair_1.html).

Monique Laberge, Ph.D.

## Pediatric concerns

### Definition

Pediatric concerns are those issues that are unique to the care of children when surgery and hospitalization are involved.

### Description

Children are not just little adults. When dealing with children medically, it is important to keep in mind the stage of their physical growth and development; their emotional development; and their maturity level. There are many different kinds of pediatric surgeries and procedures. A pediatric hospital is designed around the special needs of children and their families. All of the staff, including doctors (pediatric surgeons, pediatric anesthesiologists, pediatric radiologists), nurses, and technical support, have special training in pediatrics. Children's hospitals have specific expertise in pediatric problems and special programs for children who are ill or injured.

### Helping a child prepare for surgery

When parents are helping their child prepare for surgery, it is important to realize that, no matter how mature the child may act, he or she still needs to be treated differently than adults. Some children find it comforting to know exactly what will happen, when, and how, all in great detail. Others do not want much detail. They may need just an overview of what to expect, keeping just one step ahead of what will be done to them. The particular level of a child's development will determine the specific concerns.

For example, the biggest fear for infants and toddlers is being away from their parents. Parents should stay with the child as much as possible, and ensure that basic needs (such as eating, play, or sleeping) are met, both at home and in the hospital. Preschoolers also fear being away from the parents, but, additionally, they see hospitalization as a punishment and fear

## KEY TERMS

**Child life specialist**—A person who has had specific training in the care of children, including understanding growth and development specific to each age range and how to talk to children of different ages.

**Pediatrics**—The medical specialty of caring for children.

**Separation anxiety**—A fear of being separated from a parent or loved one; a normal developmental process, occurring at certain points in a young child's life.

bodily harm. In this case, parents should, again, stay with the child as much as possible, and start talking to them at home about the coming operation to help reassure them. For the hospital stay, parents should bring the child's favorite blanket and/or toys, pictures from home, and maybe music tapes.

For school-age children, the biggest fears are needles and pain. Parents can help by giving them information about their body and how it works, and vaguely explain that the doctor will fix them, but parents should not use language like "cut, incision, open you up, make a hole, etc." To make the hospital feel more familiar, parents can bring pictures and music tapes and/or videos from home. By adolescence, children are worried about the loss of independence, being separated from their peers, and being different (i.e., a change in their appearance). For teenagers at this stage of development, it is extremely important to explain an illness or hospitalization to them in terms that they can understand, using examples to which they can relate, and allow them to be involved in decisions, if possible. The parents should encourage them to ask questions.

### *What to expect at the hospital*

Being in a hospital and undergoing surgery is scary and stressful for a child. Hospitalization disrupts their normal routines. If the staff behaves in a trusting, nurturing way, the child may become comfortable enough to return to some normal behaviors. Trust is important to all ages of children. If a procedure will hurt, it is important to be honest and let them know what to expect. Children can only learn to trust the staff if the staff is honest with them and treats them with respect.

Books and videos developed for children that explain about going to the hospital can be helpful. Some hospitals provide programs for children to come and visit before the hospitalization, so that children will

already be familiar with the hospital environment when they are admitted. Play is a child's way of expressing emotion, especially under difficult situations. Play can serve as a distracter as well as a means by which surgery and hospitalization can be explained to children. Dolls or stuffed animals can be used to walk young children through what they will be experiencing. Hospital play areas will often have toys that represent hospital equipment, so that a procedure can be explained with the use of props. For example, there may be pretend casts and **bandages** that a child can put on a stuffed animal. How children play can also serve as an insight for parents and staff as to understand how their children are feeling about what is happening to them. As children express their concerns through play, parents and staff can then address those concerns. Play is therapeutic for children, helping them feel safer in an unfamiliar environment, and should be considered an essential element in preparing for a child's hospital stay. Play areas help to make a strange place feel comfortable, both for the child as well as for the parents. Play areas also provide a relaxed area for parents to be with their child, a friendly home-like environment where nurturing can take place.

Unfortunately, some surgeries are not planned. Emergency situations are always more stressful, both because they are unexpected and because they are often more serious. Children take their cue on how to behave from those around them. When parents are noticeably concerned, children's anxiety levels rise. Parents should remain as calm as possible to be fully present for their children.

Parents should expect to be able to be with their children most of the time. For most day surgeries, parents can stay with their child until he or she is asleep, and then can be waiting in the **recovery room** when the child is waking up after the procedure is completed. Some facilities provide pullout beds for parents to spend the night with their children, and may even have a small kitchen where they can prepare food to eat in their child's room.

Qualified staff should be available to help parents work through their concerns and anxiety. Parents with more than one child may sometimes need to leave their hospitalized child completely in the hands of hospital staff as they attend to their other children at home. Many facilities have volunteers who can stay with children when their parents need to leave the hospital.

### *What to look for in health care for a child*

While those hospitals designed especially for children are a wonderful resource, other hospitals that care for patients of all ages will often provide comparable

care. If the surgery allows for time to select a surgeon and hospital, things to look for include:

- surgeons and physicians who are board certified in pediatrics
- staff with special training in pediatrics
- equipment designed for pediatric use
- a separate wing or floor for children
- child life specialists on staff
- play rooms and toys that can be brought into a child's room

A pediatric hospital or wing will have equipment that is smaller, better suited to the child's size. Bandages may have pictures of cartoon characters on them; there may be paintings of characters from children's movies on the walls.

Staff will usually have had special training to understand what issues are important to children at different stages of development. They should use language that is adapted to explain what is happening to the child in ways that make sense to them. For example, instead of just asking a child to blow, they may ask them to imagine that they are blowing out candles on a birthday cake. All of these techniques help to make the hospital a more familiar and friendlier place, putting the child at ease and helping to lessen anxiety.

## Resources

### BOOKS

Behrman, R. E., et al. *Nelson's Textbook of Pediatrics*. 17th ed. Philadelphia: Saunders, 2004.

### ORGANIZATIONS

The Nemours Foundation. <http://kidshealth.org>.

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## Pediatric surgery

### Definition

Pediatric surgery is a specialized field of surgery for the treatment of conditions that can be surgically corrected in a baby, child, or adolescent.

### Purpose

The purpose of pediatric surgery varies with the procedure. In general, the purpose is to surgically correct a congenital condition, disease, traumatic injury, or other disorder in the pediatric patient.

## Demographics

Pediatric surgeons provide treatment for young patients—newborns up through late adolescence.

## Description

Pediatric surgery is the surgical branch that uses operative techniques to correct certain pediatric conditions (i.e., congenital abnormalities, tumors, chronic diseases, and traumatic injuries). There are different specialties within the field that include:

- pediatric general surgery
- pediatric otolaryngology (ear, nose, and throat)
- pediatric ophthalmology (eye)
- pediatric urology (urogenital system)
- pediatric orthopedic (bone) surgery
- pediatric neurological (brain and spinal cord) surgery
- pediatric plastic (reconstructive and cosmetic) surgery

The American Academy of Pediatrics has established specific guidelines for referral to subspecialists. The pediatric patient has special considerations that differentiate him or her, both physically and psychologically, from an adult. A neonate (newborn) poses great challenge in surgical treatment since the tiny structures and immature organ systems may not cope with disease-induced stress and the physical demands of a major operative procedure. A newborn infant may still be developing key bodily functions, or may have special requirements. Key areas of concern in the newborn include:

- cardiovascular (heart) system
- thermoregulation (temperature requirements of 73°F [22.8°C]).
- pulmonary (lung) function
- renal (kidney) function
- immature immunity and liver
- special requirements for fluid, electrolyte (necessary elements such as sodium, potassium, and calcium) and nutrition

The pediatric surgeon must take into account the special requirements unique to the young surgical patient. The pediatric surgeon is trained to treat the entire spectrum of surgical illnesses. The following is an overview (with symptoms) of the more common pediatric conditions that require surgery typically performed by the pediatric surgeon.

## KEY TERMS

**Atresia**—Thinning or narrowing of a body passageway.

**Large intestine**—The portion of the colon that includes the cecum; ascending, transverse, and descending sigmoid colon; rectum; and anal canal.

**Oliguria**—Decreased urine production.

**Pediatric aged patient**—The pediatric aged patient encompasses several periods during development. The first four weeks after birth are called the neonatal period. The first year after birth is called infancy, and childhood is from 13 months until puberty (between the ages of 12 and 15 years in girls and 13 and 16 years in boys).

**Polyp**—A tumor mass, generally benign and capable of surgical removal.

**Pylorus**—The area that controls food passage from the stomach to the first part of the small intestine (duodenum).

**Small intestine**—The part of the intestines that consists of the duodenum, jejunum, and ileum.

### *Alimentary tract obstruction*

Obstruction of the alimentary tract (tubes of digestion extending from the mouth to the anus) is characterized by four cardinal symptoms:

- abdominal distention (an abdomen that becomes large and appears swollen)
- bilious vomiting (due to bile in the stomach)
- maternal polyhydramnios (excess amniotic fluid in the amniotic sac, greater than 2,000 ml) before birth
- failure to pass meconium (dark green or black sticky excretion passed via the newborn's rectum) in the first 24 hours of life

**ESOPHAGEAL ATRESIA AND TRACHEOESOPHAGEAL FISTULA.** This is a congenital deformity of the esophagus (the tube that passes food from the mouth to the stomach) does not connect to the stomach. Symptoms include severe respiratory distress (the neonate cannot breathe) and excessive salivation. Other clinical signs include cyanosis (bluish discoloration of the skin due to oxygen deprivation), choking, and coughing.

**PYLORIC ATRESIA AND RELATED CONDITIONS.** Pyloric atresia is a condition that occurs when the pyloric valve, located between the stomach and duodenum, fails to open. Food cannot pass out of the stomach, resulting in vomiting clear gastric juice at attempted

feedings. Maternal polyhydramnios is present before birth in more than 60% of cases.

Other areas of the colon (duodenum, jejunum, ileum) can be obstructed during development, with symptoms present at birth. Most of these disorders share the four cardinal symptoms of alimentary obstruction.

**INTUSSUSCEPTION.** Intussusception accounts for 50% of intestinal obstruction in patients who are three months to one year of age. Eighty percent of cases are observed by the child's second birthday. The cause of intussusception is not known, and it is more common in males who are well nourished and apparently healthy. The symptoms include a sudden onset of abdominal pain characterized by episodic screaming and drawing up of the legs. In 60% of patients, vomiting and blood in the stool are common findings (either bright red or occult [hidden] blood). Typically, the bowel movements look like currant jelly, consisting of mucus and blood mixed together. Currant jelly stool is the most common clinical observation for patients with intussusception. During **physical examination**, patients will exhibit abdominal distention, and in 65% of cases there is a sausage-shaped mass that can be felt in the upper right portion of the abdomen toward the mid-abdomen. **Ultrasound** studies are a reliable method of diagnosis.

**FAILURE TO PASS MECONIUM.** Failure to pass meconium (meconium ileus) is associated with cystic fibrosis (a genetic disorder), colonic obstruction (colonic atresia), meconium plug syndrome, and aganglionic megacolon (also called Hirschsprung's disease, a congenital absence of the nerves that provide gastrointestinal tract mobility).

### *Anorectal anomalies*

There are many different types of anorectal anomalies common to male and female neonates, as well as deformities that are gender-specific since involvement of genitalia can occur. The surgery for these cases is complicated, and must be performed by an experienced pediatric surgeon. Complications of these procedures could result in permanent problems.

### *Necrotizing enterocolitis (NEC)*

NEC affects 1–2% of patients admitted to a neonatal **intensive care unit**. It is a life-threatening illness characterized by abdominal distention, bilious vomiting, lethargy, fever, occult (not obvious) or gross (clearly seen) rectal bleeding. Additionally, affected patients may exhibit signs of hypothermia (temperature less than 96.5°F or 35.8°C), bradycardia (slow



heart rate), abdominal mass (felt during palpation), oliguria, jaundice, and episodes of breathlessness (apnea). Survival of NEC surgery can be expected for 60–70% of patients.

### *Abdominal wall defects*

Omphalocele is a defect that involves protrusion of abdominal contents into an external sac. This disorder occurs in one per 5,000 births. More than 50% of omphalocele patients have serious genetic deformities involving these body systems: cardiovascular (heart), musculoskeletal (muscle and bones), genitourinary (genital and bladder systems), and central nervous (brain and spinal cord). The overall survival rate for infants with omphalocele varies, and depends on defect size, other associated genetic abnormalities, and age of newborn. (Many infants with omphalocele are premature.) Approximately 33% of patients with omphaloceles do not survive.

**GASTROSCHISIS.** Gastroschisis is a defect in the abdominal wall to the side (lateral) of the umbilicus. It usually occurs to the right of an intact normal umbilical cord. The cause is unknown. The bowel protrudes to the outside of the abdomen during intra-uterine life (while the embryo is developing inside the uterus). The amniotic fluid has an irritating effect on the exposed bowel, and causes infection of the bowels. The problem can be detected by ultrasound studies during pregnancy. Some pediatric surgeons and obstetricians recommend **cesarean section** (early elective delivery) to spare bowel trauma. The newborn patients typically require surgery, tube feedings for three to four weeks, and hospitalization for several weeks. The current survival rate for infants with gastroschisis is greater than 90%.

### *Congenital diaphragmatic hernia (CDH)*

CDH can be diagnosed by the fourth month of pregnancy via ultrasound studies. Of the infants with congenital diaphragmatic hernia (CDH), 44–66% have other congenital abnormalities as a result of developmental malformations. Anatomically, patients with CDH have a defect in development that allows a communication between the chest and abdomen. Through this defect, the abdominal contents enter the lung cavity and interfere with normal lung development. The incidence is approximately one per 2,200 live births, and males are more commonly affected than females. Usually the infants are full-term, and the defect occurs on the left side in the majority—88%—of patients.

Treatment is extensive, and usually requires three major areas:

- stabilization of patient and preoperative preparation
- operative treatment
- postoperative respiratory, metabolic, circulatory and nutritional supportive measures

Postoperatively, the infant is monitored in the neonatal intensive care setting. The postoperative period is more critical if a lung is severely underdeveloped.

### *Pyloric stenosis (PS)*

Pyloric stenosis is an obstruction in the intestine due to a larger-than-normal size of the muscle fibers of the pylorus (lower stomach opening). Pyloric stenosis is a common hereditary condition that affects males more than females, and occurs in one per 750 births. The typical symptoms include a progressive, often projectile, vomiting after attempted feedings. The gastric vomitus (bloody in 80% of patients) usually begins during the second and third week of life, and increases in force and frequency. Typically, the infant fails to gain weight, and the number of bowel movements and rate of urination decreases.

Physical examination is usually helpful in establishing a diagnosis. Palpation of the enlarged muscle fibers can be felt as an olive-shaped mass located along the midline approximately one-third to one-half of the distance from the umbilicus to the xiphoid (end of the breastbone), when the stomach is empty. Careful abdominal examination and palpation can usually identify the pyloric mass in 85% of cases.

### *Gastroesophageal reflux*

Gastroesophageal reflux disease (GERD) is a common disorder in infancy, and usually disappears by the baby's first birthday. The largest group of patients with clinically significant GERD are those who have neurologic impairment. Symptoms often include vomiting, repeated lung infections (from aspirating gastric contents during regurgitation of food-stuffs), and delayed gastric emptying. The success rate with infants who have procedures necessary to correct GERD is over 90%.

### *Meckel's diverticulum*

Meckel's diverticulum occurs in approximately 2% of the U.S. population. The diverticulum is an outgrowth of intestine that is located in a portion of the intestines called the ileum. Symptoms of obstruction are more often observed in infants, and bleeding is more common in patients after age four.

### *Intestinal polyps*

Juvenile polyps are usually present between the ages of four and 14 years, and tend to be inflammatory. The most common symptom of intestinal polyps is rectal bleeding, which is commonly due to a solitary polyp (80% of cases). Diagnosis can be done by proctosigmoidoscopy, which allows visualization of 85% of polyps.

### *Acute appendicitis*

Acute appendicitis is a relatively common surgical emergency that is misdiagnosed in 28% of patients due to a broad spectrum of symptoms that can confuse the clinician. The classic clinical symptom of acute appendicitis is the onset of pain in the middle region of the abdomen that is followed by anorexia (loss of appetite), nausea, and vomiting. The pain is persistent and radiates to the right lower abdomen, becoming more intense and localized. The physical and abdominal examinations must be carefully and accurately performed. Patients with acute appendicitis usually have an increased white blood cell (cells that fight infection) count.

Once the diagnosis is established, the child is prepared for surgery. Preoperative **antibiotics** are started at least one half-hour before the operation. If the appendix is perforated (ruptured), complications can occur as a result of kidney (renal) failure, seizures due to fever, and gram-negative sepsis (an infection that enters the bloodstream and interferes with life-saving chemical reactions). Patients who are very young, or those who were misdiagnosed and incurred long delays in treatment, are susceptible to **death**.

### *Inflammatory bowel diseases*

Some cases (approximately 25%) of inflammatory bowel disease are found in persons younger than 20 years of age. Two types can occur, Crohn's disease and ulcerative colitis.

The diagnosis of inflammatory bowel disease is usually based on presenting clinical symptoms, laboratory analysis results, endoscopic appearance, and radiologic findings. Approximately 50–60% of patients have bloody diarrhea, severe cramping, abdominal pain, and urgency.

**CROHN'S DISEASE.** The symptoms of Crohn's disease includes cramping abdominal pain, diarrhea, and strictures (constriction) resulting from bowel obstruction. Removal of diseased portions in children with Crohn's disease may be temporarily beneficial, but recurrence after surgical removal occurs in about 50% of cases within four years. Chronic symptoms may

remain into adult life, making long-term follow-up essential.

**ULCERATIVE COLITIS.** Ulcerative colitis is limited to the colon. A surgical procedure known as colectomy is curative, and indicated for intractable disease (64% of patients). Colectomy is the removal of the entire colon, or the inflamed part of it.

### *Biliary tract disorders*

A variety of biliary tract conditions may be present at birth, some requiring surgical correction.

**NEONATAL JAUNDICE.** Neonatal jaundice is common, and results from an immature system not capable of some basic biochemical reactions. Food intake can help speed these reactions, which usually resolve the condition within seven to 10 days. Jaundice that persists for over two weeks is abnormal, and could be caused by over 30 possible disorders.

**BILIARY ATRESIA.** Biliary atresia is a disease that causes inflammation of the ducts within the biliary system, resulting in fibrosis of these ducts. The incidence of biliary atresia is one per 15,000 live births, and is more common in females. Time is critical, and most patients must have surgery by two months of life. Approximately 25–30% of patients who receive early operative intervention have long-term successful outcomes. Some patients may require **liver transplantation**, and 85–90% of these patients survive.

**CHOLELITHIASIS.** Gallbladder obstruction in infants and young children is usually caused by pigmented (colored) stones resulting from blood disorders. Removal of the gallbladder (laparoscopic **cholecystectomy**) is the treatment of choice.

### *Trauma*

Accidents are the leading cause of death in children between the ages of one and 15 years, and accounts for 50% of all deaths in the pediatric age group. More than half of these deaths are due to motor vehicle accidents, followed by falls, bicycle injuries, drowning, burns, child abuse, and birth trauma. Head trauma is the single most common organ associated with traumatic death. Within recent years, the number of fatalities related to the use of firearms and violence has increased.

More than 20 million children each year sustain injuries requiring treatment. These injuries account for 100,000 cases of permanent pediatric disability. Response to trauma in pediatric patients is significantly different from older patients. Pediatric patients require special attention concerning temperature regulation, blood volume, metabolic rate and requirements, and airway

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Pediatric surgery is performed by a pediatric surgeon who has had five years of general surgery training, along with further specialized instruction and experience, and is certified in pediatric general surgery or in a specific pediatric specialty.

maintenance. Other special pediatric considerations include response to stress, communication difficulties, psychological trauma, a different pediatric trauma score system, smaller airway diameter, and increased risk of aspirating gastric contents (which could cause pneumonia). Pediatric trauma patients should have access to appropriate pre-hospital transportation, and must receive medical attention in a pediatric trauma center capable of providing the complex level of care necessary for serious pediatric trauma situations.

### *Neck masses*

Neck masses during infancy and childhood may be caused by tumors or infections, or they may be congenital. Lymphadenitis is an infection of a lymph node that becomes enlarged and tender. Most cases are resolved by treating the primary source of infection (i.e., middle ear infection and tonsillitis). Some inflamed nodes may require an incision and drainage of infection.

### *Hernias*

**INGUINAL HERNIA AND HYDROCELE.** Inguinal (groin) hernia is the most frequent disorder requiring surgery in the pediatric age group. Clinically, a right-sided inguinal hernia is more common in males (60% of cases), and there is a familial tendency. The incidence is higher in full-term infants (3.5–5%). Full-term infants and older children (without underlying diseases) can receive surgical repair in an outpatient setting. An inguinal hernia may result in herniation of the scrotum, and a communicating hydrocele (hernia with a small connection to the peritoneal cavity).

**UMBILICAL HERNIA.** Umbilical hernia is a defect of the umbilical ring, and is more common in females and African American children. Spontaneous involution occurs in 80% of cases. Larger defects may be observed for several years without complications, and their spontaneous resolution is possible. If the umbilical hernia persists, patients may develop feeding intolerance, pain, and local skin breakdown.

## QUESTIONS TO ASK THE DOCTOR

- What are the risks of surgery?
- What is the benefit of the surgery?
- What type of anesthesia will be used?
- How many surgeries of this type has the surgeon performed?
- Is there an alternative to surgery?
- Is a full recovery expected, and if not, what deficits will the child have?
- What should the parents and child do to prepare for surgery?
- What care is needed following the surgery?
- When will the child be able to return to normal activity?

### *Undescended testes*

Undescended testes are observed in 1–2% of full-term males. Approximately 30% of preterm males may have an undescended testis. Undescended testis in premature infants may descend by the first year of life, and observation is often the treatment during that time.

### *Tumors*

Wilm's tumor (nephroblastoma) is a tumor in the kidneys that forms during embryonic development. The tumor is due to a genetic abnormality; and approximately 80% of children are diagnosed between one and five years of age. In about 75–95% of cases, the patient has an abdominal mass that is detected by a parent during bathing. Blood in the urine (hematuria) occurs in 10–15% of cases, and high blood pressure (hypertension) is present in 20–25% of cases. Hypertension is the result of the tumor compressing the kidney in a specific area, causing it to release a chemical called renin, which elevates blood pressure. During physical examination, the Wilm's tumor is a smooth, round, hard, nontender flank mass. The treatment of Wilm's tumor depends on its stage, and may include surgery, chemotherapy, or radiotherapy.

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The American Pediatric Surgical Association. 60 Revere Drive Suite 500 Northbrook, IL 60062. (847) 480 9576. Fax: (847) 480 9282 E mail: eapsa@eapsa.org.

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PEG tube insertion see **Gastrostomy**

# Pelvic ultrasound

## Definition

Pelvic **ultrasound** is a procedure in which high-frequency sound waves create images of the pelvic organs. The sound waves are projected into the pelvis, and measure how they reflect—or echo—back from the different tissues.

## Purpose

Ultrasound is a preferred method of examining the pelvis, and functions as an extension of a **physical examination**, particularly for obese patients. It is a common initial step after physical examination when a patient complains of pelvic pain or abnormal vaginal bleeding. The procedure is performed routinely during pregnancy and examinations to determine the cause of infertility. Ultrasound has the ability to detect the size and shape of pelvic organs, such as the bladder, and is useful in evaluating the cause of bladder dysfunction. In women, pelvic ultrasound is used to examine the uterus, ovaries, cervix, and vagina. In general, ultrasound can detect inflammation, free fluid, cysts (abnormal fluid-filled spaces), and tumors in the pelvic region.

A primary use of pelvic ultrasound is during pregnancy. In early pregnancy (about five to seven weeks), ultrasound may determine the size of the fetus to confirm the suspected due date, detect multiple fetuses, or confirm that the fetus is alive (viable). Ultrasound is particularly useful in distinguishing between intrauterine (within the uterus) and ectopic (outside the uterus) pregnancies. Toward the middle of the pregnancy (about 16–20 weeks), the procedure can confirm fetal growth, reveal defects in the anatomy of the fetus, and

check the placenta and amniotic fluid. Toward the end of pregnancy, it may be used to evaluate fetal size, position, growth, or to check the placenta.

Doctors may use ultrasound to guide the biopsy needle during **amniocentesis** and chorionic villus sampling. The imaging allows precise placement of the long needle that is inserted into the patient's uterus to collect cells from the placenta or amniotic fluid.

## Description

Depending on the goal of the procedure, a pelvic ultrasound can also be called a bladder ultrasound, pelvic gynecologic sonogram, or obstetric sonogram. Ultrasound examinations are usually done in a doctor's office, clinic, or hospital setting. Typically, the patient will lie on an examination table with the pelvis exposed. Special gel is applied to the area to make sure that there is no air between the hand-held transducer and the skin, and to facilitate transducer movement. The physician or technologist guides the transducer over the abdomen. The transducer both creates and receives the echoes of the high-frequency sound waves (usually in the range of 3.5–10.0 megahertz). An ultrasound scan reveals the shape and densities of organs and tissues. By performing repeated scans over time, much like the frames of a movie, ultrasound can also reveal movement, such as the motions of a fetus. This technique is called real-time ultrasound.

Using a computerized tool, called a caliper, the ultrasound technologist can measure various structures shown in the image. For example, the length of the upper thigh bone (femur) or the distance between the two sides of the skull can indicate the age of the fetus.

Ultrasound technology has been safely used in medical settings for over 30 years, and several significant extensions to the procedure have made it even more useful. A specially designed transducer probe can be placed in the vagina to provide better ultrasound images. This transvaginal or endovaginal scan is particularly useful in early pregnancy or in cases where ectopic pregnancy is suspected. It is also routinely used to provide better anatomic delineation of the endometrium and pelvic masses. In men, transrectal scans, where the probe is placed in the rectum, are done to check the prostate. Doppler ultrasound has the ability to follow the flow of blood through veins and arteries, and can be useful in detecting disorders such as abnormal blood flow associated with ovarian torsion (a twisted blood supply that causes pelvic pain). Color enhancement is particularly useful in Doppler imaging, where shades of red signify flow



## KEY TERMS

**Acoustic window**—Area through which ultrasound waves move freely.

**Amniocentesis**—A procedure where a needle is inserted through the pregnant woman's abdomen and into the uterus to withdraw a sample of amniotic fluid surrounding the fetus.

**Chorionic villus sampling**—A procedure where a needle is inserted into the placenta to withdraw a sample of the placenta's inner wall cells surrounding the fetus.

**Ectopic pregnancy**—A pregnancy where the fertilized egg becomes implanted somewhere other than in the uterus; if in a fallopian tube it is called a tubal pregnancy.

**Real-time**—A type of ultrasound that takes multiple images over time in order to record movement, or the observations obtained while scanning (rather than obtained by looking at films after the procedure).

**Sonographer**—A technologist or physician who uses an ultrasound unit to take ultrasound images of patients.

**Transducer**—The handheld part of the ultrasound unit that produces the ultrasound waves and receives the ultrasound echos.

**Ultrasound**—Sound above what can be heard by the human ear, generally above 20,000 Hz (cycles per second).

away from the transducer and shades of blue signify flow toward it.

Hysterosonography is another variant ultrasound procedure. It involves the injection of saline solution into the uterus during an endovaginal scan. The saline distends the uterine cavity (or endometrium) and simplifies the identification of polyps, fibroids, and tumors. The saline outlines the lesion, making it easier to find and evaluate. Hysterosonography can also be used in the testing of patency (openness) of the fallopian tubes during infertility evaluations.

### Preparation

Before undergoing a pelvic ultrasound, the patient may be asked to drink several glasses of water and to avoid urinating for about one hour prior to exam time. When the bladder is full, it forms a convenient path, called an acoustic window, for the ultrasonic waves. A full bladder is not necessary for an endovaginal

examination, sometimes making it a preferred choice in emergency situations. Women usually empty their bladders completely before an endovaginal exam.

### Aftercare

For a diagnostic ultrasound, the lubricating gel applied to the abdomen is wiped off at the end of the procedure and the patient can immediately resume normal activities.

### Risks

Ultrasound carries with it almost no risk for complications.

### Normal results

A normal scan reveals no abnormalities in the size, shape, or density of the organs scanned. During pregnancy, a normal scan reveals a viable fetus of expected size and developmental stage. Although ultrasound is an extremely useful tool, it cannot detect all problems in the pelvic region. If a tumor or other lesion is very small or if it is masked by another structure, it may not be detected. When used during pregnancy, patients should be advised that ultrasound does not reveal all fetal abnormalities. Additionally, the reliability of ultrasound readings can depend on the skill of the technologist or physician performing the scan.

An abnormal scan may show the presence of inflammation, cysts, tumors, or abnormal blood flow patterns. These results may suggest further diagnostic procedures, or surgical or pharmacological treatment. Obstetrical ultrasound examinations may alter the anticipated due date or detect abnormalities or defects in the fetus. This information may reveal that the fetus cannot survive on its own after birth, or that it will require extensive treatment or care. The technologist performing the ultrasound should consult with a radiologist or other physician if any questionable results appear.

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#### ORGANIZATIONS

American Institute of Ultrasound in Medicine. 14750 Sweiter Lane, Suite 100, Laurel, MD 20707 5906. (301) 498 4100 or (800) 638 5352. <http://www.aium.org>.

American Registry of Diagnostic Medical Sonographers (ARDMS). 600 Jefferson Plaza, Suite 360, Rockville, MD 20852 1150. (301) 738 8401 or (800) 541 9754. <http://www.ardms.org>.

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Penile implant surgery see **Penile prostheses**

## Penile prostheses

### Definition

Penile prostheses are semi-rigid or inflatable devices that are implanted into penises to alleviate impotence.

### Purpose

The penis is composed of one channel for urine and semen, and three compartments with tough, fibrous walls containing erectile tissue. With appropriate stimulation, the blood vessels that lead out of these compartments constrict, trapping blood. Blood pressure fills and hardens the compartments producing an erection of sufficient firmness to perform sexual intercourse. Additional stimulation leads to ejaculation, where semen is pumped out of the urethra. When this system fails, erectile dysfunction or impotence (failure to create and maintain an erection) occurs.

Impotence can be caused by a number of conditions, including diabetes, spinal cord injury, prolonged drug abuse, and removal of the prostate gland. If the medical condition is irreversible, a penile prosthesis may be considered. Men whose impotence is caused by psychological problems are not recommended for implant surgery.

## KEY TERMS

**General anesthesia**—Deep sleep induced by a combination of medicines that allows surgery to be performed.

**Genital**—Sexual organ.

**Perineum**—Area between the anus and genitals.

**Scrotum**—The external pouch containing the male reproductive glands (testes) and part of the spermatic cord.

### Demographics

Recently, it has been reported that surgeons insert approximately 20,000 penile implants into American men yearly. The most common device is a multi-component inflatable implant (approximately 45% of all implants). Semi-rigid rods account for about 35% of the implants. Self-contained devices comprise approximately 20% of implants.

### Description

Penile implant surgery is conducted on persons who have exhausted all other areas of treatment. Semi-rigid devices consist of two rods that are easier and less expensive to implant than the inflatable cylinders. Once implanted, the semi-rigid device needs no follow-up adjustments; however, it produces a penis that constantly remains semi-erect. Inflatable cylinders produce a more natural effect. Men using them are able to simulate an erection via a pump located in the scrotum.

With a surgical patient under **general anesthesia**, the device is inserted into the erectile tissue of the penis through an incision in the fibrous wall. In order to insert the pump for the inflatable implant, incisions are made in the abdomen and the perineum (area between the anus and the genitals). A fluid reservoir is placed into the groin, and the pump is placed in the scrotum. The cylinders, reservoir, and pump are connected by tubes and tested before the incisions are closed.

### Diagnosis/Preparation

Surgery always requires a patient who is adequately informed about the procedure's risks and benefits. The sexual partner should also be involved in the discussion. Prior to surgery, the region undergoes antibacterial cleansing and is shaved.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A penile prosthesis is usually implanted by a urologist. This is a doctor with specialty training in diseases of the urinary system and the genital organs. The procedure is performed in a hospital with the patient under general anesthesia.

### Aftercare

To minimize swelling, ice packs are applied to the penis for the first 24 hours following surgery. The incision sites are cleansed daily to prevent infection. Pain relievers may be taken.

### Risks

With any implant, there is a slightly greater risk of infection than with simple surgery. The implant may irritate the penis and cause continuous pain. The inflatable prosthesis may need follow-up surgery to repair leaks in the reservoir or to reconnect the tubing.

### Normal results

Successful implantation of a penile prosthesis solves some problems related to impotence. After healing from the surgical procedure, men with a penile prosthesis can resume normal sexual activities.

### Morbidity and mortality rates

On a purely technical basis, morbidity associated with a surgically implanted penile implants is relatively uncommon, and is usually due to a postsurgical infection or to mechanical failure of the implanted device. Experts feel that personal dissatisfaction with a penile implant procedure is more common, and is usually due to unreasonable or inappropriate expectations for the procedure. Mortality is quite rare.

### Alternatives

Medication (sildenafil citrate [Viagra]) is useful for some men with erectile dysfunction. The medication must be prescribed and monitored by a physician.

Impotence caused psychological factors can usually be treated with appropriate counseling and therapy.

Creams are available for purchase. Most experts agree that these cannot reverse physiological impotence.

## QUESTIONS TO ASK THE DOCTOR

- What is the cause of the erectile dysfunction or impotence?
- How will the a penile prosthesis affect daily activities after recovery?
- How will the a penile prosthesis affect sexual activities after recovery?
- What will be the resulting appearance after surgery?
- Is the surgeon board certified?
- How many penile prosthesis procedures has the surgeon performed?
- What is the surgeon's complication rate?

Most experts consider mechanical rings that prevent blood flow out of a penis to be dangerous, and advise against their use.

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- American Board of Surgery. 1617 John F. Kennedy Boulevard, Suite 860, Philadelphia, PA 19103. (215) 568 4000. Fax: (215) 563 5718. <http://www.absurgery.org>.
- American Board of Urology. 2216 Ivy Road, Suite 210, Charlottesville, VA 22903. (434) 979 0059. <http://www.abu.org>.
- American College of Surgeons. 633 North St. Clair Street, Chicago, IL 60611 32311. (312) 202 5000. Fax: (312) 202 5001. E mail: [postmaster@facs.org](mailto:postmaster@facs.org). <http://www.facs.org>.
- American Foundation for Urologic Disease. 1128 North Charles Street, Baltimore, MD 21201. (800) 242 2383. <http://www.afud.org>.
- American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464 5000. <http://www.ama-assn.org>.
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Percutaneous nephrolithotomy see

**Nephrolithotomy, percutaneous**

Percutaneous transluminal angioplasty see

**Angioplasty**

## Pericardiocentesis

### Definition

A procedure performed with a needle to remove fluid for diagnostic or therapeutic purposes from the tissue covering the heart (pericardial sac).

### Purpose

The heart is surrounded by a membrane covering called the pericardial sac. The sac consists of two layers, the parietal (outer) and visceral (inner) layer, and normally contains a small amount of fluid to cushion and lubricate the heart as it contracts and expands. When too much fluid gathers in the pericardial cavity, the space between the pericardium and the outer layers of the heart, a condition known as pericardial effusion occurs. Abnormal amounts of fluid may result from:

- pericarditis, infection caused by inflammation of the pericardial sac
- trauma, such as an abnormal collection of blood due to an accident
- surgery or invasive heart procedures
- heart attack (myocardial infarction) or congestive heart failure, which occurs when the heart loses its pumping capability due to a heart condition
- kidney (renal) failure
- cancer (producing malignant effusions)

The rate of pericardial fluid accumulation is important. If fluid accumulation develops slowly, then problems with blood flow will not develop until fluid retention becomes massive. Blood can also enter the pericardial sac (hemopericardium) due to trauma, blood-thinning medications, or disease. When there is rapid or excessive build-up of fluid or blood in the pericardial cavity, the resulting compression on the heart impairs the pumping action of the vascular system (a condition called cardiac tamponade). Pericardiocentesis can be used in such an emergency situation to remove the excess accumulations of blood or fluid from the pericardial sac. For diagnostic purposes, pericardiocentesis may be advised in order to obtain fluid samples from the sac for laboratory analysis.

Prior to the discovery of **echocardiography**, pericardiocentesis was a risky procedure. The clinician had to insert a long needle below the breastbone into the pericardial sac without internal visualization. This blind approach was associated with damage to the lungs, coronary arteries, myocardium, and liver. However, with direct visualization using echocardiography, pericardiocentesis can now be performed with minor risk. Some risk is still associated with the procedure since it is considered an invasive measure.

### Demographics

Cardiac tamponade and pericarditis are two primary complications that require intervention with pericardiocentesis. Cardiac tamponade has an incidence of two in 10,000 the general U.S. population. Approximately 2% of cases are attributed to injuries that penetrate the chest. Pericarditis is more common in males than females, with a ratio of seven to three. In young adults, pericarditis is usually caused by HIV infection or a trauma injury. Malignancy or renal (kidney) failure are the main causes of this disorder in the elderly.

### Description

The patient should sit with the head elevated 30-40 degrees. This is done to maximize fluid drainage. A site close to the pericardial sac is chosen, and if time permits the patient is sedated. The puncture site is cleaned with an antiseptic iodine solution, and the area is shaved and anesthetized with lidocaine (a local anesthetic). A long cardiac needle is inserted under the xiphoid (the bottom of the breastbone) approach on the left side of the heart using guided imagery into the chest wall until the needle reaches the pericardial sac. Usually, the patient may experience a sensation of pressure when the tip of the needle penetrates the pericardial sac. When guided imagery confirms correct placement, fluid is aspirated from the sac.



## KEY TERMS

**Cardiac tamponade**—A condition caused by pericardial effusion, that seriously constrains cardiac contraction and access of blood to the heart.

**Echocardiography**—Sound waves that penetrate deep anatomical structures and generates a visual image on a monitor screen.

**Egobronchophony**—Increased intensity of the spoken voice.

**Hemodynamic**—Relating to the flow of blood through the circulatory system.

**Myocardial infarction**—A heart attack occurs when a coronary artery is blocked and blood flow to the blocked area is impaired.

**Parietal pericardium**—External or outer layer of the pericardial cavity.

**Pericardial friction rub**—A crackly, grating, low-pitched sound and is heard in both inspiration and expiration.

**Pulsus paradoxus**—A variation of the systolic pressure with respiration (diminished systolic pressure with inspiration and increased pressure with expiration).

**Tactile fremitus**—A tremor or vibration in any part of the body detected by palpation (palpation is when the clinician gently feels or presses with hands).

**Visceral pericardium**—Single layer of cells that lines both the internal surface of the heart with the parietal pericardium and the external surface of the heart.

If the procedure is performed for diagnostic purposes, aspirated fluid can be collected in specimen vials and sent for pathological analysis (i.e. for cancer cell detection in cases where malignant effusion is suspected), or the fluid is just removed if the procedure was performed urgently (i.e. cardiac tamponade). For therapeutic cases, a pericardial catheter may be attached and fixed into position to allow for continuous drainage. When the needle is removed, pressure is applied for five minutes at the puncture site to stop the bleeding, and the site is then bandaged.

### Diagnosis/Preparation

The typical symptom associated with patients requiring pericardiocentesis is chest pain, usually indicative of severe effusion. Patients with cardiac tamponade commonly have dyspnea (difficulty breathing)

and those with an infection may have fever. Some patients may have a hoarse voice from compression of a nerve called the recurrent laryngeal nerve; the pericardial sac may be so large that it pushes or compresses neighboring anatomical structures. Physical symptoms may vary, dependent both on size and the rate of filling of the pericardial effusion. Patients can also present with the following physical symptoms:

- tachycardia, an increased heart rate
- tachypnea, an increase in breathing rate
- jugular vein enlargement
- narrow pulse pressure (pulsus paradoxus)
- pericardial friction rub
- elevated central venous pressure
- hiccups from esophageal compression
- Ewart's sign (dull sound when the doctor taps the chest, tactile fremitus, egobronchophony)

The procedure can be performed in an emergency room, ICU, or at the bedside. Before the procedure patients should have an echocardiogram and basic blood analysis. No special dietary restrictions are required for pericardiocentesis. The patient will receive an IV line for sedation or other necessary medications and an **electrocardiogram** (ECG) to monitor cardiac activity. The patient must lie flat on the table, with the body elevated to a 60-degree angle. If the test is elective, then food and water restriction is recommended for six hours before the test. For infants and children, preparation depends on the child's age, level of trust, and previous exposure to this or similar procedures.

### Aftercare

The puncture site, or if a catheter is fixed in place, the catheter site, should be inspected regularly for signs of infection such as redness or swelling. **Vital signs** such as blood pressure and pulse are monitored following the procedure.

### Risks

Pericardiocentesis is an invasive procedure and therefore has associated risks. Complications are possible, but have become less common due to guided imaging techniques that improved the past blind approach. Possible risks include:

- puncture of the myocardium, the outer muscle layer of the heart
- puncture of a coronary artery, a blood vessel that supplies blood to heart muscle
- myocardial infarction (heart attack)

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A cardiologist who has received three years of training in internal medicine and three years of cardiology training typically performs the procedure. A general surgeon can also perform pericardiocentesis and typically have five years of surgical training. The procedure is performed in a hospital, either in the ER (emergency room), ICU (intensive care unit), or bedside.

- needle induced arrhythmias (irregular heartbeats)
- pneumopericardium, air entry into the pericardial sac
- infection of the pericardial membranes (pericarditis)
- accidental puncture of the stomach, lung, or liver

### Normal results

Normal pericardial fluid is clear to straw colored. During pathological examination normal pericardial fluid does not contain blood, cancer cells, or bacteria. In most individuals, a small amount of fluid (10–50 ml) is in the pericardial sac to cushion the heart. Pericardial fluid volumes over 50 ml suggest pericardial effusion. The presence of microorganisms (such as *Staphylococcus aureus*) in aspirated pericardial fluid indicates bacterial pericarditis. Blood in pericardial fluid can be seen in patients with cancer; cardiac rupture, which can occur with myocardial infarction (heart attack); or hemorrhage due to traumatic injury or accident.

### Morbidity and mortality rates

The success of pericardiocentesis has greatly improved with the use of guided imagery during the procedure. Only about 5% of patients will experience a major complication as a result of pericardiocentesis. Cardiac tamponade is fatal in almost all cases unless the excess fluid in the pulmonary sac is removed.

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## QUESTIONS TO ASK THE DOCTOR

- Where will the procedure take place?
- What type of anesthetic will be used?
- Will this procedure be used for diagnostic purposes?
- Who will be performing the procedure?

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## Peripheral endarterectomy

### Definition

A peripheral endarterectomy is the surgical removal of fatty deposits, called plaque, from the walls of arteries other than those of the heart and brain. The surgery is performed when plaque blocks an artery and obstructs the flow of blood and oxygen to other parts of the body, most commonly the legs but also the arms, kidneys, or intestines. The peripheral arteries most often treated with endarterectomy are those that supply the legs, especially the aortoiliac arteries in the pelvic area. Other arteries that may be treated with endarterectomy include the femoral arteries in the groin, the renal arteries that supply the kidneys, and the superior mesenteric arteries that supply the intestines.

### Purpose

Endarterectomy surgeries are performed to treat advanced peripheral arterial disease (PAD). PAD

most often occurs as a result of atherosclerosis, a condition characterized by the gradual build up of fats, cholesterol, cellular waste, calcium, and other substances on the inner walls of large and medium-sized arteries. Plaque, the hardened, waxy substance that results from this build up, can cause narrowing (stenosis) of an artery and block the flow of blood and oxygen. Peripheral endarterectomies are performed to reopen blocked arteries and to restore blood flow in the body (revascularization), helping to prevent heart attack, stroke, the **amputation** of a limb, organ failure, or **death**.

### Demographics

People who have been diagnosed with PAD caused by atherosclerosis are at high risk of arterial blockage (occlusion) and are candidates for peripheral endarterectomy. Occlusive arterial disease is found in 15 to 20% of men and women older than age 70. When found in people younger than 70, it occurs more often in men than in women, particularly in those who have ever smoked or who have diabetes. Women with PAD live longer than men with the same condition, which accounts for the equal incidence in older Americans. African-Americans have been shown to be at greater risk for arterial occlusion than other racial groups in the United States.

### Description

PAD is a progressive occlusive disease of the arteries, common in older people who have ever smoked or who have diabetes. Although there are other forms of arterial disease that affect peripheral arteries (Buerger's disease, Raynaud's disease, and acrocyanosis), PAD in most people is caused by widespread atherosclerosis, the accumulation of plaque on the inner lining (endothelium) of the artery walls. Most commonly, occlusive PAD develops in the legs, including the femoral arteries that supply the thighs with blood or in the common iliac arteries, which are branches of the lower abdominal aorta that also supply the legs. The arteries that supply the shoulders and arms are less commonly affected. Branches of the aorta that deliver blood to the kidneys, the infrarenal aorta and renal arteries, can become narrowed as a result of atherosclerosis, but are only rarely blocked suddenly and completely, a condition requiring immediate surgery. Even more rare is blockage of the branches that supply the liver and spleen.

The development of atherosclerosis and PAD is influenced by heredity and also by lifestyle factors,

## KEY TERMS

**Atheroma**—A collection of plaque (lesion) blocking a portion of an artery.

**Atherosclerosis (arteriosclerosis)**—A process of thickening and hardening of large and medium-sized arteries as a result of fatty deposits on their inner linings.

**Ischemia**—An inadequate blood supply (circulation) in an area of the body when arteries in the area are blocked.

**Peripheral arterial disease (PAD)**—An occlusive disease of the arteries most often caused by progressive atherosclerosis.

**Peripheral endarterectomy**—The surgical removal of fatty deposits, called plaque, from the walls of arteries other than those of the heart and brain.

**Plaque**—A collection of wax-like fatty deposits on the insides of artery walls.

**Restenosis**—The repeat narrowing of blood vessels that may occur after surgical removal of plaque when preventive measures are not taken.

**Revascularization**—Restoring normal blood flow (circulation) in the body's vascular (veins and arteries) system.

**Stenosis**—The narrowing of a blood vessel.

such as dietary habits and levels of **exercise**. The risk factors for atherosclerosis include:

- high levels of blood cholesterol and triglycerides
- high blood pressure
- cigarette smoking or exposure to tobacco smoke
- diabetes, types I and II
- obesity
- inactivity, lack of exercise
- family history of early cardiovascular disease

Just as coronary artery disease (CAD) can cause a heart attack when plaque blocks the arteries of the heart, or blockage in the carotid artery leading to the brain can cause a stroke, blockage of the peripheral arteries can create life-threatening conditions. When peripheral arteries have become narrowed by plaque accumulation (atheroma), the flow of oxygen-carrying blood to the arms, legs, or body organs will be interrupted, which can cause cell death from lack of oxygen (ischemia) and nutrition. Normal growth and cell repair cannot take place, which can lead to gangrene in the limbs and subsequent amputation. When blood

flow is blocked to internal organs, such as the kidneys or intestines, the result of tissue death can be the shut-down of the affected organ system and systemic (whole body) poisoning from waste accumulation. Death can result if **emergency surgery** is not performed to correct the blockage.

In some cases, the body will attempt to change the flow of blood when a portion of an artery is blocked by plaque. Smaller arteries around the blockage will begin to take some of the blood flow. This adaptation of the body (collateral circulation) is one reason for a lack of symptoms in some people who actually have PAD. Symptoms usually occur when the blockage is over 70% or when complete blockage occurs as a result of a piece of plaque breaking off and blocking the artery. Blockage in the legs, for example, will reduce or cut off circulation, causing painful cramping in the legs during walking (intermittent claudication) and pain in the feet during rest, especially during the night. When an artery gradually becomes narrowed by plaque, the symptoms are not as severe as when sudden, complete blockage occurs. Sudden blockage does not offer time for collateral vessels to develop and symptoms can be equally sudden and dramatic. Possible symptoms of reduced blood flow in the most typically affected arteries include:

- Arteries of the arms and legs: Gradual blockage creates muscle aches and pain, cramping, and sensations of tiredness or numbness; sudden blockage may cause severe pain, coldness and numbness. A leg or arm may become blue (cyanotic) from lack of oxygen. No pulse will be felt. Paralysis may occur.
- Lower aorta, femoral artery, and common iliac arteries: Gradual narrowing causes intermittent claudication affecting the buttocks and thighs. Men may become impotent. Sudden blockage will cause both legs to become painful, pale, and cold. No pulse will be felt. Legs may become numb. The feet may become painful, infected, or even gangrenous when gradual or complete blockage limits or cuts off circulation
- Renal arteries: Gradual narrowing may produce no symptoms and no change in kidney function. Sudden, complete blockage may cause sudden pain in the side and bloody urine. This is an emergency situation.
- Superior mesenteric artery: Gradual narrowing causes steady, severe pain in the middle of the abdomen about 30 to 60 minutes after a meal. Nutrients are lost and weight loss is common. Sudden, complete blockage causes severe abdominal pain, vomiting, and the urge to move the bowels. Blood pressure falls, intestinal gangrene may develop, and the patient may go into shock. This is an emergency situation.

Sudden, complete occlusion of an artery can also happen when a clot (thrombus) forms in an already narrowed artery. Clot formation (thrombosis) can occur anywhere in the body and travel to a narrowed portion of an affected artery and become lodged (embolism), blocking blood flow. Clots can sometimes be dissolved with anticoagulant drug therapy. When this therapy is not effective or a life-threatening blockage occurs suddenly, clots can be surgically removed using thromboendarterectomy, a procedure similar to peripheral endarterectomy.

Early treatment for PAD may include medical treatment to reduce the underlying causes: lowering cholesterol, lowering blood pressure, stopping smoking, increasing exercise, and reducing the likelihood of clot formation. Clot-dissolving drugs (thrombolytic drugs) may also be used to remove a clot medically rather than to perform surgery. When these measures are not effective, or an artery becomes completely blocked, peripheral endarterectomy may be performed to remove the blockage (see also **angioplasty** and **peripheral vascular bypass surgery**). Treatment of risk factors must continue, because surgery only corrects the immediate problem, not the underlying causes.

Peripheral endarterectomy works best in narrow areas like the leg where the artery can be easily accessed, or when there is complete blockage of an artery by an atheroma that is short in length. Endarterectomy does not work as well for smaller arteries lower in the leg or in the foot or arm. Drug therapy, **angiography**, stent placement, or surgical bypass may be used to treat blockages of the arteries in these areas.

Patients undergoing peripheral endarterectomy will typically be given **general anesthesia**. The surgery is an open surgical procedure in which a vascular surgeon makes a relatively large incision in the outer skin to access the obstructed artery being treated. In order to perform the surgery, the blood that normally flows through the artery must first be rerouted through a tube connecting the blood vessels below and above the surgical site. The surgeon will then cut the obstructed artery lengthwise and will use surgical tools to clean away the accumulation of plaque. The hard, waxy substance comes out fairly easily, sometimes in a single piece. The artery will then be sutured closed or patched with a piece of a vein, usually from the patient's leg, to enlarge the repaired artery and prevent later narrowing from post-operative scarring. The entire procedure will take about one hour if there are no complications.



## Diagnosis/Preparation

A complete patient history is essential to diagnosis, particularly information about family members who may have had diabetes or early cardiovascular disease. Symptoms will be important diagnostic indicators, letting the physician know what areas of the body may have reduced blood flow. Blood pressure will be taken in the arms and legs. Pulses will be measured in the arms, armpits, wrists, groin, ankles, and behind the knees. This will show where blockages may exist, since the pulse below a blockage is usually absent. Additionally, a **stethoscope** will be used to listen for abnormal sounds in the arteries that may indicate narrowing. Blood flow procedures may be performed, including:

- Doppler ultrasonography—direct measurement of blood flow and rates of flow, sometimes performed in conjunction with stress testing (exercise between tests).
- Angiography—an x-ray procedure that provides clear images of the affected arteries before surgery is performed.
- Blood tests—routine tests such as cholesterol and glucose, as well as tests to help identify other causes of narrowed arteries, such as inflammation, thoracic outlet syndrome, high homocysteine levels, or arteritis.
- Spiral computed tomography (CT angiography) or magnetic resonance angiography (MRI)—less invasive forms of angiography.

If ultrasonography or angiography procedures were not performed earlier to diagnose arterial blockage, these tests will be performed before surgery to evaluate the amount of plaque and the extent and exact location of narrowing. **Aspirin** therapy or other clot-prevention medication may be prescribed before surgery. Any underlying medical condition, such as high blood pressure, heart disease, or diabetes will be treated prior to peripheral endarterectomy to help get the best result from the surgery. Upon **admission to the hospital**, routine blood and urine tests will be performed.

## Aftercare

After the peripheral endarterectomy, the patient's blood pressure, temperature, and heart rate will be monitored in a hospital **recovery room** for an hour or more, and the surgical site will be checked regularly. The patient will then be transferred to a concentrated care unit to be observed for any sign of complications. The total hospital stay may be two to three days. When

the patient returns home, activities can be resumed gradually. Walking and strenuous activity may be restricted, especially if surgery was performed on the groin or leg. During recuperation, the patient may be given pain medication as needed and clot prevention (anticoagulant) medication. Patients will be advised to reduce the risk factors for atherosclerosis in order to avoid repeat narrowing or blockage of the arteries. Repeat stenosis (restenosis) has been shown to occur frequently in people who do not make the necessary changes in lifestyle, such as changes in diet, exercise, and quitting smoking. The benefits of the surgery may only be temporary if underlying disease, such as atherosclerosis, high blood pressure, or diabetes, is not also treated.

## Risks

The risks associated with peripheral endarterectomy primarily involve the underlying conditions that led to blockage of arteries in the first place. Embolism is the most serious postoperative risk; a clot or piece of tissue from the endarterectomy site that may travel to the heart, brain, or lungs can cause heart attack, stroke, or death. Restenosis, the continuing build-up of plaque, can occur within months to years after surgery if risk factors are not controlled. Other complications may include:

- reactions to anesthesia
- breathing difficulties
- changes in blood pressure
- nerve injury
- postoperative bleeding

## Normal results

The outcomes of peripheral endarterectomy as a treatment for arterial blockage are usually good. Blood flow can be restored quickly to relieve symptoms and help prevent heart attack, stroke, organ failure, or limb amputation.

## Morbidity and mortality rates

Morbidity and mortality depend upon the artery involved, the extent of the blockage, and the patient's overall condition, which directly influences response to the surgery. Time is also a factor. In cases of sudden and complete blockage of the mesenteric arteries, for example, only immediate surgery can save the person's life. Although death does not frequently occur during peripheral endarterectomy surgery, patients with widespread atherosclerosis and PAD have been shown to have increased morbidity and mortality associated with

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Peripheral endarterectomy is performed in a hospital operating room by a vascular surgeon.

coronary artery disease, because of the common risk factors, such as cigarette smoking, high blood pressure, and diabetes. PAD patients with diabetes are shown to represent 50% of all amputations. However, only a small percentage of patients undergoing peripheral endarterectomy will suffer limb loss or associated disability and reduced quality of life.

### Alternatives

Peripheral endarterectomy removes plaque directly from blocked arteries; there is no alternative way to mechanically remove plaque. However, there are alternative ways to prevent plaque build-up and reduce the risk of narrowing or blocking the peripheral arteries. Certain vitamin deficiencies in older people, for example, are known to promote high levels of homocysteine, an amino acid that contributes to atherosclerosis and a higher risk for PAD. Some nutritional supplements and alternative therapies that are recommended to help promote good vascular health include:

- Folic acid can help lower homocysteine levels and increase the oxygen-carrying capacity of red blood cells.
- Vitamins B<sub>6</sub> and B<sub>12</sub> help lower homocysteine levels.
- Antioxidant vitamins C and E work together to promote healthy blood vessels and improve circulation.
- Angelica, an herb that contains Coumadin, a recognized anticoagulant, may help prevent clot formation in the blood.
- Essential fatty acids, as found in flax seed and other oils, can help reduce blood pressure and cholesterol, and maintain elasticity of blood vessels.
- Chelation therapy may be used to break up plaque and improve circulation.

### Resources

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## QUESTIONS TO ASK THE DOCTOR

- Why do I need this surgery?
- How will the surgery improve my condition?
- What kind of anesthesia will I be given?
- What are the risks of having this surgery?
- How many of these procedures have you performed? How many of the surgery patients had complications after surgery?
- How can I expect to feel after surgery? How long will it take me to recover?
- What are my chances of developing this problem again after the surgery?
- What can I do to help prevent developing this condition again?

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L. Lee Culvert

## Peripheral vascular bypass surgery

### Definition

A peripheral vascular bypass, also called a lower extremity bypass, is the surgical rerouting of blood flow around an obstructed artery that supplies blood to the legs and feet. This surgery is performed when the build-up of fatty deposits (plaque) in an artery has

blocked the normal flow of blood that carries oxygen and nutrients to the lower extremities. Bypass surgery reroutes blood from above the obstructed portion of an artery to another vessel below the obstruction.

A bypass surgery is named for the artery that will be bypassed and the arteries that will receive the rerouted blood. The three common peripheral vascular bypass surgeries are:

- Aortobifemoral bypass surgery, which reroutes blood from the abdominal aorta to the two femoral arteries in the groin.
- Femoropopliteal bypass (fem-pop bypass) surgery, which reroutes blood from the femoral artery to the popliteal arteries above or below the knee.
- Femorotibial bypass surgery, which reroutes blood between the femoral artery and the tibial artery.

A substitute vessel or graft must be used in bypass surgeries to reroute the blood. The graft may be a healthy segment of the patient's own saphenous vein (autogenous graft), a vein that runs the entire length of the thigh. A synthetic graft may be used if the patient's saphenous vein is not healthy or long enough, or if the vessel to be bypassed is a larger artery that cannot be replaced by a smaller vein.

### Purpose

Peripheral vascular bypass surgery is performed to restore blood flow (revascularization) in the veins and arteries of people who have peripheral arterial disease (PAD), a form of peripheral vascular disease (PVD). People with PAD develop widespread hardening and narrowing of the arteries (atherosclerosis) from the gradual build-up of plaque. In advanced PAD, plaque accumulations (atheromas) obstruct arteries in the lower abdomen, groin, and legs, blocking the flow of blood, oxygen, and nutrients to the lower extremities (legs and feet). Rerouting blood flow around the blockage is one way to restore circulation. It relieves symptoms in the legs and feet, and helps avoid serious consequences such as heart attack, stroke, limb **amputation**, or **death**.

### Demographics

Approximately 8–8 million people in the United States have PAD caused by atherosclerosis. These people are at high risk of arterial occlusion, and are candidates for peripheral vascular bypass surgery. Occlusive arterial disease is found in 12–20% of men and women older than age 65. In people younger than age 70, it occurs more often in men than women, particularly in those who have ever smoked or who

## KEY TERMS

**Atheroma**—An accumulation of plaque blocking a portion of an artery.

**Atherosclerosis (arteriosclerosis)**—Process of thickening and hardening of large- and medium-sized arteries as a result of fatty deposits on their inner linings.

**Intermittent claudication**—Pain that occurs on walking and is relieved on rest.

**Ischemia**—An inadequate blood supply (circulation) in a part of the body where arteries are blocked.

**Peripheral arterial disease (PAD)**—An occlusive disease of the arteries most often caused by progressive atherosclerosis.

**Peripheral arteries**—Arteries other than those of the heart and brain, especially those that supply the lower body organs and limbs.

**Plaque**—A collection of wax-like fatty deposits on the insides of artery walls.

**Restenosis**—The repeat narrowing of blood vessels that may occur after surgical removal of plaque when preventive measures are not taken.

**Revascularization**—Restoring normal blood flow (circulation) in the body's vascular (veins and arteries) system.

**Stenosis**—Narrowing of a blood vessel.

have diabetes. Women with PAD live longer than men with the same condition, accounting for the equal incidence in older Americans. African-Americans are at greater risk for arterial occlusion than other racial groups in the United States.

### Description

The circulatory system delivers blood, oxygen, and vital nutrients to the limbs, organs, and tissues throughout the body. This is accomplished via arteries that deliver oxygen-rich blood from the heart to the tissues and veins that return oxygen-poor blood from organs and tissues back to the heart and lungs for re-oxygenation. In PAD, the gradual accumulation of plaque in the inner lining (endothelium) of the artery walls results in widespread atherosclerosis that can occlude the arteries and reduce or cut off the supply of blood, oxygen, and nutrients to organ systems or limbs.

Peripheral vascular bypass surgery is a treatment option when PAD affects the legs and feet. PAD is similar to coronary artery disease (CAD), which leads to heart attacks and carotid artery disease (CAD), which causes stroke. Atherosclerosis causes each of these diseases. Most often, atherosclerotic blockage or narrowing (stenosis) occurs in the femoral arteries that supply the thighs with blood or in the common iliac arteries, which are branches of the lower abdominal aorta that also supplies the legs. The popliteal arteries (a portion of the femoral arteries near the surface of the legs) or the posterior tibial and peroneal arteries below the knee (portions of the popliteal artery) can be affected.

Just as coronary artery disease can cause a heart attack when plaque blocks the arteries of the heart, or blockage in the carotid artery leading to the brain can cause a stroke, occlusion of the peripheral arteries can create life-threatening conditions. Plaque accumulation in the peripheral arteries blocks the flow of oxygen-carrying blood, causing cells and tissue in the legs and feet to die from lack of oxygen (ischemia) and nutrition. Normal growth and cell repair cannot take place, which can lead to gangrene in the limbs and subsequent amputation. If pieces of the plaque break off, they can travel from the legs to the heart or brain, causing heart attack, stroke, or death.

The development of atherosclerosis and PAD is influenced by heredity and also by lifestyle factors, such as dietary habits and levels of **exercise**. The risk factors for atherosclerosis include:

- high levels of blood cholesterol and triglycerides.
- high blood pressure (hypertension)
- cigarette smoking or exposure to tobacco smoke
- diabetes, types 1 and 2
- obesity
- inactivity, lack of exercise
- family history of early cardiovascular disease

Sometimes the body will attempt to change the flow of blood when a portion of an artery is narrowed by plaque. Smaller arteries around the blockage begin to take over some of the blood flow. This adaptation of the body (collateral circulation) is one reason for the absence of symptoms in some people who have PAD. Another reason is that plaque develops gradually as people age. Symptoms usually don't occur until a blockage is over 70%, or when a piece of plaque breaks off and blocks an artery completely. Blockage in the legs reduces or cuts off circulation, causing painful cramping during walking, which is relieved

on rest (intermittent claudication). The feet may ache even when lying down at night.

When narrowing of an artery occurs gradually, symptoms are not as severe as they are when sudden, complete blockage occurs. Sudden blockage does not allow time for collateral vessels to develop, and symptoms can be severe. Gradual blockage creates muscle aches and pain, cramping, and sensations of fatigue or numbness in the limbs; sudden blockage may cause severe pain, coldness, and numbness. At times, no pulse can be felt, a leg may become blue (cyanotic) from lack of oxygen, or paralysis may occur.

When the lower aorta, femoral artery, and common iliac arteries (all in the lower abdominal and groin areas) are blocked, gradual narrowing may produce cramping pain and numbness in the buttocks and thighs, and men may become impotent. Sudden blockage will cause both legs to become painful, pale, cold, and numb, with no pulse. The feet may become painful, infected, or even gangrenous when gradual or complete blockage limits or cuts off circulation. Feet may become purple or red, a condition called rubor that indicates severe narrowing. Pain in the feet or legs during rest is viewed as an indication for bypass surgery because circulation is reduced to a degree that threatens survival of the limb.

Early treatment for PAD usually includes medical intervention to reduce the causes of atherosclerosis, such as lowering cholesterol and blood pressure, **smoking cessation**, and reducing the likelihood of clot formation. When these measures are not effective, or an artery becomes completely blocked, lower extremity bypass surgery may be performed to restore circulation, reduce foot and leg symptoms, and prevent limb amputation.

Bypass surgery is an open procedure that requires **general anesthesia**. In femoropopliteal bypass or femorotibial bypass, the surgeon makes an incision in the groin and thigh to expose the affected artery above the blockage, and another incision (behind the knee for the popliteal artery, for example) to expose the artery below the blockage. The arteries are blocked off with vascular clamps. If an autogenous graft is used, the surgeon passes a dissected (cut and removed) segment of the saphenous vein along the artery that is being bypassed. If the saphenous vein is not long enough or is not of good quality, a tubular graft of synthetic (prosthetic) material is used. The surgeon sutures the graft into an opening in the side of one artery and then into the side of the other. In a femoropopliteal bypass, for example, the graft extends from the femoral artery to the popliteal artery. The clamps are then removed



and the flow of blood is observed to make sure it bypasses the blocked portion of the affected artery.

Aortobifemoral bypass surgery is conducted in much the same way, although it requires an abdominal incision to access the lower portion of the abdominal aorta and both femoral arteries in the groin. This is generally a longer and more difficult procedure. Synthetic grafts are used because the lower abdominal aorta is a large conduit, and its blood flow cannot be handled by the smaller saphenous vein. Vascular surgeons prefer the saphenous vein graft for femoropopliteal or femorotibial bypass surgery because it has proven to stay open and provide better performance for a longer period of time than synthetic grafts. Bypass surgery patients will be given heparin, a blood thinner, immediately after the surgery to prevent clotting in the new bypass graft.

## Diagnosis/Preparation

### Diagnosis

After obtaining a detailed history and reviewing symptoms, the physician examines the legs and feet, and orders appropriate tests or procedures to evaluate the vascular system. Diagnostic tests and procedures may include:

- Blood pressure and pulses—pressure measurements are taken in the arms and legs. Pulses are measured in the arms, armpits, wrists, groin, ankles, and behind the knees to determine where blockages may exist, since no pulse is usually felt below a blockage.
- Doppler ultrasonography—direct measurement of blood flow and rates of flow, sometimes performed in conjunction with stress testing (tests that incorporate an exercise component).
- Angiography—an x-ray procedure that provides clear images of the affected arteries before surgery is performed.
- Blood tests—routine tests such as cholesterol and glucose, as well as tests to help identify other causes of narrowed arteries, such as inflammation, thoracic outlet syndrome, high homocysteine levels, or arteritis.
- Spiral computed tomography (CT angiography) or magnetic resonance angiography (MRA)—less invasive forms of angiography.

### Preparation

If not done earlier in the diagnostic process, ultrasonography or **angiography** procedures may be performed when the patient is admitted to the hospital. These tests help the physician evaluate the amount of

plaque and exact location of the narrowing or obstruction. Any underlying medical condition, such as high blood pressure, heart disease, or diabetes is treated prior to bypass surgery to help obtain the best surgical result. Regular medications, such as blood pressure drugs or **diuretics**, may be discontinued in some patients. Routine pre-operative blood and urine tests are performed when the patient is admitted to the hospital.

## Aftercare

After bypass surgery, the patient is moved to a recovery area where blood pressure, temperature, and heart rate are monitored for an hour or more. The surgical site is checked regularly. The patient is then transferred to a concentrated care unit to be observed for any signs of complications. The total hospital stay for femoropopliteal bypass or femorotibial bypass surgery may be two to four days. Recovery is slower with aortobifemoral bypass surgery, which involves abdominal incisions, and the hospital stay may extend up to a week. Walking will begin immediately for patients who have had femoropopliteal or femorotibial bypasses, but patients who have had aortobifemoral bypass may be kept in bed for 48 hours. When bypass patients go home, walking more each day, as tolerated, is encouraged to help maintain blood flow and muscle strength. Feet and legs can be elevated on a footstool or pillow when the patient rests. Some swelling of the leg should be expected; it does not indicate a problem and will resolve within a month or two.

During recuperation, the patient may be given pain medication if needed, and clot prevention (anti-coagulant) medication. Any redness of the surgical site or other signs of infection will be treated with **antibiotics**. Patients are advised to reduce the risk factors for atherosclerosis in order to avoid repeat narrowing or blockage of the arteries. Repeat stenosis (restenosis) has been shown to occur frequently in people who do not make the necessary lifestyle modifications, such as changes in diet, exercise, and smoking cessation. The benefits of the bypass surgery may only be temporary if underlying disease, such as atherosclerosis, high blood pressure, or diabetes, is not also treated.

## Risks

The risks associated with peripheral vascular bypass surgery are related to the progressive atherosclerosis that led to arterial occlusion, including a return of pre-operative symptoms. In patients with advanced PAD, heart attack or heart failure may occur. Build up of plaque has also taken place in the

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Peripheral vascular bypass surgery is performed by a vascular surgeon in a hospital operating room.

patient's arteries of the heart. Restenosis, the continuing build up of plaque, can occur within months to years after surgery if risk factors are not controlled. Other complications may include:

- clot formation in a saphenous vein graft
- failed grafts or blockages in grafts
- reactions to anesthesia
- breathing difficulties
- embolism (clot from the surgical site traveling to vessels in the heart, lungs, or brain)
- changes in blood pressure
- infection of the surgical wound
- nerve injury (including sexual function impairment after aortobifemoral bypass)
- postoperative bleeding
- failure to heal properly

### Normal results

A femoropopliteal or femorotibial bypass with an autogenous graft of good quality saphenous vein has been shown to have a 60–70% chance of staying open and functioning well for five to 10 years. Aortobifemoral bypass grafts have been shown to stay open and reduce symptoms in 80% of patients for up to 10 years. Pain and walking difficulties should be relieved after bypass surgery. Success rates improve when the underlying causes of atherosclerosis are monitored and managed effectively.

### Morbidity and mortality rates

The risk of death or heart attack is about 3–5% in all patients undergoing peripheral vascular bypass surgery. Following bypass surgery, amputation is still an outcome in about 40% of all surgeries performed, usually due to progressive atherosclerosis or complications caused by the patient's underlying disease condition.

## QUESTIONS TO ASK THE DOCTOR

- Why is this surgery necessary?
- How will the surgery improve my condition?
- What kind of anesthesia will be given?
- How many of these procedures has the surgeon performed?
- How many surgical patients had complications after the procedure?
- How can the patient expect to feel after surgery?
- How soon will the patient be able to walk?
- How long will it take to recover completely?
- What are the chances of this problem recurring after surgery?
- What can be done to help prevent this problem from developing again?

### Alternatives

Peripheral vascular bypass surgery is a mechanical way to reroute blood, and there is no alternative method. Alternative ways to prevent plaque build-up and reduce the risk of narrowing or blocking the peripheral arteries include nutritional supplements and alternative therapies, such as:

- Folic acid can help lower homocysteine levels and increase the oxygen-carrying capacity of red blood cells.
- Vitamins B<sub>6</sub> and B<sub>12</sub> help lower homocysteine levels.
- Antioxidant vitamins C and E work together to promote healthy blood vessels and improve circulation.
- Angelica, an herb that contains Coumadin, a recognized anticoagulant, which may help prevent clot formation in the blood.
- Essential fatty acids, as found in flax seed and other oils, to help reduce blood pressure and cholesterol, and maintain blood vessel elasticity.
- Chelation therapy, used to break up plaque and improve circulation.

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- American Heart Association (AHA). 7272 Greenville Ave., Dallas, TX 75231. (800) 242 8721. [www.americanheart.org](http://www.americanheart.org).
- Vascular Disease Foundation. 3333 South Wadsworth Blvd. B104 37, Lakewood, CO 80227. (303) 949 8337 or (866) PADINFO (723 4636). [www.vdf.org](http://www.vdf.org).

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L. Lee Culvert

Peritoneal dialysis see **Kidney dialysis**

Peritoneal fluid analysis see **Paracentesis**

## Peritoneovenous shunt

### Definition

A peritoneovenous shunt refers to the surgical insertion of a shunting tube to achieve the continuous emptying of ascitic fluid into the venous system.

### Purpose

Ascites is a serious medical disorder characterized by the pathological accumulation of fluid in the peritoneal cavity, the smooth membrane that lines the cavity of the abdomen and surrounds the organs. Ascites is usually related to acute and chronic liver disease (cirrhosis) and to a lesser degree, to malignant tumors arising in the ovary, colon, or breast. Ascites may also be associated with chronic kidney disease and congestive heart failure. The formation of ascitic fluid results from the interplay of three factors: abnormally high pressure within the liver or the veins draining into the liver (portal hypertension); abnormally low amounts of albumin in the blood (hypoalbuminemia); and changes in sodium and water excretion by the kidneys.

When medical therapy fails, peritoneovenous shunts help manage chronic ascites.

### Demographics

Cirrhosis is the seventh leading cause of **death** by disease in the United States, killing over 25,000 people each year. Fifty percent of patients with cirrhosis will develop ascites over a period of 10 years. Cirrhosis—regardless of its cause—greatly increases the risk for liver cancer. Few studies have been conducted on the risk for liver cancer in patients with primary biliary cirrhosis; however, one study reported an incidence of 2.3%. Approximately 4% of patients with cirrhosis caused by hepatitis C develop liver cancer. In Asia, about 15% of people who have chronic hepatitis B develop liver cancer, but this high rate is not seen in other parts of the world. One Italian study that followed a group of hepatitis B patients for 11 years found no liver cancer over that period of time.

### Description

A variety of shunts have been designed for peritoneovenous shunting, including the Hyde shunt (1966-1974), LaVeen shunt (1974-1980), and Denver shunt. The latter predates the LaVeen shunt, but is more popular as of 2003. All designs work about equally well.

For the peritoneovenous shunt insertion procedure, the patient only requires a local anesthetic and a sedative. A long needle is inserted into the jugular vein in the neck, and is passed down through the superior vena cava, the large vein that delivers blood from the head, neck, and upper limbs back to the heart. This serves to widen the vein. The surgeon makes an incision and inserts a tube traversing the subcutaneous tissue of the chest wall. The tube connects the peritoneal cavity to the neck, where it enters the widened jugular vein. There the surgeon attaches a pressure-sensitive, one-way valve to prevent backflow.

### Diagnosis/Preparation

Ascites may go unnoticed for quite some time until the patient notices a slight increase in waistline. Severe ascites with marked abdominal distension becomes very disabling, especially when associated with swelling of the legs, pleural effusions (fluid around the lungs), and shortness of breath.

Diagnosis can be established by examination of the ascitic fluid, which allows the physician to differentiate between cirrhosis and tumor-induced ascites. The fluid is taken from the peritoneal cavity in a procedure called a **paracentesis**. Ascitic fluid analysis

## KEY TERMS

**Ascites**—An effusion and accumulation of serous fluid in the abdominal cavity.

**Ascitic fluid**—The fluid that accumulates in the peritoneal cavity in ascites.

**Coagulopathy**—A defect in the blood clotting mechanism.

**Edema**—The presence of abnormally large amounts of fluid in the intercellular tissue spaces of the body.

**Inferior vena cava**—Large vein that returns blood from the lower part of the body to the heart.

**Jugular vein**—Major vein of the neck that returns blood from the head to the heart.

**Hypoalbuminemia** —An abnormally low concentration of albumin in the blood.

**Paracentesis**—Surgical puncture of the abdominal cavity for the aspiration of peritoneal fluid.

**Peritoneal cavity**—The space enclosed by the peritoneum.

**Peritoneum**—The smooth membrane that lines the cavity of the abdomen, and surrounds the viscera, forming a closed sac.

**Portal hypertension**—Abnormally high pressure within the veins draining into the liver.

**Subcutaneous**—Beneath the skin.

**Superior vena cava**—Large vein that returns blood to the heart from the head, neck, and upper limbs.

**Venous system**—Circulation system that carries blood that has passed through the capillaries of various tissues, except the lungs, and is found in the veins, the right chambers of the heart, and the pulmonary arteries; it is usually dark red as a result of a lower oxygen content.

includes a total polymorph count, protein and albumin concentrations, and placement of at least 10 ml of ascitic fluid each into **blood culture** bottles for processing. If a measurement called the serum-ascitic fluid albumin gradient is greater than 11 g/L, cirrhosis, not cancer, is suspected.

## Aftercare

After surgery, the patient's **vital signs** are monitored in a **recovery room**. Pain medication and **antibiotics** are administered as needed. Once released from the hospital, the patient is expected to abstain

from alcohol, and follow a low-salt diet and medication regime designed to control ascites.

Patients also require training in shunt maintenance. To keep the fluid moving out of the abdomen, the shunt has to be properly pumped on a daily basis. Twice a day—once at bedtime and again prior to rising in the morning—the shunt is pumped about 20 times. This is essential to limit the accumulation of fibrin and other debris within the shunt, and to avoid the formation of an occlusive fibrin sheath at the venous tip.

## Risks

Complications following peritoneovenous shunt insertion are common and include infection, leakage of ascitic fluid, accumulation of abnormally large amounts of fluid in the intercellular tissue spaces of the body (edema), deregulation of the blood clotting mechanism (coagulopathy), and shunt blockage. Clogging of the shunt with debris is the most common complication. Some patients develop further complications from the ascitic fluid entering directly into their bloodstream. Scar tissue often develops, making future liver transplants difficult.

## Normal results

In spite of the complications associated with the procedure, many patients obtain useful relief from ascites following peritoneovenous shunt insertion.

## Morbidity and mortality rates

The most recent guidelines from the American Association for the Study of Liver Diseases recommend peritoneovenous shunting only under these conditions:

- Patient is diuretic-resistant and not a transplant candidate.
- Patient is not a candidate for serial therapeutic paracentesis because of multiple abdominal surgical scars.
- A physician is unavailable to perform serial paracentesis.

Cirrhosis is irreversible, but the rate of progression can be very slow depending on its cause and other factors. Five-year survival rates are about 85% in the United States and can be lower or higher depending on severity.

## Alternatives

Alternative treatments for ascites include:

- Diuretics. Diuretics are medications that promote the excretion of urine and help eliminate excess fluids. The treatment of ascites always involves restricting dietary



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Peritoneovenous shunt insertion is performed in a hospital by a surgeon specialized in gastroenterology or hepatology.

- salt and taking diuretic pills to increase the output of salt in the urine. This treatment is effective, at least in the short-term, in 90% of patients.
- Repeated large-volume paracentesis. This approach, also called serial paracentesis, features repeated surgical puncture of the abdominal cavity and aspiration of the ascitic fluid.
  - Transjugular portosystemic shunt. A shunting procedure designed to relieve portal hypertension.
  - Portocaval shunt. Another shunting procedure designed to relieve portal hypertension.
  - Liver transplantation. Replacement of the patient's liver by one obtained from a donor. Liver transplantation is the only definitive treatment for ascites, and the only treatment that has been clearly shown to improve survival.

There is no satisfactory treatment for refractory ascites in patients with cirrhosis. Both peritoneovenous shunts and paracentesis have been used, but there is uncertainty about their relative merits.

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## QUESTIONS TO ASK THE DOCTOR

- Is there any other treatment available for ascites?
- What are the risks associated with peritoneovenous shunting?
- How long will it take to recover from the surgery?
- How does the shunting mechanism work?
- How many peritoneovenous shunt procedures does the surgeon perform each year?
- Will further surgery be required?
- What happens if the shunt becomes blocked?

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### ORGANIZATIONS

American Gastroenterological Association. 4930 Del Ray Avenue, Bethesda, MD 20814. (301) 654-2055. [www.gastro.org](http://www.gastro.org).

Society for Vascular Surgery. 900 Cummings Center, Beverly, MA 01915-1314. (978) 927-8330. [svs.vascularweb.org](http://svs.vascularweb.org).

### OTHER

"Ascites." *Family Practice Notebook*. [www.fpnotebook.com/GI35.htm](http://www.fpnotebook.com/GI35.htm).

Monique Laberge, Ph.D.

Permanent pacemakers see **Pacemakers**  
PET scan see **Positron emission tomography (PET)**

## pH monitoring

### Definition

pH is a value that represents the balance of acidic and alkaline molecules in a given system. The human body requires a very precise balance between these in order to properly maintain homeostasis. Homeostasis, or physiological equilibrium, is the maintenance of stable conditions for bodily function. pH monitoring is the practice of keeping track of where the pH value

lies in order to quickly diagnose and treat disorders that alter pH.

### Description

pH monitoring is done to guard against physiological states in which the amount of acidic or alkaline molecules in the body is out of balance. Another term for acidic and alkaline is “acid and base”. Acid is represented in the body as hydrogen ions. Base is represented in the body as hydroxide ions. Too much of either one can cause serious physical harm. A pH scale is designed with the number seven falling in the middle, defined as neutral. At a pH of seven the amount of acid and base present lies in balance. Any pH greater than seven is considered more alkaline or basic. Any pH less than seven is considered more acidic. Each area of the body has its own normal range for pH. Human blood normally lies between a pH of 7.34 to 7.45. Human stomach acid normally lies between a pH of 1.5 to 2.0. Human urine normally has a pH of approximately 6.0.

A physiological state where the blood is too acidic with a low pH is called acidosis. Acidosis is caused by an imbalance in hydrogen ions present in the blood, causing the pH to fall below 7.35. On the other side of the scale, alkalosis is a physiological state where the blood pH value rises above 7.45 due an imbalance in hydroxide, and becomes too basic. The farther the pH is altered from the normal range, the more serious the patient’s condition. Even relatively small changes in blood pH can be life threatening. Blood pH values generally considered compatible with mammalian life lie between a pH of 6.8 to 7.8. For this reason, the body uses blood as a buffering system to maintain pH balance. Certain states of disease, disorders, or physical conditions sometimes overwhelm the body’s buffering systems and medical assistance becomes necessary to maintain life. In these cases, pH monitoring is a critical tool in guarding against or treating drastic alterations in body chemistry.

### Monitoring pH for Acidosis

Acidosis is physiological state of excessive acid in the blood. Acidosis can be caused by an increase in acid, or simply a decrease of base, causing what is known as metabolic acidosis. Acidosis can also be caused by abnormal respiratory function. Taking in too much carbon dioxide or too little oxygen through the lungs leads to increased amounts of carbon dioxide in the blood. Carbon dioxide in the blood is changed into multiple components, resulting in the release of hydrogen ions, causing acidosis. The type of acidosis originally caused by carbon dioxide and respiratory functioning is known as respiratory acidosis.

If an increase in acid or decrease in base occurs beyond the body’s pH buffering capabilities, there are other compensatory mechanisms to restore equilibrium in pH. In response to a drop in blood pH, the brain causes a change in respiration for fast, deep breathing. This type of breathing causes an increased amount of carbon dioxide to be exhaled, drawing more and more carbon dioxide from the blood. The more carbon dioxide leaves the blood, the more hydrogen ions are removed, helping to correct acidosis. Additionally, the kidneys may increase excretion of hydrogen ions or decrease excretion of hydroxide ions in the urine. Even with these compensatory mechanisms, a severe state of acidosis often requires medical attention to correct, with pH monitoring as a critical tool for health management. Without proper medical attention the acidotic patient may experience nausea, vomiting, fatigue, confusion, weakness, shock, coma, or **death**. The treatment of acidosis is dependent on the cause of the disorder.

### Conditions that Potentially Cause Acidosis and May Require pH Monitoring

- Ingestion of Wood Alcohol or Antifreeze (excessive acid)
- Aspirin Overdose (excessive acid)
- Poorly Controlled Diabetes (excessive acid)
- Kidney Dysfunction or Failure (cannot excrete acid normally)
- Lung Dysfunction (cannot expel carbon dioxide normally; e.g., severe pneumonia, emphysema, or asthma)
- Drugs that Disrupt Respiration (cannot expel carbon dioxide normally; e.g., narcotic pain-killer overdose)
- Ingestion of Acidic Poisons (excessive acid)
- Extreme Diarrhea (expel excessive base)

### Monitoring pH for Alkalosis

Alkalosis is a physiological state of excessive base in the blood. Alkalosis can be caused by an increase in base, or a decrease of acid, causing what is known as metabolic alkalosis. Alkalosis can also be caused by abnormal respiratory function. Exhaling too much carbon dioxide leads to a decrease in carbon dioxide in the blood. A decrease in carbon dioxide in the blood leads to a decrease in hydrogen ions and a relative excess of hydroxide ions. This type of alkalosis is known as respiratory alkalosis. Respiratory alkalosis can be induced by hyperventilation, a type of breathing that is very rapid and deep and leads to expulsion of large amounts of carbon dioxide.

## KEY TERMS

**Acidosis**—A pathological state in which there is a relative excess of hydrogen ions in the arterial blood.

**Alkaline**—A basic substance with pH above 7.0.

**Alkalosis**—A pathological state in which there is a relative excess of hydroxide ions in the arterial blood.

**Anxiety Attack**—A disorder in which sudden feelings of dread, fear, and apprehension of danger enter a person's mind in an overwhelming manner. Attacks may lead to a state of hyperventilation.

**Arterial Blood**—Blood from the arteries, the blood vessels that carry oxygen from the lungs to supply the body tissues.

**Arterial Blood Gas (ABG)**—A type of blood laboratory test done to check the blood for imbalances in pH or gases that affect pH.

**Asthma**—An inflammatory respiratory disorder in which the airway becomes obstructed and breathing is difficult.

**Coronary Artery Bypass Surgery**—A surgical procedure where arteries or veins from elsewhere in the patient's body grafted into the arteries of the heart as a way to bypass damaged or narrowed heart blood vessels. Heart blood vessels may have been damaged or narrowed from fat deposition and need to be bypassed to increase the blood supply and oxygen delivered to the heart.

**Corticosteroid**—A type of drug used to treat inflammatory conditions that also alters blood ions and affects pH.

**Diuretic**—A type of drug used to treat hypertension that also alters blood ions and affects pH.

**Electrode**—A device used to record an electric circuit or changes in ion concentrations.

**Emphysema**—Lung disease that causes damage to lung tissue and breathlessness.

**Heart Lung Machine**—A machine that temporarily takes over the function of the heart and lungs during surgical procedures in order to maintaining blood circulation and delivery of oxygen to body tissues while the heart is being operated on.

**Heart Valve Replacement Surgery**—Surgery performed to repair or replace the valves in the heart that control blood flow through the heart and are responsible for the audible heartbeat.

**Homeostasis**—The process of maintaining balance in the normal vital life functions of a living organism.

**Hydrogen Ions**—Ions that contain one hydrogen atom with a positive charge. Hydrogen ions cause blood to be acidic.

**Hydroxide Ions**—Ions that contain one oxygen and one hydrogen atom, with a negative charge. Hydroxide ions cause blood to be alkaline.

**Ischemia**—A state of decreased oxygen, where body tissues may experience damage due to oxygen deprivation.

**Narcotic Pain Killer**—A type of pain killer often used after surgical procedures that may alter blood pH.

**Physiological**—Pertaining to the normal vital life functions of a living organism.

**Pneumonia**—An inflammatory lung disease that affects the ability of the respiratory system to function.

**Radial Artery**—An artery present in the wrist that is convenient for drawing blood intended for laboratory testing.

**Respiratory Function**—The ability of the breathing structures of the body, including the lungs, to function.

**Venous Blood**—Blood that carries carbon dioxide from the tissues to the heart and then the lungs to be oxygenated.

If an increase in base or decrease in acid occurs beyond the body's pH buffering capabilities, compensatory mechanisms to restore equilibrium in pH include a change in respiration for slow, shallow breathing. This type of breathing causes a decreased amount of carbon dioxide to be exhaled, thereby increasing the amount of carbon dioxide and hydrogen ions in the blood. Additionally, the kidneys may increase excretion of hydroxide ions or decrease excretion of hydrogen ions in the urine. Similar to acidosis,

a severe state of alkalosis often requires medical attention to correct, with pH monitoring as a critical tool for health management. Without proper medical attention the patient may experience irritability, muscle cramping, muscle spasms, seizures, delirium, and death. The treatment of alkalosis is dependent on the cause of the disorder.

Conditions that Potentially Cause Alkalosis and May Require pH Monitoring

- Prolonged Vomiting (loss of excessive acid)
- Ingestion of Alkaline Poisons (excessive base)
- Drugs that Cause Excessive Loss of Sodium or Potassium Ions (e.g., diuretics and corticosteroids)
- Severe Anxiety Attacks (hyperventilation)
- Pain and Fever (hyperventilation)
- Aspirin Overdose (Aspirin can cause both acidosis and alkalosis)

### How pH is Monitored

pH is monitored through laboratory tests done on the blood drawn from an artery. Arterial blood is an accurate indicator of blood pH. Venous blood holds too much carbon dioxide taken from the tissues to be useful. Blood is usually taken from the radial artery located in the wrist. The blood is tested for pH, as well as levels of carbon dioxide and other pertinent blood components. The laboratory test is known as Arterial Blood Gas (**ABG**). It is very important that room air is not accidentally introduced into the sample of blood drawn, as the oxygen present would make the blood unsuitable for testing. If the patient's condition warrants it, the ABG test may be done several times a day.

### pH Monitoring during Heart Surgery

Some types of heart surgery involve temporarily depriving parts of the heart of its blood supply during the procedure (while the patient is on a heart lung machine to maintain bodily function). Local blood deprivation results in decreased heart tissue oxygen (a condition called ischemia), increased tissue carbon dioxide levels, heart tissue acidosis, and possibly death of heart tissue. The level to which this actually occurs during the procedure varies from person to person. The severity of tissue acidosis has been shown to directly associate with the degree of ischemia that tissue is experiencing and consequent impact on long-term survival of the surgery patient.

Specific low pH values during different points in the surgical procedure have been identified as dangerous levels of acidosis. Allowing the heart tissue to fall below these values may be associated with post-operative heart failure and mortality. Purposefully raising the pH levels before these specific points in the procedure, prior to heart tissue ischemia and a drop in pH, may help keep the heart tissue pH above dangerous levels of acidosis and ischemia. Special intraoperative heart pH monitors have been designed to supervise the pH value of heart tissue during surgery and keep track of the surgeon's efforts in pH modification. Electrodes designed as sterile probes that detect pH are inserted directly into the heart and used as an early warning

system for dangerous changes in pH. Surgical procedures that may be benefited by pH monitors include heart valve replacement surgery and coronary artery bypass surgery. pH monitoring is an important tool for surgeons to avoid or reverse acidosis and ischemia during heart surgery, thereby improving long-term patient survival.

### Resources

#### BOOKS

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Maria Basile, PhD

## Phacoemulsification for cataracts

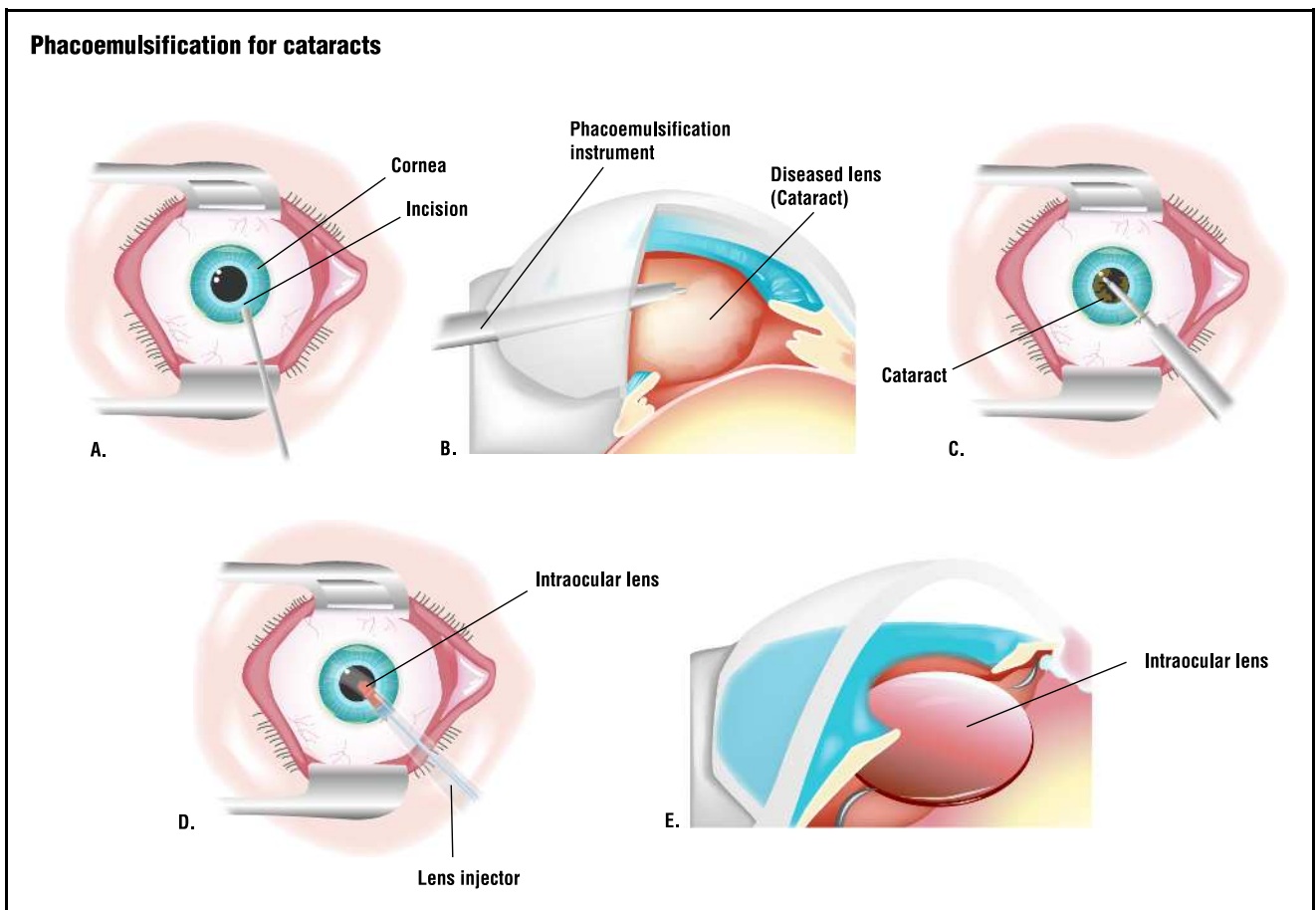
### Definition

Phacoemulsification cataract surgery is a procedure in which an ultrasonic device is used to break up and then remove a cloudy lens, or cataract, from the eye to improve vision. The insertion of an intraocular lens (IOL) usually immediately follows phacoemulsification.

### Purpose

Phacoemulsification, or phaco, as surgeons refer to it, is used to restore vision in patients whose vision has become cloudy from cataracts. In the first stages of a cataract, people may notice only a slight cloudiness as it affects only a small part of the lens, the part of the eye that focuses light on the retina. As the cataract grows, it blocks more light and vision becomes cloudier. As vision worsens, the surgeon will recommend cataract surgery, usually phaco, to restore clear vision. With advancements in cataract surgery such as the IOL patients can sometimes experience dramatic vision improvement.





In a phacoemulsification procedure, an incision is first made in the cornea, the outer covering of the eye (A). A phacoemulsification instrument uses ultrasonic waves to break up the cataract (B). Pieces of the cataract are then suctioned out (C). To repair the patient's vision, a folded intraocular lens is pushed through the same incision (D) and opened in place (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## Demographics

As people age, cataracts are likely to form. The National Eye Institute (NEI) reports in a 2002 study that more than half of all United States residents 65 and older have a cataract. People who smoke are at a higher risk for cataracts. Increased exposure to sunlight or infrared radiation without eye protection may also be a cause.

Cataracts also can occur anytime because of injury, exposure to toxins, or such diseases as diabetes. Congenital cataracts are caused by genetic defects or developmental problems, or exposure to some contagious diseases during pregnancy.

However, the most common form of cataract in the United States is age-related. According to the NEI, cataracts are more common in women than in men, and Caucasians have cataracts more frequently than other races, especially as people grow older. People

who live close to the equator also are at higher risk for cataracts because of increased sunlight exposure. Heavy alcohol consumption is also a risk factor for cataract formation.

More than 2.5 million cataract surgeries are performed in the United States each year. The NEI reports that the federal government, through **Medicare**, spends more than \$3.4 billion each year treating cataracts. Cataract surgery is one of the most common surgeries performed, and also one of the safest and most effective. Phaco is currently the most popular version of cataract surgery.

## Description

Phacoemulsification is a variation of **extracapsular cataract extraction (ECCE)**, a procedure in which the lens and the front portion of the capsule are removed. Formerly the most popular cataract surgery,

## KEY TERMS

**Astigmatism**—Asymmetric vision defects due to irregularities in the cornea.

**Capsulorrhexis**—The creation of a continuous circular tear in the front portion of the lens capsule during cataract surgery to allow for removal of the lens nucleus.

**Cornea**—Clear, bowl-shaped structure at the front of the eye. It is located in front of the colored part of the eye (iris). The cornea lets light into the eye and partially focuses it.

**Floaters**—Spots in the field of vision.

**Glaucoma**—Disease of the eye characterized by increased pressure of the fluid inside the eye. Untreated, glaucoma can lead to blindness.

**Lens (the crystalline lens)**—A transparent structure in the eye that focuses light onto the retina.

**Myopia**—A refractive error that causes distant objects to appear blurry. Myopia results when light does not focus properly on the retina.

**Retina**—The inner light-sensitive layer of the eye containing rods and cones.

the older method of extracapsular extraction involves a longer incision, about 0.4 in (10 mm), or almost half the length of the eye. Recovery from the larger incision used for extracapsular extraction also requires almost a week-long hospital stay after surgery, and limited physical activity for weeks or even months.

Dr. Charles Kelman (1930–2004) introduced the technique of phacoemulsification in the late 1960s. He was inspired by his dentist's use of ultrasonic tools. His goal was to remove the cataract with a smaller incision, less pain, and shorter recovery time. He discovered that the cataract could be broken up, or emulsified, into small pieces using an **ultrasound** tip. At first, phaco was slow to catch on because of its high learning curve. With its success rate and shorter recovery period, surgeons slowly learned the technique. Over the past decades, surgeons have constantly refined phaco to make it even safer and more successful. Innovations in technology such as the foldable IOL also have helped improve outcomes by allowing surgeons to make smaller incisions.

During surgery, the patient will probably breathe through an oxygen tube because it might be difficult to breathe with the draping. The patient's blood pressure and heart rate also are likely to be monitored.

Before making the incision, the surgeon inserts a long needle, usually through the lower eyelid, to anesthetize the area behind the eyeball. The surgeon then puts pressure on the eyeball with his or her hand or a weight to see if there is any bleeding (possibly caused by inserting the anesthetic). The pressure will stop this bleeding. This force also decreases intraocular pressure (IOP), which lowers the chances of complications.

After applying the pressure, the surgeon looks through a microscope and makes an incision about 0.1 in (3 mm) on the side of the anesthetized cornea. As of 2003, surgeons are beginning to favor the temporal location for the incision because it has proved to be safer. The incision site also varies depending on the size and denseness of the cataract. Once the incision is made, a viscoelastic fluid is injected to reduce shock to the intraocular tissues. The surgeon then makes a microscopic circular incision in the membrane that surrounds the cataract; this part of the procedure is called capsulorrhexis. A water stream then frees the cataract from the cortex. The surgeon inserts a small titanium needle, or phaco tip, into the cornea. The ultrasound waves from the phaco tip emulsify the cataract so that it can be removed by suction. The surgeon first focuses on the cataract's central nucleus, which is denser than the rest of the cataract.

While the cataract is being emulsified, the machine simultaneously aspirates the cataract through a small hole in the tip of the phaco probe. The surgeon then removes the cortex of the lens, but leaves the posterior capsule, which is used to support the intraocular lens.

The folded IOL is inserted by an injector. The folded IOL means that a larger incision is not required. After the IOL is inserted into the capsular bag, the viscoelastic fluid is removed. No sutures are usually required after the surgery. Some surgeons may recommend that patients wear an eye shield immediately after the surgery.

The entire procedure takes between 15 and 20 minutes. The phaco procedure itself takes only a few minutes.

Most surgeons prefer a certain technique for the procedure, although they might vary due to the cataract's density and size. The variations on the phaco procedure lie mostly on what part of the nucleus the surgeon focuses on first, and how the cataract is emulsified. Some surgeons prefer a continuous "chop," while others divide the cataract into quadrants for removal. One procedure, called the "phaco flip," involves the surgeon inverting and then rotating the lens for removal. Advances in technology also may allow for even smaller incisions, some speculate as small as 0.05 in (1.4 mm).

## Diagnosis/Preparation

People may have cataracts for years before vision is impaired enough to warrant surgery. Eye doctors may first suggest eyeglasses to temporarily help improve vision. But as the lens grows cloudier, vision deteriorates.

As cataracts develop and worsen, patients may notice these common symptoms:

- gradual (and painless) onset of blurry vision
- poor central vision
- frequent changes in prescription for corrective lenses
- increased glare from lights
- near-vision improvement to the point where reading glasses may no longer be needed
- poor vision in sunlight

Cataracts grow faster in younger people or in patients with diabetes, so doctors will recommend surgery more quickly in those cases. Surgery may also be recommended sooner if the patient suffers from such other eye diseases as age-related macular degeneration and the cataract interferes with complete eye examination.

When symptoms worsen to the point that everyday activities become problematic, surgery becomes necessary. A complete ocular exam will determine the severity of the cataract and what type of surgery the patient will receive. For some denser cataracts, the older method of extracapsular extraction is preferred.

The diagnostic examination should include measurement of visual acuity under both low and high illumination, microscopic examination of eye structures and pupil dilation, assessment of visual fields, and measurement of intraocular pressure (IOP).

If cataracts are detected in both eyes, each eye must be treated separately.

The patient's overall health must also be considered, and how it will affect the surgery's outcome. Surgeons may recommend a complete **physical examination** before surgery.

Although preoperative instructions may vary, patients are usually required not to eat or drink anything after midnight the day of the surgery. Patients must disclose all medications to determine if they must be discontinued before surgery. Patients taking **aspirin** for blood thinning usually are asked to stop for two weeks before surgery. Blood-thinning medications may put patients at risk for intraocular bleeding or hemorrhage. Coumadin, the prescription medicine for blood thinning, might still be taken if the risk for

stroke is high. People should consult with their eye doctor and internist to decide the best course of action.

An A-scan measurement, which determines the length of the eyeball, will be performed. This test helps to determine the refractive power of the IOL. Other pre-surgical testing such as a **chest x ray**, blood work, or **urinalysis** may be requested if other medical problems are an issue.

The surgeon may also request patients begin using antibiotic drops before the surgery to limit the chance of infection.

Cataract surgery is done on an outpatient basis, so patients must arrange for someone to take them home after surgery. On the day of the surgery, doctors will review the pre-surgical tests and insert dilating eye drops, antibiotic drops, and a corticosteroid or non-steroidal anti-inflammatory drop. Anesthetic eye drops will be given in both eyes to keep both eyes comfortable during surgery. A local anesthetic will be administered. Patients are awake for the surgery, but are kept in a relaxed state.

The patient's eye is scrubbed prior to surgery and sterile drapes are placed over the shoulders and head. The patient is required to lie still and focus on the light of the operating microscope. A speculum is inserted to keep the eyelids open.

## Aftercare

Immediately following surgery, the patient is monitored in an outpatient recovery area. The patient is advised to rest for at least 24 hours, until he or she returns to the surgeon's office for follow-up. Only light meals are recommended on the day of surgery. The patient may still feel drowsy and may experience some eye pain or discomfort. Usually, over-the-counter medications are advised for pain relief, but patients should check with their doctors to see what is recommended. Such other side effects as severe pain, nausea, or vomiting should be reported to the surgeon immediately.

There will be some changes in the eye during recovery. Patients may see dark spots, which should disappear a few weeks after surgery. There also might be some discharge and itching of the eye. Patients may use a warm, moist cloth for 15 minutes at a time for relief and to loosen the discharge. All matter from the discharge should be gently cleared away with a tissue, not a fingertip. Pain and sensitivity to light are also experienced after surgery. Some patients may also have slight drooping or bruising of the eye which will improve as the eye heals.

Patients have their first postoperative visit the day after surgery. The surgeon will remove the eye shield and prescribe eye drops to prevent infections and control intraocular pressure. These eye drops are used for about a month after surgery.

Patients are advised to wear an eye shield while sleeping, and refrain from rubbing the eye for at least two weeks. During that time, the doctor will give the patient special tinted sunglasses or request that he or she wear current prescription eyeglasses to prevent possible eye trauma from accidental rubbing or bumping. Unlike other types of cataract extraction, patients can resume normal activity almost immediately after phaco.

Subsequent exams are usually at one week, three weeks, and six to eight weeks following surgery. This can change, however, depending on any complications or any unusual postoperative symptoms.

After the healing process, the patient will probably need new corrective lenses, at least for close vision. While IOLs can remove the need for myopic correction, patients will probably need new lenses for close work.

### Risks

Complications are unlikely, but can occur. Patients may experience spontaneous bleeding from the wound and recurrent inflammation after surgery. Flashing, floaters, and double vision may also occur a few weeks after surgery. The surgeon should be notified immediately of these symptoms. Some can easily be treated, while floaters may be a sign of retinal detachment.

Retinal detachment is one possible serious complication. The retina can become detached by the surgery if there is any weakness in the retina at the time of surgery. This complication may not occur for weeks or even years; one study reported in 2006 that patients who have had cataracts removed by phaco have an increased risk of retinal detachment 20 years after surgery.

Infections are another potential complication, the most serious being endophthalmitis, which is an infection in the eyeball. This complication, once widely reported, is much more uncommon today because of newer surgery techniques and **antibiotics**.

Patients may also be concerned that their IOL might become displaced, but newer designs of IOLs also have limited reports of intraocular lens dislocation.

Other possible complications are the onset of glaucoma and, in very rare cases, blindness.

It is possible that a secondary cataract may develop in the remaining back portion of the capsule. This can occur for as long as one to two years after surgery. YAG capsulotomy, using a laser, is most often

used for the secondary cataract. This outpatient procedure requires no incision. The laser makes a small opening in the remaining back part of the lens to allow light to penetrate.

### Normal results

Most patients have restored visual acuity after surgery, and some will have the best vision of their lives after the insertion of IOLs. Some patients will no longer require the use of eyeglasses or contact lenses after cataract surgery. Patients will also have better color and depth perception and be able to resume normal activities they may have stopped because of impaired vision from the cataract, such as driving, reading, or sports.

### Morbidity and mortality rates

Phacoemulsification has lowered the previous risks from cataract surgery, making it a much safer procedure. Before phacoemulsification, **death** after cataract surgery was still rare, but usually stemmed from the possible complications of **general anesthesia**. Phaco is performed under **local anesthesia**, eliminating the risk of general anesthetic use.

Other serious complications such as blindness also have been reduced with the widespread use of phaco. Newer antibiotics have enabled physicians to combat former debilitating infections that previously would have caused blindness.

### Alternatives

Some older methods of cataract surgery may have to be used if the cataract is too large to remove with a small incision, including:

- Extracapsular cataract extraction (ECCE). While phaco is considered a type of extracapsular extraction, the older version of this technique requires a much larger incision and does not use the phaco machine. It is similar in that the lens and the front portion of the capsule are removed and the back part of the capsule remains. The surgeon might consider this technique if the patient has corneal disease or if the pupil becomes too small during the first stages of surgery. While standard ECCE and phacoemulsification have similar success rates and complication rates when performed by surgeons of comparable skill and length of experience, a meta-analysis of 17 trials of these two methods reported in 2006 that phacoemulsification gives a better long-term outcome than standard ECCE with sutures.



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Ophthalmologists and optometrists may detect cataracts; however, only an ophthalmologist can perform cataract surgery. An anesthesiologist may be on hand during surgery to administer the local anesthetic. Surgical nurses will assist the ophthalmologist in the operating room and assist the patient preoperatively and postoperatively.

The outpatient surgery is performed in a hospital or surgery suite designed for ophthalmic surgery.

- Intracapsular cataract extraction (ICCE). This technique also requires a larger incision than phaco. It differs in that the lens and the entire capsule are removed. While ICCE is the easiest cataract surgery for the surgeon technically, this method carries an increased risk for the patient with increased potential for detachment of the retina and swelling after surgery. Recovery is long and most patients will have to use large “cataract glasses” to see.

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## QUESTIONS TO ASK THE DOCTOR

- Will Medicare pay for the surgery and my aftercare?
- If I have a cataract in the other eye, how long must I wait to have the other eye treated?
- Will I still need reading glasses after surgery? Will I still need eyeglasses to see far away even if you insert an intraocular lens?
- How many cataract surgeries have you performed? How many of these have been phacoemulsification?
- What precautions should I take to protect my eye after surgery?
- When can I resume my normal activities after surgery? Contact sports?

### ORGANIZATIONS

- American Academy of Ophthalmology. P.O. Box 7424, San Francisco, CA 94120 7424. (415) 561 8500. <http://www.aao.org>.
- American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991 4100. <http://www.aoanet.org>.
- American Society of Cataract and Refractive Surgery. 4000 Legato Road, Suite 700, Fairfax, VA 22033 4055. (703) 591 2220. E mail: <ascrs@ascrs.org>. <http://www.ascrs.org>.
- National Eye Institute. 2020 Vision Place Bethesda, MD 20892 3655. (301) 496 5248. <http://www.nei.nih.gov>.

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## Pharyngectomy

### Definition

A pharyngectomy is the total or partial surgical removal of the pharynx, the cavity at the back of the mouth that opens into the esophagus at its lower end.

The pharynx is cone-shaped, has an average length of about 3 in (76 mm), and is lined with mucous membrane.

### Purpose

A pharyngectomy procedure is performed to treat cancers of the pharynx that include:

- **Throat cancer.** Throat cancer occurs when cells in the pharynx or larynx (voice box) begin to divide abnormally and out of control. A total or partial pharyngectomy is usually performed for cancers of the hypopharynx (last part of the throat), in which all or part of the hypopharynx is removed.
- **Hypopharyngeal carcinoma (HPC).** A carcinoma is a form of cancerous tumor that may develop in the pharynx or adjacent locations and for which surgery may be indicated.

### Description

Whether a pharyngectomy is performed in total or with only partial removal of the pharynx depends on the localized amount of cancer found. The procedure may also involve removal of the larynx, in which case it is called a laryngopharyngectomy. Well-localized, early stage HPC tumors can be amenable to a partial pharyngectomy or a laryngopharyngectomy, but laryngopharyngectomy is more commonly performed for more advanced cancers. It can be total, involving removal of the entire larynx, or partial and may also involve removal of part of the esophagus (esophagectomy). Patients undergoing laryngopharyngectomy will lose some speaking ability and require special techniques or reconstructive procedures to regain the use of their voice.

Following a total or partial pharyngectomy, the surgeon may also need to reconstruct the throat so that the patient can swallow. A **tracheotomy** is used when the tumor is too large to remove. In this procedure, a hole is made in the neck to bypass the tumor and allow the patient to breathe.

For this type of surgery, patient positioning requires access to the lower part of the neck for the surgeon. This is conveniently achieved by placing the patient on a table fitted with a head holder, allowing the head to be bent back but well supported.

If a laryngopharyngectomy is performed, the surgeon starts with a curved horizontal neck skin incision. The **laryngectomy** incision is usually made from the breastbone to the lower most of the laryngeal cartilages, such that a 1–2 in (2.54–5.08 cm) bridge of skin is preserved. Once the incision is deepened, flaps are elevated until the larynx is exposed. The anterior jugular veins and strap muscles are left undisturbed. The

sternocleidomastoid muscle is then identified. The layer of cervical fibrous tissue is cut (incised) longitudinally from the hyoid (the bony arch that supports the tongue) above to the clavicle (collarbone) below. Part of the hyoid is then divided, which allows the surgeon to enter the loose compartment bounded by the sternomastoid muscle and carotid sheath (which covers the carotid artery) and by the pharynx and larynx in the neck. The pharyngectomy incisions and laryngeal removal are performed, and a view of the pharynx is then possible. Using scissors, the surgeon performs bilateral (on both sides), direct cuts, separating the pharynx from the larynx. If a preliminary tracheotomy has not been performed, the oral endotracheal tube is withdrawn from the tracheal stump and a new, cuffed, flexible tube inserted for connection to new anesthesia tubing. The wound is thoroughly irrigated (flushed); all clots are removed; and the wound is closed. The pharyngeal wall is closed in two layers. The muscle layer closure always tightens the opening to some extent and is usually left undone at points where narrowing may be excessive. In fact, studies show that a mucosal (inner layer) closure alone is sufficient for proper healing.

### Diagnosis/Preparation

The initial **physical examination** for a pharyngectomy usually includes examination of the neck, mouth, pharynx, and larynx. A neurologic examination is sometimes also performed. Laryngoscopy is the examination of choice, performed with a long-handled mirror, or with a lighted tube called a laryngoscope. A local anesthetic might be used to ease discomfort. A MRI of the oral cavity and neck may also be performed.

If the physician suspects throat cancer, a biopsy will be performed—this involves removing tissue for examination in the laboratory under a microscope. Throat cancer can only be confirmed through a biopsy or using fine needle aspiration (FNA). The physician also may use an imaging test called a computed tomography (CT) scan. This is a special type of x ray that provides images of the body from different angles, allowing a cross-sectional view. A CT-scan can help to find the location of a tumor, to judge whether or not a tumor can be removed surgically, and to determine the cancer's stage of development.

Before surgery, the patient is also examined for nutritional assessment and supplementation, and careful staging of cancer, while surgical airway management is planned with the anesthesiologist such that a common agreement is reached with the surgeon concerning the timing of tracheotomy and intubation.

## KEY TERMS

**Anesthesia**—A combination of drugs administered by a variety of techniques by trained professionals that provide sedation, amnesia, analgesia, and immobility adequate for the accomplishment of the surgical procedure with minimal discomfort, and without injury, to the patient.

**Biopsy**—Procedure that involves obtaining a tissue specimen for microscopic analysis to establish a precise diagnosis.

**Carcinoma**—A malignant growth that arises from epithelium, found in skin or, more commonly, the lining of body organs.

**Computed tomography (CT) scan**—An imaging technique that creates a series of pictures of areas inside the body, taken from different angles. The pictures are created by a computer linked to an x-ray machine.

**Dysphagia**—Difficulty in eating as a result of disruption in the swallowing process. Dysphagia can be a serious health threat because of the risk of aspiration pneumonia, malnutrition, dehydration, weight loss, and airway obstruction.

**Esophagectomy**—Surgical removal of the esophagus.

**Esophagus**—A long hollow muscular tube that connects the pharynx to the stomach.

**Fine needle aspiration (FNA)**—Technique that allows a biopsy of various bumps and lumps. It allows the

otolaryngologist to retrieve enough tissue for microscopic analysis and thus make an accurate diagnosis of a number of problems, such as inflammation or cancer.

**Fistula**—An abnormal passage or communication, usually between two internal organs or leading from an internal organ to the surface of the body.

**Hypopharynx**—The last part of the throat or the pharynx.

**Laryngopharyngectomy**—Surgical removal of both the larynx and the pharynx.

**Laryngoscopy**—The visualization of the larynx and vocal cords. This may be done directly with a fiberoptic scope (laryngoscope) or indirectly with mirrors.

**Laryngectomy**—Surgical removal of the larynx.

**Larynx**—Voice box.

**Magnetic resonance imaging (MRI)**—A procedure in which a magnet linked to a computer is used to create detailed pictures of areas inside the body.

**Pharynx**—The cavity at the back of the mouth. It is cone shaped and has an average length of about 3 in (76 mm) and is lined with mucous membrane. The pharynx opens into the esophagus at the lower end.

**Tracheotomy**—Opening of the trachea (windpipe) to the outside through a hole in the neck.

The anesthesiologist may elect to use an orotracheal (through the mouth and trachea) tube with anesthetic, which can be removed if a subsequent tracheotomy is planned.

### Aftercare

After undergoing a pharyngectomy, special attention is given to the patient's pulmonary function and fluid/nutritional balance, as well as to local wound conditions in the neck, thorax, and abdomen. Regular postoperative checks of calcium, magnesium, and phosphorus levels are necessary; supplementation with calcium, magnesium, and 1,25-dihydroxycholecalciferol is usually required. A patient may be unable to take in enough food to maintain adequate nutrition and experience difficulty eating (dysphagia). Sometimes it may be necessary to have a feeding tube placed through the skin and muscle of the abdomen directly

into the stomach to provide extra nutrition. This procedure is called a **gastrostomy**.

**Reconstructive surgery** is also required to rebuild the throat after a pharyngectomy in order to help the patient with swallowing after the operation. Reconstructive surgeries represent a great challenge because of the complex properties of the tissues lining the throat and underlying muscle that are so vital to the proper functioning of this region. The primary goal is to re-establish the conduit connecting the oral cavity to the esophagus and thus retaining the continuity of the alimentary tract. Two main techniques are used:

- **Myocutaneous flaps.** Sometimes a muscle and area of skin may be rotated from an area close to the throat, such as the chest (pectoralis major flap), to reconstruct the throat.
- **Free flaps.** With the advances of microvascular surgery (sewing together small blood vessels under a microscope), surgeons have many more options to

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A pharyngectomy is major surgery performed by a surgeon trained in otolaryngology. An anesthesiologist is responsible for administering anesthesia and the operation is performed in a hospital setting. Otolaryngology is the oldest medical specialty in the United States. Otolaryngologists are physicians trained in the medical and surgical management and treatment of patients with diseases and disorders of the ear, nose, throat (ENT), and related structures of the head and neck. They are commonly referred to as ENT physicians.

With cancer involved in pharyngectomy procedures, the otolaryngologist surgeon usually works with radiation and medical oncologists in a treatment team approach.

reconstruct the area of the throat affected by a pharyngectomy. Tissues from other areas of the patient's body such as a piece of intestine or a piece of arm muscle can be used to replace parts of the throat.

### Risks

Potential risks associated with a pharyngectomy include those associated with any head and neck surgery, such as excessive bleeding, wound infection, wound slough, fistula (abnormal opening between organs or to the outside of the body), and, in rare cases, blood vessel rupture. Specifically, the surgery is associated with the following risks:

- Drain failure. Drains unable to hold a vacuum represent a serious threat to the surgical wound.
- Hematoma. Although rare, blood clot formation requires prompt intervention to avoid pressure separation of the pharyngeal repair and compression of the upper windpipe.
- Infection. A subcutaneous infection after total pharyngectomy is recognized by increasing redness and swelling of the skin flaps at the third to fifth post-operative day. Associated odor, fever, and elevated white blood cell count will occur.
- Pharyngocutaneous fistula. Patients with poor pre-operative nutritional status are at significant risk for fistula development.
- Narrowing. More common at the lower, esophageal end of the pharyngeal reconstruction than in the

## QUESTIONS TO ASK THE DOCTOR

- How will the surgery affect my ability to swallow and to eat?
- What type of anesthesia will be used?
- How long will it take to recover from the surgery?
- When can I expect to return to work and/or resume normal activities?
- To what extent will my ability to speak be affected?
- What are the risks associated with a pharyngectomy?
- How many pharyngectomies do you perform in a year?

upper end, where the recipient lumen of the pharynx is wider.

- Functional swallowing problems. Dysphagia is also a risk which depends on the extent of the pharyngectomy.

### Normal results

Oral intake is usually started on the seventh post-operative day, depending on whether the patient has had preoperative radiation therapy, in which case it may be delayed. Mechanical voice devices are sometimes useful in the early, post-operative phase, until the pharyngeal wall heals. Results are considered normal if there is no re-occurrence of the cancer at a later stage.

### Morbidity and mortality rates

Smokers are at high risk of throat cancer. According to the Harvard Medical School, throat cancer also is associated closely with other cancers: 15% of throat-cancer patients also are diagnosed with cancer of the mouth, esophagus, or lung. Another 10–20% of throat-cancer patients develop these other cancers later. Other people at risk include those who drink a lot of alcohol, especially if they also smoke. Vitamin A deficiency and certain types of human papillomavirus (HPV) infection also have been associated with an increased risk of throat cancer.

Surgical treatment for hypopharyngeal carcinomas is difficult as most patients are diagnosed with advanced disease, and five-year disease specific survival is only 30%. Cure rates have been the highest with surgical resection followed by postoperative radiotherapy. Immediate reconstruction can be accomplished with regional and free tissue transfers. These techniques have greatly reduced morbidity, and allow most patients to successfully resume an oral diet.



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American Academy of Otolaryngology. One Prince Street, Alexandria, VA 22314 3357. (703) 836 4444. <http://www.entnet.org/>

American Cancer Society (ACS). 1599 Clifton Rd. NE, Atlanta, GA 30329 4251. (800) 227 2345. <http://www.cancer.org>

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Pharynx removal see **Pharyngectomy**

Phenobarbital see **Barbiturates**

Phlebectomy see **Vein ligation and stripping**

## Phlebography

### Definition

Phlebography is an x-ray test that provides an image of the leg veins after a contrast dye is injected into a vein in the patient's foot.

### Purpose

Phlebography is primarily performed to diagnose deep vein thrombosis—a condition in which clots form in the veins of the leg. Pulmonary embolism can occur when those clots break off and travel to the lungs and pulmonary artery. Phlebography can also be used to evaluate congenital vein problems, assess the function of the deep leg vein valves, and identify a vein for arterial bypass grafting. **Ultrasound** has replaced phlebography in many cases; but phlebography is the "gold standard," or the best test by which others are judged, even though it is not used routinely.

### Description

Phlebograph, (also called venography, ascending contrast phlebography, or contrast phlebography) is an invasive diagnostic test that provides a constant image of leg veins on a fluoroscope screen. Phlebography identifies the location and extent of blood clots, and enables the condition of the deep leg veins to be assessed. It is especially useful when there is a strong suspicion of deep vein thrombosis, after noninvasive tests have failed to identify the disease.

Phlebography is the most accurate test for detecting deep vein thrombosis. It is nearly 100% sensitive and specific in making this diagnosis. (Pulmonary embolism is diagnosed in other ways.) Accuracy is crucial since deep vein thrombosis can lead to pulmonary embolism, a potentially fatal condition.

Phlebography is not used often; however, because it is painful, expensive, time-consuming, exposes the patient to a fairly high dose of radiation, and can cause complications. In about 5% of cases, there are technical problems in conducting the test.

Phlebography takes 30–45 minutes, and can be done in a physician's office, a laboratory, or a hospital. During the procedure, the patient lies on a tilting x-ray table. The area where the catheter will be inserted is shaved, if necessary, and cleaned. In some cases, a local anesthetic is injected to numb the skin at the site of the insertion. A small incision may be required to make a point for insertion. The catheter is inserted and the contrast solution (or dye) is slowly

## KEY TERMS

**Contrast solution**—A liquid dye injected into the body that allows structures, including veins, to be seen by x rays. Without the dye, the veins could not be seen on x rays.

**Deep vein thrombosis**—The development or presence of a blood clot in a vein deep within the leg. Deep vein thrombosis can lead to pulmonary embolism.

**Invasive**—A diagnostic test that invades healthy tissue; in the case of phlebography, through an incision in a healthy vein.

**Pulmonary embolism**—An obstruction of a blood vessel in the lungs, usually due to a blood clot that blocks a pulmonary artery. A pulmonary embolism can be very serious and in some cases is fatal.

injected. Injection of the dye causes a warm, flushing feeling in the leg that may spread through the body. The contrast solution may also cause slight nausea. Approximately 18% of patients experience discomfort from the contrast solution.

In order to fill the deep venous system with dye, a tight band (tourniquet) may be tied around the ankle or below the knee of the side into which the dye is injected, or the lower extremities may be tilted. The patient is asked to keep the leg still. The physician observes the movement of the solution through the vein with a fluoroscope. At the same time, a series of x rays is taken. When the test is finished, fluid is injected to clear the contrast from the veins, the catheter is removed, and a bandage is applied over the injection site.

## Preparation

Fasting or drinking only clear liquids is necessary for four hours before the test, although the procedure may be done in an emergency even if the patient has eaten. The contrast solution contains iodine, to which some people are allergic. Patients should tell their physician if they have allergies or hay fever, or if they have had a reaction to a contrast solution.

## Aftercare

Patients should drink large amounts of fluids to flush the remaining contrast solution from their bodies. The area around the incision will be sore for a few days. The physician should be notified if there is

swelling, redness, pain, or fever. Pain medication is rarely needed. In most cases, the patient can resume normal activities the next day.

## Risks

Phlebography can cause complications such as phlebitis, tissue damage, and the formation of deep vein thrombosis in a healthy leg. A rare side effect in up to 8% of cases is a severe allergic reaction to the dye. This usually happens within 30 minutes after injection of the dye, and requires medical attention.

## Normal results

Normal phlebography results show proper blood flow through the leg veins.

Abnormal phlebography results show well-defined filling defects in veins. These findings confirm a diagnosis of deep vein thrombosis:

- blood clots
- consistent filling defects
- an abrupt end of a contrast column
- major deep veins that are unfilled
- dye flow that is diverted

## Resources

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## Phlebotomy

### Definition

Phlebotomy is the act of drawing or removing blood from the circulatory system through a cut (incision) or puncture in order to obtain a sample for analysis and diagnosis. Phlebotomy is also done as part of the patient's treatment for certain blood disorders.

### Purpose

Phlebotomy that is part of treatment (therapeutic phlebotomy) is performed to treat polycythemia vera, a condition that causes an elevated red blood cell volume (**hematocrit**). Phlebotomy is also prescribed for patients with disorders that increase the amount of iron in their blood to dangerous levels, such as hemochromatosis, hepatitis B, and hepatitis C. Patients with pulmonary edema may undergo phlebotomy procedures to decrease their total blood volume.

Phlebotomy is also used to remove blood from the body during **blood donation** and for analysis of the substances contained within it.

### Description

Phlebotomy is performed by a nurse or a technician known as a phlebotomist. Blood is usually taken from a vein on the back of the hand or just below the elbow. Some blood tests, however, may require blood from an artery. The skin over the area is wiped with an antiseptic, and an elastic band is tied around the arm. The band acts as a tourniquet, retaining blood within the arm and making the veins more visible. The phlebotomy technician feels the veins in order to select an appropriate one. When a vein is selected, the technician inserts a needle



**Preparing phlebotomy needles for withdrawal of blood samples.** (Pulse Picture Library/CMP Images/Phototake. Reproduced by Permission.)

### KEY TERMS

**Finger stick**—A technique for collecting a very small amount of blood from the fingertip area.

**Hemochromatosis**—A genetic disorder known as iron overload disease. Untreated hemochromatosis may cause osteoporosis, arthritis, cirrhosis, heart disease, or diabetes.

**Thrombocytosis**—A vascular condition characterized by high blood platelet counts.

**Tourniquet**—Any device that is used to compress a blood vessel to stop bleeding or as part of collecting a blood sample. Phlebotomists usually use an elastic band as a tourniquet.

into the vein and releases the elastic band. The appropriate amount of blood is drawn and the needle is withdrawn from the vein. The patient's pulse and blood pressure may be monitored during the procedure.

For some tests requiring very small amounts of blood for analysis, the technician uses a finger stick. A lance, or small needle, makes a small cut in the surface of the fingertip, and a small amount of blood is collected in a narrow glass tube. The fingertip may be squeezed to get additional blood to surface.

The amount of blood drawn depends on the purpose of the phlebotomy. Blood donors usually contribute a unit of blood (500 mL) in a session. The volume of blood needed for laboratory analysis varies widely with the type of test being conducted. Typically one or several small (5–10 mL) tubes are drawn. Therapeutic phlebotomy removes a larger amount of blood than donation and blood analysis require. Phlebotomy for treatment of hemochromatosis typically involves removing a unit of blood—250 mg of iron—once a week. Phlebotomy sessions are required until iron levels return to a consistently normal level, which may take several months to several years. Phlebotomy for polycythemia vera removes enough blood to keep the patient's hematocrit (proportion of red blood cells) below 45%. The frequency and duration of sessions depends on the patient's individual needs.

### Diagnosis/Preparation

Patients having their blood drawn for analysis may be asked to discontinue medications or to avoid food (to fast) for a period of time before the blood test. Patients donating blood will be asked for a brief medical history, have their blood pressure taken, and have their hematocrit checked with a finger stick test prior to donation.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Phlebotomy is usually performed by a phlebotomy technician. Arterial collection may be performed by a physician. Collection occurs in the hospital or outpatient clinic.

### Aftercare

After blood is drawn and the needle is removed, pressure is placed on the puncture site with a cotton ball to stop bleeding, and a bandage is applied. It is not uncommon for a patient to feel dizzy or nauseated during or after phlebotomy. The patient may be encouraged to rest for a short period once the procedure is completed. Patients are also instructed to drink plenty of fluids and eat regularly over the next 24 hours to replace lost blood volume. Patients who experience swelling of the puncture site or continued bleeding after phlebotomy should seek immediate medical treatment.

### Risks

Most patients will have a small bruise or mild soreness at the puncture site for several days. Therapeutic phlebotomy may cause thrombocytosis and chronic iron deficiency (anemia) in some patients. As with any invasive procedure, infection is also a risk. This risk is minimized by the use of prepackaged sterilized equipment and careful attention to proper technique. There is no risk of HIV infection from phlebotomy, since all needles are disposed of after a single use. Arterial blood collection carries a higher risk than venous collection, and is performed by a physician or other specially trained professional. Patients who are anemic or have a history of cardiovascular disease may not be good candidates for phlebotomy.

### Normal results

Normal results include obtaining the needed amount of blood with the minimum of discomfort to the patient.

### Morbidity and mortality rates

Properly performed, phlebotomy does not carry the risk of mortality. It may cause temporary pain and bleeding, but these are usually easily managed.

### Alternatives

Phlebotomy is a necessary medical procedure, and is required for a wide variety of other procedures.

## QUESTIONS TO ASK THE DOCTOR

- How many tubes of blood will you withdraw?

### Resources

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## Photocoagulation therapy

### Definition

Photocoagulation therapy is a method of treating detachments (tears) of the retina (the layer of light-sensitive cells at the back of the eye) with an argon laser. The high-intensity beam of light from the laser is converted into heat, which forces protein molecules in the affected tissue to condense and seal the tear.

### Purpose

The purpose of photocoagulation therapy is to reattach a torn or detached portion of the retina and/or prevent further growth of abnormal blood vessels in the retina that can cause a detachment.

### Demographics

The incidence of RD in the United States is about 0.3%, or one in 15,000 people.

The most common risk factors associated with RD are extreme nearsightedness (5% risk); cataract removal without lens implantation (2%); and cataract removal with loss of the vitreous body during surgery (10%). It is estimated that 15% of people with RD in one eye will eventually develop it in the other eye.

Males account for 60% and females for 40% of patients with RD below the age of 45. Above age 45, there is no significant gender difference.

With regard to racial or ethnic background, the incidence of RD is higher among Jews in the United



## KEY TERMS

**Choroid**—The middle of the three tunicae or coats that surround the eyeball; the choroid lies between the retina and the sclera.

**Coats' disease**—A chronic and progressive disorder of the retina marked by exudative RD. It is named for George Coats (1876-1915), a British ophthalmologist. It occurs most frequently in preadolescent boys and young adults.

**Cornea**—The transparent front portion of the exterior cover of the eye.

**Cryopexy**—Reattachment of a detached retina by freezing the tissue behind the tear with nitrous oxide.

**Diabetic retinopathy**—Degeneration of the retina related to diabetes; both type 1 and type 2 diabetes can lead to diabetic retinopathy.

**Eales disease**—A disorder marked by recurrent hemorrhages into the retina and vitreous body. It occurs most often in males between the ages of 10 and 25.

**Exudative RD**—A type of retinal detachment caused by the accumulation of tissue fluid underneath the retina.

**Floaters**—Spots seen in front of the eyes, caused by clumping of the collagen fibers in the vitreous body.

**Laser**—A device that produces high-intensity, narrowly focused monochromatic light by exciting atoms and causing them to give off their energy in phase.

**Laser in situ keratomileusis (LASIK)**—A procedure in which the shape of the cornea is changed with an excimer laser in order to correct the patient's vision.

**Macula**—A small, yellowish depressed area on the retina that absorbs the shorter wave lengths of visible light and is responsible for fine detailed vision.

**Marfan's syndrome**—A hereditary disorder that affects the connective tissues of the body, the lens of the eye, and the cardiovascular system.

**Ophthalmology**—The branch of medicine that deals with the diagnosis and treatment of eye disorders.

**Optometrist**—A primary health care provider who examines eyes and diagnoses disorders of the eye as well as prescribing eyeglasses, contact lenses, and other vision aids.

**Pneumatic retinopexy**—Reattachment of a detached retina using an injected gas bubble to hold the retina against the back of the eye.

**Pupil**—The opening in the center of the iris of the eye that allows light to enter the eye.

**Retina**—The innermost of three layers of tissue surrounding the human eyeball. The retina surrounds the vitreous body and joins the optic nerve at the back of the eye.

**Retinal detachment (RD)**—A condition in which the inner layers of cells in the retina separate from the underlying pigmented layers of cells called the choroid.

**Retinopathy of prematurity (ROP)**—A disorder that occurs in premature infants in which blood vessels in the eye continue to grow in an abnormal pattern after delivery. It can lead to retinal detachment and blindness. ROP is also known as retrolental fibroplasia.

**Sclera**—The tough white outer tunica or coat of the eyeball.

**Tunica (plural, tunicae)**—The medical term for a membrane or piece of tissue that covers or lines a body part. The retina is the innermost of three tunicae that surround the eyeball.

**Vitrectomy**—Surgical removal of the vitreous body.

**Vitreous body**—The transparent gel that fills the inner portion of the eyeball between the lens and the retina. It is also called the vitreous humor or crystalline humor.

States than in the general population; the incidence of RD among African Americans is lower than average.

## Description

### *Structure of the human eye*

To fully understand how photocoagulation therapy works, it is helpful to have a basic picture of the structure of the human eye. The retina is the innermost tunica, or covering, of the posterior part of the eyeball. It is made of several layers of cells, one of which

contains the rod and cone cells that are sensitive to light. Behind the retina are the other two tunicae of the eye, the choroid and the sclera. The sclera is a tough white layer of tissue that covers the exterior of the eyeball. At the front of the eye, the sclera is continuous with a transparent area of tissue known as the cornea.

At the back of the eye, the retina is continuous with the optic nerve. The macula, which is a yellowish oval-shaped area that is the central point of vision, lies in the center of the retina. In front of the retina is the vitreous body, which is also known as the vitreous humor, or

simply the vitreous. The vitreous body is a clear gel that consists primarily of water and collagen fibers.

### *Types of retinal detachment (RD)*

**RHEGMATOGENOUS.** A rhegmatogenous RD is the most common of the three types of retinal detachment. The word rhegmatogenous comes from a Greek word that means “tear.” A rhegmatogenous RD typically occurs in older people. As the vitreous body in the center of the eyeball ages, it shrinks and pulls away from the retina. This separation is called a posterior vitreous detachment (PVD). A PVD is not the same thing as a retinal detachment, although it may slightly increase the risk of an RD. In places where the retina is still attached to the vitreous body, a small hole or tear can develop. Over time, fluid can seep into the area around the hole or tear and thus enlarge the area of detached tissue.

**TRACTION.** Traction RDs are most often found in adults with diabetic retinopathy or infants with retinopathy of prematurity (ROP). Diabetic retinopathy is a disorder that develops when the patient’s diabetes affects the small blood vessels in the eye. Although diabetic retinopathy is more severe in patients with type 1 diabetes (insulin-dependent), it can also occur in patients with type 2. Retinal detachment is most likely to occur in a subtype of the disorder known as proliferative diabetic retinopathy. The term proliferative refers to the abnormal growth of new blood vessels along the surface of the vitreous body. These new blood vessels can bleed into the vitreous body and form scar tissue that pulls on the retina. Eventually, the scar tissue can exert enough pulling force to cause a retinal detachment.

In ROP, a traction RD can develop because premature birth interrupts the normal development of the blood vessels in the baby’s eyes. After the baby is born, some of these blood vessels grow along the retina, bleed into the vitreous body, and form scar tissue similar to that found in diabetic retinopathy. Retinal detachment in ROP can be treated with photocoagulation.

**EXUDATIVE.** Exudative RDs occur when tissue fluid builds up in the space between the retina and the choroid underneath it. If enough fluid leaks into this space, it can push the retina away from the choroid and cause it to detach. Exudative RDs are associated with certain inflammatory disorders of the eye; tumors, including melanoma (cancer) of the choroid; and a congenital disorder known as Coats’ disease, which affects the growth of the blood vessels in the retina.

### *Risk factors for retinal detachment*

Retinal detachment is associated with a number of different factors and conditions, including:

- extreme nearsightedness
- genetic factors (retinal detachment tends to run in families)
- premature birth (the risk of ROP is highest in premature infants weighing less than 2.2 lb [1 kg] at birth)
- type 1 or type 2 diabetes
- cataract surgery
- sickle cell disease
- Coats’ disease
- Eales’ disease
- Marfan’s syndrome
- breast cancer or melanoma
- leukemia
- history of previous retinal detachment
- age (Retinal detachment is most common in people between the ages of 40 and 70.)
- traumatic injury to the eye
- laser in-situ keratomileusis surgery (LASIK, a procedure done to correct vision and eliminate the need for glasses or contact lenses)

Photocoagulation therapy for retinal detachment is usually performed with an argon laser. A laser is a device that produces high-intensity, narrowly focused monochromatic light by exciting atoms and causing them to give off their energy in phases. The word laser comes from “light amplification by stimulated emission of radiation.” An argon laser uses ionized argon to generate its light, which is in the blue-green portion of the visible light spectrum.

In a laser photocoagulation treatment, the patient is asked to sit in front of the instrument. After applying anesthetic eye drops, the ophthalmologist places a contact lens on the patient’s eye and focuses the laser beam through it. He or she operates the laser by foot. The patient may see a brief burst of blue-green light. When the laser beam reaches the retina at the back of the eye, its light is absorbed by the pigment in the cells and converted to heat, which seals the edge of the retinal detachment against the underlying choroid. The procedure is short, taking about 10–30 minutes.

## **Diagnosis/Preparation**

### *Diagnosis*

The diagnosis of retinal detachment requires direct examination of the eye as well as taking the patient’s medical history. The diagnosis may be made in some cases by an optometrist, who is a health professional qualified to examine the eye for diseases and disorders as well as taking measurements for corrective lenses. If the symptoms of RD appear suddenly,

however, the patient is more likely to be diagnosed by an ophthalmologist, who is a physician specializing in treating disorders of the eye.

**PATIENT HISTORY.** Retinal detachment is not usually painful, and the patient's eye will look normal from the outside. In almost all cases, a patient with RD consults a doctor because he or she is having one or more of the following visual disturbances:

- blurring of vision that is not helped by blinking the eye
- a gray or black curtain or shade coming across the field of vision from one direction
- floaters, which appear as moving black spots in front of the eye (The sudden appearance of a large group, or "shower," of floaters is a serious symptom of RD.)
- flashes of light
- objects appearing wavy or distorted in shape
- blind spot in the visual field

The visual symptoms of retinal detachment may develop either gradually or suddenly. In a very small number of cases, a sudden retinal detachment may cause complete loss of vision in the affected eye.

Patients who have gone to a primary care physician or emergency room for these visual symptoms are referred to an ophthalmologist. Many ophthalmologists will give patients a piece of paper with a circle on it and ask them to draw what they are seeing on the circle in the area corresponding to the part of their visual field that is affected. In some cases, the location of the spots, light flashes, or shadows that a patient sees is a clue to the part of the retina that is detached.

The ophthalmologist will take a patient history, asking about a family history of eye disorders; previous diseases or disorders of the eye; other diseases or disorders that the patient may have, particularly diabetes or sickle cell disease; and a history of head trauma, direct blows to the eye, or surgical removal of a foreign body from the eye. If the patient suffered a head or eye injury within the past six months, the ophthalmologist will ask whether the visual disturbances started at the time of the injury or several months later.

**EYE EXAMINATION.** After taking the history, the ophthalmologist will examine the eye itself. This examination has several parts, including:

- A test of visual clarity or sharpness. This test is the same one used by an optometrist when fitting a patient for glasses or contact lenses.
- An external check for bleeding or any other signs of trauma to the eye.

- A test that measures the response of the pupil of the eye to changes in light intensity. One sign of RD is a difference in the pupillary reaction between the affected eye and the normal one. The pupil will not contract as far as it normally does when the doctor shines a light into the affected eye.
- A test that measures the amount of fluid pressure inside each eyeball. In RD, the affected eye typically has a lower pressure measurement than the other eye.
- Examination of the eye with a slit lamp, which is an instrument with a high-intensity light source that can be focused as a thin sliver of light. The examiner uses the slit lamp together with a binocular ophthalmoscope (an instrument that looks like a microscope with two eyepieces) in order to check first the front and then the back of the eye for any abnormalities. To check the front part, the doctor will touch the side of the eye with a strip of paper containing an orange dye. The dye stains the film of tear fluid on the outer surface of the eye, making it easier to see the structures in the front of the eye. Patients with RD usually have normal results for this part of the slit-lamp examination. In the second part, the doctor puts some drops in the patient's eye to make the pupil dilate. This procedure allows him or her to see the structures in the back of the eye. If the patient has RD, the doctor may see the retina lifted upward or forward, possibly moving back and forth. The retina will have a grayish color with darker blood vessels visible. It may have a pitted surface resembling an orange peel, and there may also be a line visible at the edge of the detachment.

**LABORATORY AND IMAGING STUDIES.** Today, there are no laboratory tests for retinal detachment. **Ultrasound**, however, can be used to diagnose retinal detachment if the doctor cannot see the retina with a slit lamp because of cataracts or blood seeping into the vitreous body. If the RD is exudative, ultrasound can be used to detect a tumor or hemorrhage underneath the retina.

### *Preparation*

Treatment of RD follows as soon as possible after the diagnosis; however, an immediate procedure is not usually necessary since the time frame for treatment of a detached retina is several hours rather than only a few minutes.

If the patient has suffered a traumatic injury to the eye, the eye may be covered with a protective shield prior to treatment.

Preparation for photocoagulation therapy consists of eye drops that dilate the pupil of the eye and

numb the eye itself. The laser treatment is painless, although some patients require additional anesthetic for sensitivity to the laser light.

### Aftercare

Patients who have had photocoagulation therapy for retinal detachment are asked to have a friend or family member drive them home. The reason for this precaution is that the eye medication used to dilate the pupil of the patient's eye before the procedure takes several hours to wear off. During this period, the eye is unusually sensitive to light. The patient can go to work the next day with no restrictions on activity.

### Risks

The most common risks of laser photocoagulation therapy are mild discomfort at the beginning of the procedure and the possibility that a second laser treatment will be needed to reattach the retina securely.

### Normal results

Over 90% of retinal detachments can be repaired with prompt treatment, although sometimes a second procedure is needed. About 40% of patients treated for retinal detachment will have good vision within six months of surgery. The results are less favorable if the retina has been detached for a long time or if there is a large growth of fibrous tissue that has caused a traction detachment. These patients, however, will still have some degree of reading or traveling vision after the retina has been reattached. In a very small minority of patients, the surgeon cannot reattach the retina because of extensive growths of fibrous scar tissue on it.

### Morbidity and mortality rates

The mortality rate for laser photocoagulation treatment of retinal detachment is extremely low; morbidity depends to a large extent on the cause of the RD. A study done in 2001 reported that laser therapy for rhegmatogenous RDs is as effective as pneumatic retinopexy or **scleral buckling**, but has the advantage of fewer complications after the procedure. In the treatment of ROP, laser photocoagulation has been found to be more effective than cryopexy in reducing the infant's risk of nearsightedness in later life.

### Alternatives

Alternatives to laser photocoagulation as a treatment for RD depend on the location and size of the retinal detachment. Photocoagulation treatment works best on small tears in the retina. One alternative

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Laser treatment of retinal detachment is performed by an ophthalmologist, who has specialized in the medical and surgical treatment of eye disorders. Ophthalmology is one of 24 specialties recognized by the American Board of Medical Specialties.

Photocoagulation therapy for retinal detachment is done as an outpatient procedure, either in the ophthalmologist's office or in an ambulatory surgery center.

for the treatment of small areas of detachment is cryopexy, which is performed as an outpatient procedure under **local anesthesia**. In cryopexy, the ophthalmologist uses nitrous oxide to freeze the tissue underneath the retinal tear. This procedure leads to the formation of scar tissue that seals the edges of the tear in place.

Pneumatic retinopexy is a procedure that can be used if the RD is located in the upper part of the eye. After numbing the patient's eye with a local anesthetic, the ophthalmologist injects a small bubble of gas into the vitreous body. The gas bubble rises and presses the torn part of the retina back against the underlying choroid. The bubble is slowly absorbed over the next two weeks. The ophthalmologist then uses either photocoagulation or cryopexy to complete the reattachment of the retina.

If the RD is large, the doctor may decide to perform a scleral buckle treatment or a vitrectomy. These procedures are more invasive than laser photocoagulation or cryopexy; however, they are still usually done as outpatient procedures. In a scleral buckle procedure, the doctor attaches a tiny silicon band to the sclera. The buckle, which remains in the eye permanently, puts pressure on the retina to hold it in place.

In a vitrectomy, the ophthalmologist removes the vitreous body and replaces it with air or a saline solution that puts pressure on the retina to hold it in place. Vitrectomies are usually performed if there is a very large tear in the retina; if the macula is involved; or if blood that has leaked into the vitreous body is interfering with diagnosis or treatment.

### Resources

#### BOOKS

- Marx, John A., et al. *Rosen's Emergency Medicine*. 6th ed. St. Louis, MO: Mosby, Inc., 2006.
- Yanoff, M et al. *Ophthalmology*. 2nd ed. St. Louis: Mosby, 2004.



## QUESTIONS TO ASK THE DOCTOR

- What are my chances of having normal vision after the laser therapy?
- What is the likelihood of my needing another laser treatment?
- Am I likely to develop retinal detachment in my other eye?
- How often should I schedule preventive eye examinations from now on?

### PERIODICALS

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- Wu, Lihteh, and Carlos Cabezas. "Retinal Detachment, Exudative." *eMedicine*, June 28, 2001 [March 24, 2003]. [www.emedicine.com/OPH/topic407.htm](http://www.emedicine.com/OPH/topic407.htm).

### ORGANIZATIONS

American Academy of Ophthalmology. P. O. Box 7424, San Francisco, CA 94120-7424. (415) 561-8500. [www.aao.org](http://www.aao.org).

American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991-4100. [www.aoanet.org](http://www.aoanet.org).

Canadian Ophthalmological Society (COS). 610-1525 Carling Avenue, Ottawa ON K1Z 8R9 Canada. [www.eyesite.ca](http://www.eyesite.ca).

Diabetic Retinopathy Foundation. 350 North LaSalle, Suite 800, Chicago, IL 60610. [www.retinopathy.org](http://www.retinopathy.org).

Wills Eye Hospital. 840 Walnut Street, Philadelphia, PA 19107. (215) 928-3000. [www.willseye.org](http://www.willseye.org).

Rebecca Frey, PhD

## Photorefractive keratectomy (PRK)

### Definition

Photorefractive keratectomy (PRK) is a noninvasive refractive surgery in which the surgeon uses an excimer laser to reshape the cornea of the eye by removing the epithelium, the gel-like outer layer of the cornea.

### Purpose

PRK, one of the first (and once the most popular) refractive surgeries, eliminates or reduces moderate nearsightedness (myopia), hyperopia (farsightedness), and astigmatism; it is most commonly used to treat myopia. Successfully treated PRK patients no longer require corrective lenses, and those who do still require correction, require much less.

PRK is an elective, **outpatient surgery**, and people choose the treatment for different reasons. Some simply no longer want to wear eyeglasses for cosmetic reasons. Sports enthusiasts may find eyeglasses or contact lenses troublesome during physical activities. Others may experience pain or dryness while wearing contact lenses, or have corneal ulcers that make wearing contact lenses painful. Firefighters and police officers may have trouble seeing in emergency situations when their contact lenses get dry or their eyeglasses fog up.

### Demographics

There is no such thing as a typical PRK patient. Because it is an **elective surgery**, patients come from every age group and income bracket. PRK candidates, however, must be 18 or older; have myopia, hyperopia, or astigmatism; and have had stable vision for at least two years. While PRK is experiencing a slight resurgence in popularity, it lags behind the newer and less painful **laser in-situ keratomileusis (LASIK)**. The American Academy of Ophthalmology (AAO) estimates that 95% of all refractive surgeries are **LASIK**.

## KEY TERMS

**Ablation**—The vaporization of eye tissue.

**Astigmatism**—Asymmetric vision defects due to irregularities in the cornea.

**Cornea**—The clear, curved tissue layer in front of the eye. It lies in front of the colored part of the eye (iris) and the black hole in the center of the iris (pupil).

**Corneal topography**—Mapping the cornea's surface with a specialized computer that illustrates corneal elevations.

**Dry eye**—Corneal dryness due to insufficient tear production.

**Enhancement**—A secondary refractive procedure performed in an attempt to achieve better visual acuity.

**Excimer laser**—An instrument that is used to vaporize tissue with a cold, coherent beam of light with a single wavelength in the ultraviolet range.

**Hyperopia**—The inability to see near objects as clearly as distant objects, and the need for accommodation to see objects clearly.

**Myopia**—A vision problem in which distant objects appear blurry. People who are myopic or nearsighted can usually see near objects clearly, but not far objects.

**Presbyopia**—A condition affecting people over the age of 40 in which the focusing of near objects fails to work because of age-related hardening of the lens of the eye.

The first PRK patients are sometimes referred to as “early adopters.” These are people who are always interested in the latest technology and have the financial resources to take advantage of it. In the mid-1990s when PRK was first approved, patients were in their early 30s to mid-40s and financially stable. Prices have now stabilized at about \$1,800 per eye for PRK.

While it has lost favor with the general public, PRK is the choice of the United States military. Military doctors prefer PRK over LASIK because the latter involves cutting a flap that doctors fear may loosen and become unhinged during combat.

### Description

PRK was first performed in the 1980s and widely used in Europe and Canada in the early 1990s, but was not approved in the United States until 1995. PRK

was the most popular refractive procedure until the creation of LASIK, which has a much shorter recovery time. PRK is still the preferred option for patients with thin corneas, corneal dystrophies, corneal scars, or recurrent corneal erosion.

PRK takes about 10 minutes to perform. Immediately before the procedure, the ophthalmologist may request corneal topography (a corneal map) to compare with previous maps to ensure the treatment plan is still correct. Ophthalmic personnel will perform a refraction to make sure the refractive correction the surgeon will program into the excimer laser is correct.

Patients may be given a sedative such as Valium to relax them before the surgery. Anesthetic drops will be applied to numb the eye and prevent pain during the procedure.

After the eye drops are inserted, the surgeon prepares the treated eye for surgery. If both eyes are being treated on the same day, the non-treated eye is patched. The surgeon inserts a speculum in the first eye to be treated to hold the eyelids apart and prevent movement. The patient stares at the blinking light of a laser microscope and must fixate his or her gaze on that light. The patient must remain still.

The surgeon double-checks the laser settings to make sure they are programmed correctly for the refractive error. With everything in place, the eye surgeon removes the surface corneal cells (epithelium) with a sponge, mechanical blade, or the excimer laser. With the epithelium completely removed, the surgeon will begin reshaping, or ablating, the cornea. This takes 15–45 seconds, and varies for refractive error; the stronger the error, the longer the ablation. Patients may worry that moving could cause irreversible eye damage, but they should know that, at the slightest movement, the doctor immediately stops the laser. When the ablation is completed, the surgeon places a bandage contact lens on the treated eye to protect it and allow the healing process to take place; it also eases some of the pain of the exposed cornea. The surgeon will also dispense anti-inflammatory and antibiotic eye drops to stop infection and reduce pain.

### Diagnosis/Preparation

Patients should have a complete eye evaluation and medical history taken before surgery. Soft contact lens wearers should stop wearing their lenses at least one week before the initial exam. Gas-permeable lens wearers should not wear their lenses from three weeks to a month before the exam. Contact lens wear alters the cornea's shape, which should be allowed to return to its natural shape before the exam.

Patients should also disclose current medications. Allergy medications and birth control pills have been known to cause haze after surgery. Physicians will want to examine the potential risks involved with these medications.

Patients who have these conditions/history should not have the procedure, including:

- pregnant women or women who are breastfeeding
- patients with very small or very large refractive errors
- patients with scarred corneas or macular disease
- people with autoimmune diseases
- diabetics
- glaucoma patients
- patients with persistent blepharitis

Physicians will perform a baseline eye evaluation, including a manifest and cycloplegic refraction, measurement of intraocular pressure (to determine if the patient has glaucoma), slit-lamp biomicroscopy, tear film evaluation, corneal topography, evaluation of corneal thickness, dilated fundus examination, and measurement of scotopic pupil size.

If the patient is an appropriate candidate, he or she must sign an **informed consent** form that states he or she is aware of possible complications and outcomes of the procedure.

#### *Presurgery preparations*

The patient is advised to discontinue contact lens wear immediately and refrain from using creams, lotions, makeup, or perfume for at least two days before surgery. Patients may also be asked to scrub their eyelashes for a period of time to remove any debris.

#### **Aftercare**

Patients usually have follow-up appointments at 24 hours, four days, one week, one month, three months, six months, and then annually following PRK. More frequent visits may be necessary, if there are complications.

Patients should refrain from strenuous activity for at least one month after surgery. Creams, lotions, and makeup must also be avoided for at least two weeks.

The bandage contact lens is removed by the surgeon usually after four days (during the second visit). Patients must be diligent in using antibiotic drops and steroid drops. Because the epithelium is completely removed, there is a greater chance of infection and pain; the eye drops are needed to minimize these possible complications. The eye drops must be used for at

least four months for some patients. The slow healing process is imperative to keeping the desired correction.

PRK has a long recovery rate, which is why LASIK gained popularity so quickly. Unlike LASIK, in which patients notice improved vision immediately and are back to normal routines the next day, PRK patients are advised to rest for at least two days. PRK patients also experience moderate pain the first few days of recovery, and may need pain relievers such as Demerol to ease the pain. Vision also fluctuates the first few weeks of recovery as the epithelium grows back. This can cause haze, and patients become concerned that the surgery was unsuccessful. PRK patients need to be aware that vision can fluctuate for as long as up to six months after surgery. Incorrect use of eye drops can cause regression.

#### **Risks**

PRK patients may experience glare, vision fluctuation, development of irregular astigmatism, vision distortion (even with corrective lenses), glaucoma, loss of best visual acuity, and, though extremely rare, total vision loss.

A more common side effect is long-term haze. Some patients who have aggressive healing processes can form corneal scars that can cause haze. With proper screening for this condition and with the use of eye drops, this risk can be lessened.

Complications associated with LASIK, such as photophobia, haloes, and dry eye, are not as common with PRK. However, The patient may be under-corrected or overcorrected, and enhancements might be needed to attain the best visual acuity.

#### **Normal results**

Most PRK patients achieve 20/40 vision, which means in most states they can legally drive a car without vision correction. Some patients will still need corrective lenses, but the lenses will not need to be as powerful.

There have been reports of regression after the PRK healing process is completed. Sometimes a patient will require an enhancement, and the surgeon must repeat the surgery. Patients should also be aware that with the onset of presbyopia after age 40, they will probably require vision correction for reading or close work.

#### **Morbidity and mortality rates**

Information about PRK mortality and morbidity is limited because the procedure is elective. Complications that can lead to more serious conditions, such as

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

An ophthalmologist performs PRK with the aid of ophthalmic technicians and nurses. The surgeon may have received specific refractive surgery training in medical school, but because it is a relatively new procedure, older surgeons may not have completed such training. Instead, these surgeons may have completed continuing medical education courses or may have had training provided by the laser companies.

Preparation and aftercare may be handled by an optometrist who works with the ophthalmologist on these cases. The optometrist usually establishes eligibility for PRK, and may also perform much of the follow-up, with the exception of the first post-PRK visit.

Hospitals are one setting for this surgery, but the most common location is an ambulatory surgery center or surgery suite. Surgeons at surgery centers owned by refractive surgery companies also perform PRK. These businesses hire support staff, optometrists and surgeons in a stand-alone surgery center or in a hospital.

infection, are treated with **topical antibiotics**. There is also a chance the patient could have a severe reaction to the **antibiotics** or steroids used in the healing process.

### Alternatives

Because these patients only have mild to moderate myopia, hyperopia, or astigmatism, they can choose from most refractive surgeries and non-surgical procedures.

#### *Surgical alternatives*

- **Laser in-situ keratomileusis (LASIK).** The most popular refractive surgery, it is similar to PRK, but differs in how it reshapes the cornea. Instead of completely removing tissue, LASIK leaves a “flap” of tissue that the surgeon moves back into place after ablation. LASIK is less painful with a shorter recovery time. However, there are more complications associated with LASIK.
- **Radial keratotomy (RK).** RK was the first widely used surgical correction for mild to moderate

## QUESTIONS TO ASK THE DOCTOR

- Why do you believe that PRK is the correct refractive surgery for me?
- How many PRK procedures have you performed?
- Is PRK your preferred procedure?
- How well will I see after the surgery?
- How many of your patients experience serious complications?
- Who will treat complications, if any, after the procedure?
- How long with the recovery process take? Do I need to limit my activities?

myopia. The surgeon alters the shape of the cornea without a laser. This is one of the oldest refractive procedures, and has proved successful on lower and moderate corrections.

- **Astigmatic keratotomy (AK).** AK is a variation of RK used to treat mild to moderate astigmatism. AK has proved successful if the errors are mild to moderate.

#### *Non-surgical alternatives*

Contact lenses and eyeglasses also can correct refractive errors. Improvements in contact lenses have made them easier to wear, and continuous-wear contact lenses, which a patient can sleep in for as long as 30 days, can provide a similar effect to PRK. A customized rigid gas-permeable contact lens is used for orthokeratology (Ortho-K), in which a patient wears the lens for a predetermined amount of time to reshape the cornea. After removing the lens, the patient’s vision is improved and remains improved until the cornea returns to its natural shape. At that time, the patient repeats the process.

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#### ORGANIZATIONS

American Academy of Ophthalmology. P.O. Box 7424, San Francisco, CA 94120 7424. (415) 561 8500.  
www.aao.org.

American Society of Cataract and Refractive Surgery. 4000 Legato Road, Suite 850, Fairfax, VA 22033 4055. (703) 591 2220. E mail: ascrs@ascrs.org. www.ascrs.org.



Council for Refractive Surgery Quality Assurance. 8543 Everglade Drive, Sacramento, CA 95826 0769. (916) 381 0769. E mail: info@usaeyes.org. www.usaeyes.org.

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Mary Bekker

## Physical examination

### Definition

A physical examination is an evaluation of the body and its functions using inspection, palpation (feeling with the hands), percussion (tapping with the fingers), and auscultation (listening). A complete health assessment also includes gathering information about a person's medical history and lifestyle, doing laboratory tests, and screening for disease.

### Purpose

The annual physical examination has been replaced by the periodic health examination. How often this is done depends on the patient's age, sex, and risk factors for disease. The United States Preventative Services Task Force (USPSTF) has developed guidelines for preventative health examinations that health care professionals widely follow. Organizations that promote detection and prevention of specific diseases, like the American Cancer Society, generally recommend more intensive or frequent examinations.

A comprehensive physical examination provides an opportunity for the healthcare professional to obtain baseline information about the patient for future use, and to establish a relationship before problems happen. It provides an opportunity to answer questions and teach good health practices. Detecting a problem in its early stages can have good long-term results.

### Precautions

The patient should be comfortable and treated with respect throughout the examination. As the examination proceeds, the examiner should explain what he or she is doing and share any relevant findings.

### Description

A complete physical examination usually starts at the head and proceeds all the way to the toes. However, the exact procedure will vary according to the needs of the patient and the preferences of the examiner. An average examination takes about 30 minutes. The cost of the examination will depend on the charge for the professional's time and any tests that are done. Most health plans cover routine physical examinations including some tests.

#### *The examination*

First, the examiner will observe the patient's appearance, general health, and behavior, along with measuring height and weight. The vital signs—including pulse, breathing rate, **body temperature**, and blood pressure—are recorded.

With the patient sitting up, the following systems are reviewed:

- Skin. The exposed areas of the skin are observed; the size and shape of any lesions are noted.
- Head. The hair, scalp, skull, and face are examined.
- Eyes. The external structures are observed. The internal structures can be observed using an ophthalmoscope (a lighted instrument) in a darkened room.
- Ears. The external structures are inspected. A lighted instrument called an otoscope may be used to inspect internal structures.
- Nose and sinuses. The external nose is examined. The nasal mucosa and internal structures can be observed with the use of a penlight and a nasal speculum.
- Mouth and pharynx. The lips, gums, teeth, roof of the mouth, tongue, and pharynx are inspected.
- Neck. The lymph nodes on both sides of the neck and the thyroid gland are palpated (examined by feeling with the fingers).
- Back. The spine and muscles of the back are palpated and checked for tenderness. The upper back, where the lungs are located, is palpated on the right and left sides and a stethoscope is used to listen for breath sounds.

- **Breasts and armpits.** A woman's breasts are inspected with the arms relaxed and then raised. In both men and women, the lymph nodes in the armpits are felt with the examiner's hands. While the patient is still sitting, movement of the joints in the hands, arms, shoulders, neck, and jaw can be checked.

Then while the patient is lying down on the examining table, the examination includes:

- **Breasts.** The breasts are palpated and inspected for lumps.
- **Front of chest and lungs.** The area is inspected with the fingers, using palpation and percussion. A stethoscope is used to listen to the internal breath sounds.

The head should be slightly raised for:

- **Heart.** A stethoscope is used to listen to the heart's rate and rhythm. The blood vessels in the neck are observed and palpated.

The patient should lie flat for:

- **Abdomen.** Light and deep palpation is used on the abdomen to feel the outlines of internal organs including the liver, spleen, kidneys, and aorta, a large blood vessel.
- **Rectum and anus.** With the patient lying on the left side, the outside areas are observed. An internal digital examination (using a finger), is usually done if the patient is over 40 years old. In men, the prostate gland is also palpated.
- **Reproductive organs.** The external sex organs are inspected and the area is examined for hernias. In men, the scrotum is palpated. In women, a pelvic examination is done using a speculum and a Papanicolaou test (Pap test) may be taken.
- **Legs.** With the patient lying flat, the legs are inspected for swelling, and pulses in the knee, thigh, and foot area are found. The groin area is palpated for the presence of lymph nodes. The joints and muscles are observed.
- **Musculoskeletal system.** With the patient standing, the straightness of the spine and the alignment of the legs and feet is noted.
- **Blood vessels.** The presence of any abnormally enlarged veins (varicose), usually in the legs, is noted.

In addition to evaluating the patient's alertness and mental ability during the initial conversation, additional inspection of the nervous system may be indicated:

- **Neurologic screen.** The patient's ability to take a few steps, hop, and do deep knee bends is observed. The strength of the hand grip is felt. With the patient sitting down, the reflexes in the knees and feet can be tested with a small hammer. The sense of touch in

the hands and feet can be evaluated by testing reaction to pain and vibration.

- Sometimes additional time is spent examining the 12 nerves in the head (cranial) that are connected directly to the brain. They control the sense of smell, strength of muscles in the head, reflexes in the eye, facial movements, gag reflex, and muscles in the jaw. General muscle tone and coordination, and the reaction of the abdominal area to stimulants like pain, temperature, and touch would also be evaluated.

## Preparation

Before visiting the health care professional, the patient should write down important facts and dates about his or her own medical history, as well as those of family members. He or she should have a list of all medications with their doses or bring the actual bottles of medicine along. If there are specific concerns about anything, writing them down is a good idea.

Before the physical examination begins, the bladder should be emptied and a urine specimen can be collected in a small container. For some blood tests, the patient may be told ahead of time not to eat or drink after midnight.

The patient usually removes all clothing and puts on a loose-fitting hospital gown. An additional sheet is provided to keep the patient covered and comfortable during the examination.

## Aftercare

Once the physical examination has been completed, the patient and the examiner should review what laboratory tests have been ordered and how the results will be shared with the patient. The medical professional should discuss any recommendations for treatment and follow-up visits. Special instructions should be put in writing. This is also an opportunity for the patient to ask any remaining questions about his or her own health concerns.

## Risks

Other than discovering an unknown condition or health problem, which is the reason for performing a physical examination, there are no risks associated with the procedure.

## Normal results

Normal results of a physical examination correspond to the healthy appearance and normal functioning of the body. For example, appropriate reflexes will be

## KEY TERMS

**Auscultation**—The process of listening to sounds that are produced in the body. Direct auscultation uses the ear alone, such as when listening to the grating of a moving joint. Indirect auscultation involves the use of a stethoscope to amplify the sounds from within the body, like a heartbeat.

**Hernia**—The bulging of an organ, or part of an organ, through the tissues normally containing it; also called a rupture.

**Inspection**—The visual examination of the body using the eyes and a lighted instrument if needed. The sense of smell may also be used.

**Ophthalmoscope**—Lighted device for studying the interior of the eyeball.

**Otoscope**—An instrument with a light for examining the internal ear.

**Palpation**—The examination of the body using the sense of touch. There are two types: light and deep.

**Percussion**—An assessment method in which the surface of the body is struck with the fingertips to obtain sounds that can be heard or vibrations that can be felt. It can determine the position, size, and consistency of an internal organ. It is done over the chest to determine the presence of normal air content in the lungs, and over the abdomen to evaluate air in the loops of the intestine.

**Reflex**—An automatic response to a stimulus.

**Speculum**—An instrument for enlarging the opening of any canal or cavity in order to facilitate inspection of its interior.

**Stethoscope**—A Y-shaped instrument that amplifies body sounds such as heartbeat, breathing, and air in the intestine. Used in auscultation.

**Varicose veins**—The permanent enlargement and twisting of veins, usually in the legs. They are most often seen in people with occupations requiring long periods of standing, and in pregnant women.

present, no suspicious lumps or lesions will be found, and **vital signs** will be normal.

## Abnormal results

Abnormal results of a physical examination include any findings that indicated the presence of a disorder, disease, or underlying condition. For example, the presence of lumps or lesions, fever, muscle weakness or lack

of tone, poor reflex response, heart arrhythmia, or swelling of lymph nodes will point to a possible health problem.

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### ORGANIZATIONS

American Academy of Family Physicians. 11400 Tomahawk Creek Parkway, Leawood, KS 66211 2672. (913) 906 6000. E mail: [fp@aafp.org](mailto:fp@aafp.org). <http://www.aafp.org>.

American Academy of Pediatrics. 141 Northwest Point Boulevard, Elk Grove Village, IL 60007 1098. (847) 434 4000; Fax: (847) 434 8000. E mail: [kidsdoc@aap.org](mailto:kidsdoc@aap.org). <http://www.aap.org/default.htm>.

American College of Physicians. 190 N Independence Mall West, Philadelphia, PA 19106 1572. (800) 523 1546, x2600, or (215) 351 2600. <http://www.acponline.org>.

American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464 5000. <http://www.ama-assn.org>.

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L. Fleming Fallon, Jr, MD, DrPH

Pitocin see **Uterine stimulants**

Pituitary gland removal see

**Hypophysectomy**

## Planning a hospital stay

### Definition

Planning a hospital stay includes determining what hospitals or facilities are covered by the patient's insurance plan, evaluating the credentials of the health care providers and the hospital, gathering information about the hospital, including services offered, scheduling the hospital stay, completing pre-admission testing, receiving and following all of the appropriate pre-admission instructions, registering at the hospital upon arrival, and completing an **informed consent** form.

### Purpose

Patients are admitted to the hospital for a variety of reasons, including scheduled tests, procedures, or surgeries, emergency medical treatment, administration of medication, or to stabilize or monitor an existing medical condition.

Planning a hospital stay helps the patient understand what to expect before **admission to the hospital** and ensures the patient is physically and psychologically ready.

### Description

If the hospital stay was planned, some of the steps involved in preparing for the hospital stay will take place beginning one to two weeks before the patient is admitted to the hospital. Many of these steps will not apply if the hospital stay was unexpected or was the result of an emergency.

### Determining insurance coverage

Although there are many types of hospitals available to meet the needs of different patients, the patient's choice of hospital may be limited by his or her insurance plan. The patient should find out if the selected hospital is approved by his or her plan. If the patient receives care from a facility that is not approved by the health care plan, the patient may be responsible for paying for most or all of the medical expenses related to the hospital stay.

Managed care insurance plans often require pre-certification before any hospital stay, except for emergency hospital admissions. Usually, the patient's doctor has to authorize the hospital stay, and some types of care provided in the hospital may require insurance clearance.

If the patient has **Medicare** insurance (for patients over age 65), a semiprivate room, meals, general nursing care, and other **hospital services** and supplies are covered services. Those services not covered by Medicare include private duty nursing, a private room (unless medically necessary), and television and telephone fees.

The patient may desire to seek a **second opinion** to confirm the doctor's treatment recommendations. The patient should check with his or her insurance provider to determine if the second opinion consultation is covered.

**FOR PATIENTS WITHOUT INSURANCE COVERAGE.** For patients who do not have insurance coverage, other payment options and sources of financial aid can be discussed. The patient should ask to speak with the hospital's financial counselor for more information.

### Evaluating credentials

The patient should find out if the physicians who will provide care in the hospital are board certified. Even though board certification is not required for an individual physician to practice medicine, most hospitals require that a certain percentage of their staff be board certified. There are 24 certifying boards recognized by the American Board of Member Specialties (ABMS) and the American Medical Association (AMA). Most of the ABMS boards issue time-limited certificates, valid for six to 10 years. This requires physicians to become re-certified to maintain their board certification—a process that includes a credential review, continuing education in the specialty, and additional examinations.



## KEY TERMS

**Anesthesiologist**—A specially trained physician who administers anesthesia.

**Case manager**—A health care professional who can provide assistance with a patient's needs beyond the hospital.

**Catheter**—A small, flexible tube used to deliver fluids or medications or used to drain fluid or urine from the body.

**Clinical nurse specialists**—Nurses with advanced training as well as a master's degree.

**Discharge planner**—A health care professional who helps patients arrange for health and home care needs after they go home from the hospital.

**Electrocardiogram (ECG, EKG)**—A test that records the electrical activity of the heart using small electrode patches attached to the skin on the chest.

**General anesthesia**—Anesthesia that makes the patient unconscious and not feel pain.

**Guided imagery**—A form of focused relaxation that coaches the patient to visualize calm, peaceful images.

**Infectious disease team**—A team of physicians who help control the hospital environment to protect patients against harmful sources of infection.

**Informed consent**—An educational process between health care providers and patients intended to instruct the patient about the nature and purpose of the procedure or treatment, the risks and benefits of the procedure, and alternatives, including the option of not proceeding with the test or treatment.

**Inpatient surgery**—Surgery that requires an overnight stay of one or more days in the hospital.

**Local anesthesia**—Anesthesia that numbs a localized area of the body.

**NPO**—A term that means "nothing by mouth." NPO refers to the time after which the patient is not allowed to eat or drink prior to a procedure or treatment.

**Nurse manager**—The nurse responsible for managing the nursing care on the nursing unit and also supervises all of the other personnel who work on the nursing unit.

**Nursing unit**—The floor or section of the hospital where patient rooms are located.

**Outpatient surgery**—Also called same-day or ambulatory surgery.

**Pharmacologist**—Medication specialist who checks patients' blood levels to monitor their response to immunosuppressive medications.

**Regional anesthesia**—Anesthesia that does not make the patient unconscious; it works by blocking sensation in a region of the body.

**Registered nurses**—Specially trained nurses who provide care during the patient's hospital stay. Registered nurses provide medical care, medications, and education, as well as assess the patient's condition.

**Social worker**—A health care provider who can provide support to patients and families, including assistance with a patient's psychosocial adjustment needs and referrals for community support.

A physician's membership in professional societies is also an important consideration. Professional societies provide an independent forum for medical specialists to discuss issues of mutual interest and concern. They provide a place for doctors to discuss the latest practices and technologies, and to learn from each others' experiences of cases that went well or poorly. Examples of professional societies include the Society of Thoracic Surgeons (STS) and the American College of Physicians–American Society of Internal Medicine (ACP-ASIM).

To find information about a physician's qualifications, the patient can call a state or county medical association for assistance. A reference book is also available, *The Official ABMS Directory of Board-Certified Medical Specialists*, which lists all physicians

who are certified by approved boards. This publication also contains brief information about each physician's medical education and training. The directory can be found in many hospital and university libraries, and in some local libraries.

### *Evaluating the health care team*

Selecting a hospital that has a multi-disciplinary team of specialists is important. The medical team should include surgeons (as applicable), physicians who specialize in the patient's medical condition (such as cardiologists for heart disease and pulmonologists for lung disease), infectious disease specialists, pharmacologists, and advanced care registered nurses. Other medical team members may include fellows, residents, interns, clinical coordinators, physical therapists, occupational therapists,

respiratory therapists, registered dietitians, social workers, and financial counselors.

### *Evaluating the hospital*

The patient should find out if the hospital has been accredited by the Joint Commission on Accreditation of Healthcare Organizations, a professionally sponsored program that stimulates a high quality of patient care in health care facilities. Joint Commission accreditation means the hospital voluntarily sought accreditation and met national health and safety standards.

Here are some questions to consider when evaluating a hospital:

- Does the hospital offer treatment for the patient's specific condition? How experienced is the hospital staff in treating that condition?
- What is the hospital's success record in providing the specific medical treatment or procedure the patient needs?
- Does the hospital have experience treating other patients the same age as the potential patient?
- Does the hospital explain the patient's rights and responsibilities?
- Does the hospital have a written description of its services and fees?
- How much does the patient's type of treatment cost at the hospital?
- Is financial help available?
- Who will be responsible for the patient's specific care plan while he or she is in the hospital?
- If the hospital is far from the patient's home; will accommodations be provided for caregivers?
- What type of services are available during the patient's hospital stay?
- Will a discharge plan be developed before the patient goes home from the hospital?
- Does the hospital provide training to help the patient care for his or her condition at home?

### *Hospital services*

Usually, the patient receives information about the hospital from the admitting office when the hospital stay is scheduled. This information should include directions to the hospital, parking information, lodging information if the patient is from out of town, types of rooms, and services offered.

Hospital services offered may include:

- Ethics consultation: Bioethics professionals are available at most hospitals to provide advice or help the

patient identify, analyze, and resolve ethical issues that may arise during the patient's care at the hospital.

- Barber or beautician: These services may incur a fee, in addition to the fees of the patient's hospital stay.
- Complementary techniques such as guided imagery and relaxation tapes, massage therapy, or aromatherapy (to reduce a patient's stress and anxiety).
- Home care: If home health services will be needed after the patient is discharged, they can be arranged by the social worker or nursing staff.
- Interpreter: An interpreter or other special services may be available to assist patients and family members who do not speak the language or are from out of the country.
- Nutrition therapy: Registered dietitians are available to provide comprehensive nutrition assessment, counseling, and education.
- Ombudsman: Health care personnel available to address concerns and problems about medical services that cannot be resolved by reporting these concerns to the nursing staff.
- Pastoral care: Clergy members are available at most hospitals to provide religious support and services to meet patients' spiritual needs. Many hospitals also have a small chapel that provides a quiet retreat for patients and family members of all religious backgrounds and faiths.
- Patient education: A variety of services are available to teach patients about their medical condition or to help them prepare for their scheduled tests or procedures. Patient education may include one-on-one instruction from a health care provider, educational sessions in a group setting, or self-guided learning videos or modules. Informative and instructional handouts are usually provided to explain specific medications, tests, or procedures.
- Pediatric services: Many hospitals have dedicated services and programs available to help children, teenagers, and their parents feel better prepared to cope more effectively with hospital stays, surgery, procedures, and other health-related events.
- Social work: Social workers are available to help patients manage the changes that may occur as a result of the patient's hospitalization. Social workers provide referrals to community resources and can help the family make arrangements for care in the home as necessary after the patient is discharged from the hospital.

### *Patient rights and responsibilities*

All hospitals have a list of **patient rights** and responsibilities, established by the American Hospital

Association. These rights and responsibilities are usually published and posted throughout the hospital. By law, all patients have certain rights. Some patient rights include the right to:

- considerate and respectful care
- complete information about diagnosis, treatment, and expected recovery in terms the patient can understand
- knowledge of the name and function of any health care professional providing care
- informed consent
- the right to refuse treatment to the extent permitted by law and be informed of the medical consequences of refusing treatment

Each patient should obtain a list of his or her rights and responsibilities prior to a hospital admission.

### *Hospital environment*

Most hospital rooms have a bed, bedside table, chair, telephone, television, and bathroom. Some hospitals charge a fee for use of the telephone or television; patients should be notified of these charges prior to their hospital admission. Each patient area has a call signal button so the patient can notify the nursing staff if help is needed. Most hospital rooms are doubles that are shared by two patients. In many cases a private room can be specifically requested in one is available. Some hospitals also have wards in which four or more patients stay in one room. Three nutritionally balanced meals are provided to the patient daily during a hospital stay; daily menus are usually provided for patients to select their food choices, as applicable. (Some patients have dietary restrictions so their food choices may be limited.)

### *Hospital caregivers*

Sometimes, the patient's personal or family physician is not the attending physician who is in charge of the patient's overall care and treatment in the hospital. The attending physician may be a doctor on the hospital staff or a specialist. Fellows, residents, or interns may also provide care. Fellows are doctors who receive training in a special area of medicine after their residency training. Residents are doctors who have recently graduated from medical school and are training in a medical specialty. Interns are first-year residents.

Nurses work closely with doctors to supervise the care provided in the hospital. Nurses take the patient's **vital signs**, administer medications, provide treatments, and teach patients how to care for themselves. The head nurse, also called the clinical nurse manager, coordinates care for each patient on the nursing unit.

Other health care providers include medical technologists, radiographers, and nuclear medicine technicians who perform diagnostic tests, therapists such as physical therapists, occupational therapists, and speech therapists who provide specialized care as needed, and dietitians who provide nutrition counseling and nutrition assessments. There are several other health care providers who may assist patients during their hospital stay; patients should ask for more information about the types of providers they may be in contact with during the time they are in the hospital.

### *Information for visitors and family members*

It may be helpful for the patient to select a spokesperson from the family to communicate with the health care providers. This may improve communication with the health care providers as well as with other family members. The patient should also communicate his or her wishes regarding the spokesperson's telephone communications to other family members.

Educational classes may be available for family members to learn more about the patient's condition and what to expect during the patient's **recovery at home**.

If a family member needs to contact the patient or the patient's other family members, the family member should call the hospital and ask for the nursing unit where the patient is staying. The nursing unit staff can connect the caller to the patient's room, take a message, or connect the caller to the patient's family members who are present. Since every hospital has **patient confidentiality** rules, some information may not be able to be disclosed over the telephone.

Most hospitals prohibit the use of cellular phones in patient care areas, as they interfere with the operation of medical equipment.

Most hospitals are smoke-free environments. There are usually designated outside areas where visitors can smoke.

Most hospitals have designated visiting hours that should be adhered to by family members and friends.

Most hospitals have on-site pharmacies where family members can fill the patient's prescriptions, gift shops, and a cafeteria. Usually a list of on-site and off-site dining options can be obtained from the hospital's information desk or social work department.

### *Preadmission testing*

Preadmission testing includes a review of the patient's medical history, a complete **physical examination**, a variety of tests, patient education, and meetings with the health care team. The review of the patient's

medical history includes an evaluation of the patient's previous and current medical conditions, surgeries and procedures, medications, and any other health conditions such as allergies that may impact the patient's hospital stay. Preadmission testing is generally scheduled for a few days before the hospital admission.

The patient may find it helpful to bring along a family member or friend to the preadmission testing appointments. This caregiver can help the patient remember important details to prepare for the hospital stay.

### *Preadmission instructions*

Preadmission instructions include information about reserving blood products if necessary, taking or discontinuing medications, eating and drinking, **smoking cessation**, limiting activities, and preparing items to bring to the hospital.

### *Blood transfusions and blood donation*

Blood transfusions may be necessary during surgery. A blood **transfusion** is the delivery of whole blood or blood components to replace blood lost through trauma, surgery, or disease. About one in three hospitalized patients will require a blood transfusion. The surgeon can provide an estimate of how much blood the patient's procedure may require.

To decrease the risk of infection and immunologic complications, some hospitals offer a **blood donation** program if surgery is scheduled or if it is known that blood products will be needed by the patient during his or her hospital stay. Autologous blood (from the patient) is the safest blood available for transfusion, since there is no risk of disease transmission. Methods of autologous donation or collection include:

- **Intraoperative blood collection:** The blood lost during surgery is processed, and the red blood cells are re-infused during or immediately after surgery.
- **Preoperative donation:** The patient donates blood once a week for about one to three weeks before surgery. The blood is separated and the blood components needed are re-infused during surgery.
- **Immediate preoperative hemodilution:** The patient donates blood immediately before surgery to decrease the loss of red blood cells during surgery. Immediately after donating, the patient receives fluids to compensate for the amount of blood removed. Since the blood is diluted, fewer red blood cells are lost from bleeding during surgery.
- **Postoperative blood collection:** Blood lost from the surgical site right after surgery is collected and re-infused after the surgical site has been closed.

The physician determines what type of blood collection process, if any, is appropriate.

### *Medication guidelines*

Depending on the reason for the hospital stay, certain medications may be prescribed or restricted. The health care team will provide specific guidelines. If certain medications need to be restricted before the hospital stay, the patient will receive a complete list of the medications (including prescription, over-the-counter, and herbal medications) to avoid taking. The patient should not bring any medications to the hospital unless specifically instructed to by the hospital staff. In the majority of cases all necessary medications, as ordered by the doctor, will be provided in the hospital.

### *Eating and drinking guidelines*

Before most procedures, the patient is advised not to eat or drink anything after midnight the evening before the surgery. This includes no smoking and no gum chewing. The patient should not drink any alcoholic beverages for at least 24 hours before being hospitalized, unless instructed otherwise.

### *Smoking cessation*

Patients are encouraged to quit smoking and stop using tobacco products prior to their hospital admission and to make a commitment to be a nonsmoker. Quitting smoking will help the patient recover more quickly. There are usually several community-based smoking cessation programs available. Members of the hospital staff are more than happy to recommend a program to fit the patient's needs.

### *Activity*

The patient should eat healthy foods, rest, and **exercise** as normal before a hospitalization, unless given other instructions. The patient should try to get enough sleep, although this can often be difficult if the patient is nervous or anxious about the upcoming hospital stay.

The patient should make arrangements ahead of time for someone to care for children and take care of any other necessary activities at home such as getting the mail or newspapers. The patient should inform family members about the scheduled hospital stay, so they can provide help and support.

### *Items to bring to the hospital*

The patient should bring a list of current medications, allergies, and appropriate medical records upon



admission to the hospital. The patient should also bring a prepared list of questions to ask.

The patient should not bring valuables such as jewelry, credit cards, checkbooks, or other such items. A small amount of cash (no more than \$20) may be packed to purchase items such as newspapers or magazines. If necessary, patients can secure their personal belongings in the hospital cashier's office, safe, or vault for safekeeping until discharge. Most hospitals state in their policies that they are not responsible for lost or stolen personal items.

The patient should only pack what is needed. Some essential items include a toothbrush, toothpaste, comb or brush, deodorant, razor (not electric), slippers, robe, pajamas, and one change of comfortable clothes to wear when going home. The patient should also pack eyeglasses, hearing aids, and dentures, including their carrying cases, if applicable. These items should be labeled with the patient's name when not in use, should be stored in their carrying cases, and put in the bedside stand so they are not lost. They should never be placed on food trays because they may be forgotten and thrown out with the food garbage.

The patient should bring a list of family members' names and phone numbers to contact in an emergency. The patient may also want to pack a book or other personal item such as a family picture.

Personal electronic devices such as hair dryers, curling irons, electric razors, personal televisions, computers, and other electronic devices are not permitted in the hospital, since these devices may interfere with the hospital's medical equipment.

### *Transportation*

The patient should arrange for transportation home, since the effects of certain medications given in the hospital make it unsafe to drive.

### **Hospital registration and admission**

Upon arriving at the hospital, the patient first reports to the hospital registration or admitting area. The patient will be required to complete paperwork and show an insurance identification card, if insured. Often, a pre-registration process performed prior to the date of hospital admission helps make the registration process run smoothly. An identification bracelet that includes the patient's name and doctor's name will be placed on the patient's wrist.

If the patient is not feeling well upon arrival to the hospital, a family member or caregiver can help the patient complete the admitting process. Sometimes, a

patient's illness may require that the hospital stay be rescheduled.

### *Informed consent*

The health care provider will review the informed consent form and ask the patient to sign it. Informed consent is an educational process between health care providers and patients. Before any procedure is performed or any form of medical care is provided, the patient is asked to sign a consent form. Before signing the form, the patient should understand the nature and purpose of the procedure or treatment, the risks and benefits of the procedure, and alternatives, including the option of not proceeding with the procedure. Signing the informed consent form indicates that the patient understands and permits the surgery or procedure to be performed. During the discussion about the procedure, health care providers are available to answer the patient's questions about the consent form or procedure.

### *Advance directives*

As part of the admissions process, the patient will be asked about advance directives. Advance directives are legal documents that increase a patient's control over medical decisions. A patient may decide medical treatment in advance, in the event that he or she becomes physically or mentally unable to communicate his or her wishes. Advance directives either state what kind of treatment the patient wants to receive (**living will**), or authorize another person to make medical decisions for the patient when he or she is unable to do so (**durable power of attorney**).

Advance directives are not required and may be changed or canceled at any time. Any change should be written, signed, and dated in accordance with state law, and copies should be given to the physician and to others who received original copies. Advance directives can be revoked either in writing or by destroying the document.

Advance directives are not do-not-resuscitate (DNR) orders. A **DNR order** indicates that a person—usually with a terminal illness or other serious medical condition—has decided not to have **cardiopulmonary resuscitation** (CPR) performed in the event that his or her heart or breathing stops.

### *Admission tests*

Some routine tests will be performed, including blood pressure, temperature, pulse, and weight checks, blood tests, **urinalysis**, **chest x ray**, and **electrocardiogram** (ECG). A brief physical exam will be performed.

## QUESTIONS TO ASK THE DOCTOR

- How can I prepare myself for the hospital stay?
- Who are the members of the health care team at this hospital?
- What types of questions should I ask my insurance provider to determine if the medical expenses of my hospital stay will be covered?
- What type of tests or procedures will be performed?
- What types of precautions must I follow before and after my hospital stay?
- Will I have to have blood transfusions during my hospital stay?
- Can I take my medications the day I am admitted to the hospital?
- Should I change my diet or eating habits before my hospital stay?
- How long will I have to stay in the hospital?
- What kind of pain or discomfort will I experience and what can I take to relieve it?
- What types of resources are available to me during my hospital stay, and during my recovery at home?
- After I go home from the hospital, how long will it take me to recover?
- What are the signs of infection, and what types of symptoms should I report to my doctor?
- What types of medications will I have to take? How long will I have to take them?
- When will I be able to resume my normal activities? When will I be able to drive? When will I be able to return to work?
- What lifestyle changes (including diet, weight management, exercise, and activity changes) are recommended to improve my condition?
- How often do I need to see my doctor for follow-up visits?

The health care team will ask several questions to evaluate the patient's condition. The patient should inform the health care team if he or she drinks alcohol on a daily basis so precautions can be taken to avoid complications.

### Results

Patients who receive proper preparation for their hospital experience, including physical and psychological preparation, are less anxious and are more likely to make a quicker recovery at home, with fewer complications.

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- American Association of Nurse Anesthetists (AANA). 222 South Prospect Avenue, Park Ridge, IL 60068-4001. (847) 692-7050. <http://www.aana.com/>.
- American College of Surgeons. 633 N. Saint Clair Street, Chicago, IL 60611-3211. (312) 202-5000. <http://www.facs.org/>.
- American Hospital Association. One North Franklin, Chicago, IL 60606. (312) 422-3000. <http://www.hospitalconnect.com>.
- American Society of Anesthesiologists (ASA). 520 North Northwest Highway, Park Ridge, IL 60068-2573. (847) 825-5586. <http://www.asahq.org/>.
- Joint Commission on Accreditation of Healthcare Organizations (JCAHO). One Renaissance Boulevard, Oakbrook Terrace, IL 60181. (630) 792-5800. <http://www.jcaho.org>.
- National Heart, Lung and Blood Institute. Information Center. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-2222. <http://www.nhlbi.nih.gov>.
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## Plastic, reconstructive, and cosmetic surgery

### Definition

Plastic, reconstructive, and cosmetic surgery procedures are a variety of operations performed in order to repair or restore body parts to look normal, or to

change a body part to look better. These types of surgery are highly specialized. They are characterized by careful preparation of a person's skin and tissues, by precise cutting and suturing techniques, and by care taken to minimize scarring. Recent advances in the development of miniaturized instruments, new materials for artificial limbs and body parts, and improved surgical techniques have expanded the range of plastic surgery procedures that can be performed.

### Purpose

Although these three types of surgery share some common techniques and approaches, they have somewhat different emphases. Plastic surgery is usually performed to treat birth defects and to remove skin blemishes such as warts, acne scars, or birthmarks. Cosmetic surgery procedures are performed to make persons look younger or enhance their appearance in other ways. Reconstructive surgery is used to reattach body parts severed in combat or accidents, to perform skin grafts after severe burns, or to reconstruct parts of person's body that were missing at birth or removed by surgery. Reconstructive surgery is the oldest form of plastic surgery, having developed out of the need to treat wounded soldiers in wartime.

### Demographics

The top 10 most commonly performed elective cosmetic surgeries in the United States include the following:

- liposuction
- breast augmentation
- eyelid surgery
- face lift
- tummy tuck
- collagen injections
- chemical peel
- laser skin resurfacing
- rhinoplasty
- forehead lift

There were approximately 31 million surgical procedures performed in the United States in 2006. Because many plastic and reconstructive surgical procedures are performed in private professional offices or as outpatient procedures, accurate statistics concerning the number of procedures performed are not available.

## KEY TERMS

**Blepharoplasty**—Surgical reshaping of the eyelid.

**Dermabrasion**—A technique for removing the upper layers of skin with planing wheels powered by compressed air.

**Face lift**—Plastic surgery performed to remove sagging skin and wrinkles from an individual's face.

**Liposuction**—A surgical technique for removing fat from under the skin by vacuum suctioning.

**Mammoplasty**—Surgery performed to change the size or shape of breasts.

**Rhinoplasty**—Surgery performed to change the shape of the nose.

### Description

#### *Plastic surgery*

Plastic surgery includes a number of different procedures that usually involve skin. Operations to remove excess fat from the abdomen ("tummy tucks"), **dermabrasion** to remove acne scars or tattoos, and reshaping the cartilage in children's ears (**otoplasty**) are common applications of plastic surgery.

#### *Cosmetic surgery*

Most cosmetic surgery is done on the face. It is intended either to correct disfigurement or to enhance a person's features. The most common cosmetic procedure for children is correction of a cleft lip or palate. In adults, the most common procedures are remodeling of the nose (**rhinoplasty**), removal of baggy skin around the eyelids (**blepharoplasty**), face lifts (rhytidectomy), or changing the size or shape of the breasts (mammoplasty). Although many people still think of cosmetic surgery as only for women, growing numbers of men are choosing to have face lifts and eyelid surgery, as well as hair transplants and "tummy tucks."

#### *Reconstructive surgery*

Reconstructive surgery is often performed on burn and accident victims. It may involve the rebuilding of severely fractured bones, as well as **skin grafting**. Reconstructive surgery includes such procedures as the reattachment of an amputated finger or toe, or implanting a prosthesis. Prostheses are artificial structures and materials that are used to replace missing limbs or teeth, or arthritic hip and knee joints.

## Diagnosis/Preparation

### General preparation

Preparation for nonemergency plastic or reconstructive surgery includes individual education, as well as medical considerations. Some operations, such as nose reshaping or the removal of warts, small birthmarks, and tattoos can be done as outpatient procedures under **local anesthesia**. Most plastic and reconstructive surgery, however, involves a stay in the hospital and **general anesthesia**.

### Medical preparation

Preparation for plastic surgery includes the surgeon's detailed assessment of the parts of an individual's body that will be involved. Skin grafts require evaluating suitable areas of skin for the right color and texture to match the skin at the graft site. Face lifts and cosmetic surgery in the eye area require very close attention to the texture of the skin and the placement of surgical cuts (incisions).

Persons scheduled for plastic surgery under general anesthesia will be given a **physical examination**, blood and urine tests, and other tests to make sure that they do not have any previously undetected health problems or blood clotting disorders. The surgeon will check the list of prescription medications that the prospective patient may be taking to make sure that none of them will interfere with normal blood clotting or interact with the anesthetic.

Individuals are asked to avoid using **aspirin** or medications containing aspirin for a week to two weeks before surgery, because these drugs lengthen the time of blood clotting. Smokers are asked to stop smoking two weeks before surgery because smoking interferes with the healing process. For some types of plastic surgery, individuals may be asked to donate several units of their own blood before the procedure, in case a **transfusion** is needed during the operation. The prospective patient will be asked to sign a consent form before the operation.

### Personal education

The surgeon will meet with the prospective patient before the operation is scheduled, in order to explain the procedure and to be sure that the individual is realistic about the expected results. This consideration is particularly important for people undergoing cosmetic surgery.

### Medical considerations

Some people should not have plastic surgery because of certain medical risks. These groups include:

- persons recovering from a heart attack, severe infection (for example, pneumonia), or other serious illnesses
- people with infectious hepatitis or HIV infections
- individuals with cancer whose cancer might spread (metastasize)
- people who are extremely overweight (Individuals who are more than 30% overweight should not have liposuction.)
- persons with blood clotting disorders

### Psychological

Plastic, cosmetic, and reconstructive surgeries have an important psychological dimension because of the high value placed on outward appearance in Western society. Many people who are born with visible deformities or disfigured by accidents later in life develop emotional problems related to social rejection. Other people work in fields such as acting, modeling, media journalism, and even politics, where their employment depends on how they look. Some people have unrealistic expectations of cosmetic surgery and think that it will solve all their life problems. It is important for anyone considering non-emergency plastic or cosmetic surgery to be realistic about its results. One type of psychiatric disorder, called body dysmorphic disorder, is characterized by an excessive preoccupation with imaginary or minor flaws in appearance. Persons with this disorder frequently seek unnecessary plastic surgery.

## Aftercare

### Medical

Medical aftercare following plastic surgery under general anesthesia includes bringing patients to a **recovery room**, monitoring their **vital signs**, and giving medications to relieve pain as necessary. Persons who have had fat removed from the abdomen may be kept in bed for as long as two weeks. Individuals who have had mammoplasties, **breast reconstruction**, and some types of facial surgery typically remain in the hospital for a week after the operation. Those who have had **liposuction** or eyelid surgery are usually sent home in a day or two.

People who have had outpatient procedures are usually given **antibiotics** to prevent infection and are sent home as soon as their vital signs are normal.

### Psychological

Some individuals may need follow-up psychotherapy or counseling after plastic or reconstructive surgery. These people typically include children whose schooling and social relationships have been affected



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Plastic, reconstructive, and cosmetic surgical procedures are performed by surgeons with specialized training in plastic and reconstructive surgery. Depending on the complexity of the procedures, they may be performed in hospitals as an inpatient, in outpatient facilities, or in private professional offices.

by birth defects, as well as persons of any age whose deformities or disfigurements were caused by trauma from accidents, war injuries, or violent crimes.

### Risks

The risks associated with plastic, cosmetic, and reconstructive surgery include the postoperative complications that can occur with any surgical operation under anesthesia. These complications include wound infection, internal bleeding, pneumonia, and reactions to the anesthesia.

In addition to these general risks, some plastic, cosmetic, and reconstructive surgical procedures carry specific risks:

- formation of undesirable scar tissue
- development of persistent pain, redness, or swelling in the area of the surgery
- infection inside the body related to inserting a prosthesis (These infections can result from contamination at the time of surgery or from bacteria migrating into the area around the prosthesis at a later time.)
- anemia or fat embolisms from liposuction
- rejection of skin grafts or tissue transplants
- loss of normal feeling or function in the area of the operation (For example, it is not unusual for women who have had mammoplasties to lose sensation in their nipples.)
- complications resulting from unforeseen technological problems (The best-known example of this problem was the discovery in the mid-1990s that breast implants made with silicone gel could leak into the recipient's body.)

### Normal results

Normal results include an individual's recovery from the surgery with satisfactory results and without complications.

## QUESTIONS TO ASK THE DOCTOR

- What will be the resulting appearance?
- Is the surgeon board certified in plastic and reconstructive surgery?
- How many similar procedures has the surgeon performed?
- What is the surgeon's complication rate?

### Morbidity and mortality rates

Morbidity and mortality rates vary with the complexity and severity of different procedures. Mortality is similar to that associated with all surgical procedures. Morbidity is influenced by personal expectations. From a surgical perspective, most morbidity is due to errors associated with anesthesia, procedure, pain medications, and after care. From an individual's perspective, morbidity involves the degree to which actual results compared to expected outcomes. The latter distinction is very subjective.

### Alternatives

Alternatives to plastic, reconstructive, and cosmetic surgical procedures include using various products that may be affixed to articles of clothing or the surface of the body.

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- American Academy of Facial Plastic and Reconstructive Surgery. 310 S. Henry Street, Alexandria, VA 22314. (703) 299 9291. <http://www.aafprs.org/>.
- American Board of Plastic Surgery. Seven Penn Center, Suite 400, 1635 Market Street, Philadelphia, PA 19103 2204. (215) 587 9322. <http://www.abplsurg.org/>.
- American College of Surgeons. 633 North Saint Claire Street, Chicago, IL, 60611. (312) 202 5000. <http://www.facs.org/>.
- American Society for Aesthetic Plastic Surgery. 11081 Winners Circle, Los Alamitos, California 90720. (888) 272 7711. <http://www.surgery.org/>.
- American Society of Plastic Surgeons. 444 E. Algonquin Rd., Arlington Heights, IL 60005. (847) 228 9900. <http://www.plasticsurgery.org/>.

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L. Fleming Fallon, Jr., MD, DrPH

Platelet count see **Complete blood count**

# Pneumectomy

## Definition

Pneumectomy is the medical term for the surgical removal of a lung.

## Purpose

A pneumectomy is most often used to treat lung cancer when less radical surgery cannot achieve satisfactory results. It may also be the most appropriate treatment for a tumor located near the center of the lung that affects the pulmonary artery or veins, which transport blood between the heart and lungs. In addition, pneumectomy may be the treatment of choice when the patient has a traumatic chest injury that has damaged the main air passage (bronchus) or the lung's major blood vessels so severely that they cannot be repaired.

## Demographics

Pneumonectomies are usually performed on patients with lung cancer, as well as patients with such noncancerous diseases as chronic obstructive pulmonary disease (COPD), which includes emphysema and chronic bronchitis. These diseases cause airway obstruction.

Approximately 342,000 Americans die of lung disease every year. Lung disease is responsible for one in seven deaths in the United States, according to the American Lung Association. This makes lung disease America's number three killer. More than 35 million Americans are now living with chronic lung disease.

## Lung cancer

Lung cancer is the leading cause of cancer-related deaths in the United States. It is projected to claim more than nearly 158,160,300 lives in 2007. Lung cancer kills more people than cancers of the breast, prostate, colon, and pancreas combined. Cigarette smoking accounts for nearly 90% of cases of lung cancer in the United States.

Lung cancer is the second most common cancer among both men and women and is the leading cause of **death** from cancer in both sexes. In addition to the use of tobacco as a major cause of lung cancer among smokers, second-hand smoke contributes to the development of lung cancer among nonsmokers. Exposure to asbestos and other hazardous substances is also known to cause lung cancer. Air pollution is also a probable cause, but makes a relatively small contribution to incidence and mortality rates. Indoor exposure to radon may also make a small contribution to the total incidence of lung cancer in certain geographic areas of the United States.

In each of the major racial/ethnic groups in the United States, the rates of lung cancer among men are about two to three times greater than the rates among women. Among men, age-adjusted lung cancer incidence

## KEY TERMS

**Bronchodilator**—A drug that relaxes bronchial muscles resulting in expansion of the bronchial air passages.

**Bronchopleural fistula**—An abnormal connection between an air passage and the membrane that covers the lungs.

**Corticosteroids**—Any of various adrenal-cortex steroids used as anti-inflammatory agents.

**Emphysema**—A chronic disease characterized by loss of elasticity and abnormal accumulation of air in lung tissue.

**Empyema**—An accumulation of pus in the lung cavity, usually as a result of infection.

**Malignant mesothelioma**—A cancer of the pleura (the membrane lining the chest cavity and covering the lungs) that typically is related to asbestos exposure.

**Pleural space**—The small space between the two layers of the membrane that covers the lungs and lines the inner surface of the chest.

**Pulmonary embolism**—Blockage of a pulmonary artery by a blood clot or foreign matter.

**Pulmonary rehabilitation**—A program to treat COPD, which generally includes education and counseling, exercise, nutritional guidance, techniques to improve breathing, and emotional support.

rates (per 100,000) range from a low of about 14 among Native Americans to a high of 117 among African Americans, an eight-fold difference. For women, the rates range from approximately 15 per 100,000 among Japanese Americans to nearly 51 among Native Alaskans, only a three-fold difference.

### *Chronic obstructive pulmonary disease*

The following are risk factors for COPD:

- current smoking or a long-term history of heavy smoking
- employment that requires working around dust and irritating fumes
- long-term exposure to second-hand smoke at home or in the workplace
- a productive cough (with phlegm or sputum) most of the time
- shortness of breath during vigorous activity

- shortness of breath that grows worse even at lower levels of activity
- a family history of early COPD (before age 45)

## Diagnosis/Preparation

### *Diagnosis*

In some cases, the diagnosis of a lung disorder is made when the patient consults a physician about chest pains or other symptoms. The symptoms of lung cancer vary somewhat according to the location of the tumor; they may include persistent coughing, coughing up blood, wheezing, fever, and weight loss. In cases involving direct trauma to the lung, the decision to perform a pneumectomy may be made in the emergency room. Before scheduling a pneumectomy, however, the surgeon reviews the patient's medical and surgical history and orders a number of tests to determine how successful the surgery is likely to be.

In the case of lung cancer, blood tests, a bone scan, and computed tomography scans of the head and abdomen indicate whether the cancer has spread beyond the lungs. **Positron emission tomography (PET)** scanning is also used to help stage the disease. Cardiac screening indicates how well the patient's heart will tolerate the procedure, and extensive pulmonary testing (e.g., breathing tests and quantitative ventilation/perfusion scans) predicts whether the remaining lung will be able to make up for the patient's diminished ability to breathe.

### *Preparation*

A patient who smokes must stop as soon as a lung disease is diagnosed. Patients should not take **aspirin** or ibuprofen for seven to 10 days before surgery. Patients should also consult their physician about discontinuing any blood-thinning medications such as Coumadin or warfarin. The night before surgery, patients should not eat or drink anything after midnight.

## Description

In a conventional pneumectomy, the surgeon removes only the diseased lung itself. In a partial pneumectomy, one or more lobes of a lung are removed. In an extrapleural pneumectomy, the surgeon removes the lung, part of the membrane covering the heart (pericardium), part of the diaphragm, and the membrane lining the chest cavity (parietal pleura). Either operation is extensive, and require that the patient be given **general anesthesia**. An intravenous line inserted into one arm supplies fluids and medication throughout the operation, which usually lasts one to three hours.

The surgeon begins the operation by cutting a large opening on the same side of the chest as the diseased lung. This posterolateral **thoracotomy** incision extends from a point below the shoulder blade around the side of the patient's body along the curvature of the ribs at the front of the chest. Sometimes the surgeon removes part of the fifth rib in order to have a clearer view of the lung and greater ease in removing the diseased organ.

A surgeon performing a traditional pneumectomy then:

- deflates (collapses) the diseased lung
- ties off the lung's major blood vessels to prevent bleeding into the chest cavity
- clamps the main bronchus to prevent fluid from entering the air passage
- cuts through the bronchus
- removes the lung
- staples or sutures the end of the bronchus that has been cut
- makes sure that air is not escaping from the bronchus
- inserts a temporary drainage tube between the layers of the pleura (pleural space) to draw air, fluid, and blood out of the surgical cavity
- closes the chest incision

### Aftercare

Chest tubes drain fluid from the incision and a respirator helps the patient breathe for at least 24 hours after the operation. The patient may be fed and medicated intravenously. If no complications arise, the patient is transferred from the surgical **intensive care unit** to a regular hospital room within one to two days.

A patient who has had a conventional pneumectomy will usually leave the hospital within 10 days. Aftercare during hospitalization is focused on:

- relieving pain
- monitoring the patient's blood oxygen levels
- encouraging the patient to walk in order to prevent formation of blood clots
- encouraging the patient to cough productively in order to clear accumulated lung secretions

If the patient cannot cough productively, the doctor uses a flexible tube (bronchoscope) to remove the lung secretions and fluids.

Recovery is usually a slow process, with the remaining lung gradually taking on the work of the lung that has been removed. The patient may gradually resume

normal non-strenuous activities. A pneumectomy patient who does not experience postoperative problems may be well enough within eight weeks to return to a job that is not physically demanding; however, 60% of all pneumectomy patients continue to struggle with shortness of breath six months after having surgery.

### Risks

The risks for any surgical procedure requiring anesthesia include reactions to the medications and breathing problems. The risks for any surgical procedure include bleeding and infection.

Between 40% and 60% of pneumectomy patients experience such short-term postoperative difficulties as:

- prolonged need for a mechanical respirator
- abnormal heart rhythm (cardiac arrhythmia); heart attack (myocardial infarction); or other heart problem
- pneumonia
- infection at the site of the incision
- a blood clot in the remaining lung (pulmonary embolism)
- an abnormal connection between the stump of the cut bronchus and the pleural space due to a leak in the stump (bronchopleural fistula)
- accumulation of pus in the pleural space (empyema)
- kidney or other organ failure

Over time, the remaining organs in the patient's chest may move into the space left by the surgery. This condition is called postpneumectomy syndrome; the surgeon can correct it by inserting a fluid-filled prosthesis into the space formerly occupied by the diseased lung.

### Normal results

The doctor will probably advise the patient to refrain from strenuous activities for a few weeks after the operation. The patient's rib cage will remain sore for some time.

A patient whose lungs have been weakened by noncancerous diseases like emphysema or chronic bronchitis may experience long-term shortness of breath as a result of this surgery. On the other hand, a patient who develops a fever, chest pain, persistent cough, or shortness of breath, or whose incision bleeds or becomes inflamed, should notify his or her doctor immediately.



## WHO PERFORMS THE SURGERY AND WHERE IS IT PERFORMED?

Pneumonectomies are performed in a hospital by a thoracic surgeon, who is a physician who specializes in chest, heart, and lung surgery. Thoracic surgeons may further specialize in one area, such as heart surgery or lung surgery. They are board-certified through the Board of Thoracic Surgery, which is recognized by the American Board of Medical Specialties. A doctor becomes board certified by completing training in a specialty area and passing a rigorous examination.

## Morbidity and mortality rates

In the United States, the immediate survival rate from surgery for patients who have had the left lung removed is between 96% and 98%. Due to the greater risk of complications involving the stump of the cut bronchus in the right lung, between 88% and 90% of patients survive removal of this organ. Following lung volume reduction surgery, most investigators now report mortality rates of 5–9%.

## Alternatives

### *Lung cancer*

The treatment options for lung cancer are surgery, radiation therapy, and chemotherapy, either alone or in combination, depending on the stage of the cancer.

After the cancer is found and staged, the cancer care team discusses the treatment options with the patient. In choosing a treatment plan, the most significant factors to consider are the type of lung cancer (small cell or non-small cell) and the stage of the cancer. It is very important that the doctor order all the tests needed to determine the stage of the cancer. Other factors to consider include the patient's overall physical health; the likely side effects of the treatment; and the probability of curing the disease, extending the patient's life, or relieving his or her symptoms.

### *Chronic obstructive pulmonary disease*

Although surgery is rarely used to treat COPD, it may be considered for people who have severe symptoms that have not improved with medication therapy. A significant number of patients with advanced COPD face a miserable existence and are at high risk of death, despite advances in medical technology. This

## QUESTIONS TO ASK THE DOCTOR

- Why is it necessary to remove the whole lung?
- What benefits can I expect from a pneumonectomy?
- What are the risks of this operation?
- What are the normal results?
- How long will my recovery take?
- Are there any alternatives to this surgery?

group includes patients who remain symptomatic despite the following:

- smoking cessation
- use of inhaled bronchodilators
- treatment with antibiotics for acute bacterial infections, and inhaled or oral corticosteroids
- use of supplemental oxygen with rest or exertion
- pulmonary rehabilitation

After the severity of the patient's airflow obstruction has been evaluated, and the foregoing interventions implemented, a pulmonary disease specialist should examine him or her, with consideration given to surgical treatment.

Surgical options for treating COPD include laser therapy or the following procedures:

- **Bullectomy.** This procedure removes the part of the lung that has been damaged by the formation of large air-filled sacs called bullae.
- **Lung volume reduction surgery.** In this procedure, the surgeon removes a portion of one or both lungs, making room for the remaining lung tissue to work more efficiently. Its use is considered experimental, although it has been used in selected patients with severe emphysema.
- **Lung transplant.** In this procedure a healthy lung from a donor who has recently died is given to a person with COPD.

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National Cancer Institute (NCI), Building 31, Room 10A03, 31 Center Drive, Bethesda, MD 20892 2580. Phone: (800) 4 CANCEER. (301) 435-3848. [www.nci.nih.gov](http://www.nci.nih.gov).

National Comprehensive Cancer Network. 50 Huntingdon Pike, Suite 200, Rockledge, PA 19046. (215) 728-4788. Fax: (215) 728-3877. [www.nccn.org/](http://www.nccn.org/).

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Portacaval shunting see **Portal vein bypass**

## Portal vein bypass

### Definition

Portal vein bypass surgery diverts blood from the portal vein into another vein. It is performed when pressure in the portal vein is so high that it causes internal bleeding from blood vessels in the esophagus (the tube that brings food from the mouth to the stomach).

### Purpose

The portal vein carries blood from the stomach and abdominal organs to the liver. It is a major vein that splits into many branches. In people with liver failure and cirrhosis, a chronic degenerative liver disease causing irreversible scarring of the liver, the liver is incapable of processing blood from the bowels. As a result, an abnormally high pressure develops in the veins that drain blood from the bowels as the body tries to form other channels for the blood to empty into the main circulation. These channels consist of fragile veins that surround the esophagus, stomach, or other areas of the digestive tract. Because of the fragility of these veins, they are prone to rupturing, which can result in massive amounts of bleeding. The abnormally high pressure within the veins draining into the liver, called portal hypertension, can also result in the formation of fluid seeping from the surface of the liver and collecting in large quantities in the abdominal cavity, a condition known as ascites.

Massive internal bleeding caused by portal hypertension occurs in about 40% of patients with cirrhosis. It is initially fatal in at least half of these patients. Patients who survive are likely to experience bleeding recurrence. Portal vein bypass, also called portacaval shunting, is performed on these surviving patients to control bleeding.

The purpose of portal vein bypass surgery is to lower portal hypertension by shunting blood away from the portal venous system and into the main venous system.

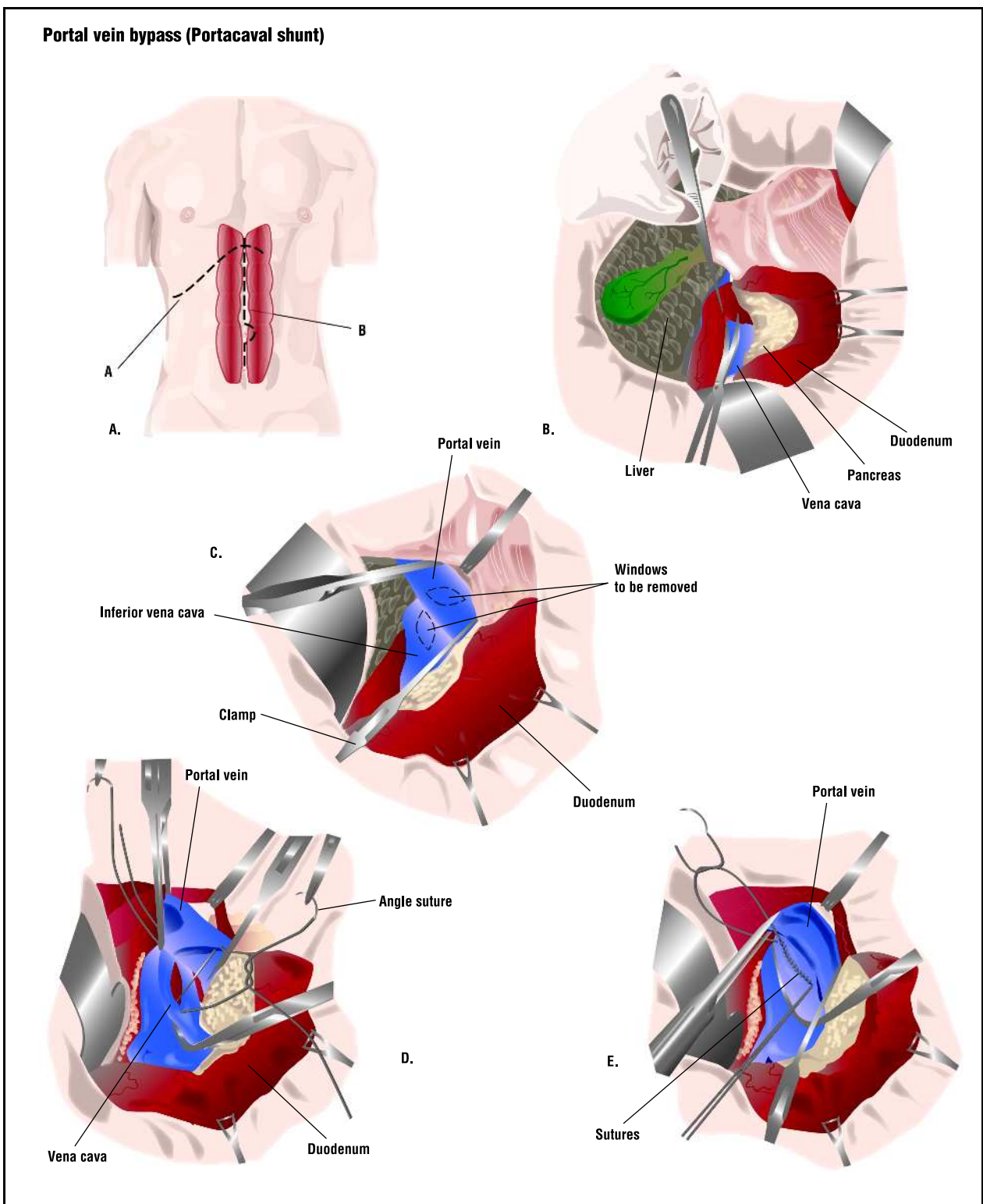
### Demographics

Cirrhosis of the liver is caused by chronic liver disease. Common causes of chronic liver disease in the United States include hepatitis C infection and long-term alcohol abuse. Men and women are equally affected, but onset is earlier in men.

### Description

Different portal vein bypass procedures are available. The surgery is usually performed under **general anesthesia**. The surgeon makes an abdominal incision and locates the portal vein. In portacaval shunting, blood from the portal vein is diverted into the inferior vena cava (one of the main veins leading back to the heart). This is the most common type of bypass. In splenorenal shunting, the splenic vein (a part of the portal vein) is connected to the renal (kidney) vein. A mesocaval shunt connects the superior mesenteric vein (another part of the portal vein) to the inferior vena cava.

Another procedure, called tranjugular intrahepatic portosystemic shunt (TIPS), has become the favored surgical approach. A TIPS is performed



Portal vein bypass can be achieved through one of two incisions (A). Once the abdomen is entered, the inferior vena cava is exposed (B). Further exposure reveals the portal vein. Both the portal vein and inferior vena cava are clamped (C). Windows are cut in both vessels (D), and the two are connected with sutures (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Ascites**—Fluid buildup in the abdominal cavity caused by fluid leaks from the surface of the liver and intestine.

**Cirrhosis**—A chronic degenerative liver disease causing irreversible scarring of the liver.

**Inferior vena cava**—A large vein that returns blood from the legs, pelvis, and abdomen to the heart.

**Portal hypertension**—Abnormally high pressure within the veins draining into the liver.

**Portal vein**—A large vein that carries blood from the stomach and intestines to the liver.

**Varices**—Uneven, permanent dilation of veins.

through a small nick in the skin, working through specialized instruments that are passed through the body using an x-ray camera for guidance. The TIPS procedure creates a shunt within the liver itself, by linking the portal vein with a vein draining away from the liver together with a device called a stent, which acts as a scaffold to support the connection between these two veins inside the liver.

## Diagnosis/Preparation

A radiologist assesses patients for bypass surgery based on their medical history, **physical examination**, blood work, and liver imaging studies performed using computed tomography (CT) scans, ultrasounds, or **magnetic resonance imaging** (MRI) scans, and in consultation with the treating gastroenterologist, hepatologist, or surgeon.

Standard preoperative blood and urine tests are also performed. The heart and arterial blood pressure are monitored both during and after the operation.

## Aftercare

The patient is connected to a heart monitor and fed through a nasogastric tube. Vital functions are monitored through blood and urine tests. Patients receive pain medication and **antibiotics**. Once released from the hospital, patients are expected to abstain from alcohol and to follow a diet and medication schedule designed to reduce the risks of bleeding.

## Risks

Portal vein bypass surgery is high risk because it is performed on patients who are generally in poor

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Portal vein bypass surgery is performed by a surgeon specialized in gastroenterology or hepatology in a hospital setting, very often as an emergency operation.

health. Those patients who survive the operation still face the risk of heart failure, brain disease due to a decrease in the liver's conversion of waste products (liver encephalopathy), hemorrhage, lung complications, infection, coma, and **death**.

## Normal results

More than 90% of patients that undergo TIPS to prevent bleeding from varices will have a relief in their symptoms and experience little to no bleeding after surgery. When TIPS is performed for ascites, 60–80% of people will have relief in their ascites. The survival rate is directly related to the amount of liver damage patients have; the less damage, the more likely the patient is to recover. Cooperation with restrictions on alcohol and diet affect long-term survival.

## Morbidity and mortality rates

Liver cirrhosis is a major medical problem worldwide and is associated with significant morbidity and mortality from its complications such as liver cell insufficiency and portal hypertension with ascites and gastrointestinal bleeding.

## Alternatives

Before resorting to bypass surgery, physicians first attempt to treat portal hypertension with medications known as nonselective beta-blockers. These medications need to be taken daily to produce an effect and some patients may not be able to remain on beta-blocker therapy if they develop side effects. Other patients on beta-blocker therapy also remain at risk for bleeding from varices and from ascites.

Another approach is to seal off the veins to prevent rupturing. In sclerotherapy, a camera (endoscope) is passed down through the esophagus to inject the abnormal veins with substances that close them off. This can also be achieved with variceal band ligation, a procedure by which the abnormal veins are tied off with small rubber bands. Although sclerotherapy and variceal



## QUESTIONS TO ASK THE DOCTOR

- What are the possible complications involved in portal vein bypass surgery?
- Why is the surgery required?
- Are there any alternatives?
- What type of anesthesia will be used?
- How is the surgery performed?
- How long will I be in the hospital?
- How much portal vein bypass surgery do you perform in a year?

band ligation are very effective in targeting the abnormal and fragile veins around the esophagus, they do not lower the pressure of the blood inside the portal venous system. Thus, portal hypertension may still result in fluid accumulation inside the abdominal cavity, or in bleeding.

The best approach to relieve portal hypertension within a patient is by replacing their liver with a new one capable of filtering the blood. However, not many patients are suitable candidates for a liver transplant.

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## Positron emission tomography (PET)

### Definition

Positron emission tomography (PET) is a non-invasive scanning technique that utilizes small amounts of radioactive positrons (positively charged particles) to visualize body function and metabolism.

### Purpose

PET is the fastest growing nuclear medicine tool in terms of increasing acceptance and applications. It is useful in the diagnosis, staging, and treatment of cancer because it provides information that cannot be obtained by other techniques such as computed tomography (CT) and **magnetic resonance imaging (MRI)**.

PET scans are performed at medical centers equipped with a small cyclotron. Smaller cyclotrons and increasing availability of certain radiopharmaceuticals are making PET a more widely used imaging modality.

Physicians first used PET to obtain information about brain function, and to study brain activity in various neurological diseases and disorders including stroke, epilepsy, Alzheimer's disease, Parkinson's disease, and Huntington's disease; and in psychiatric disorders such as schizophrenia, depression, obsessive-compulsive disorder, attention deficit hyperactivity disorder (ADHD), and Tourette syndrome. PET is now used to evaluate patients for these cancers: head and neck, lymphoma, melanoma, lung, colorectal, breast, and esophageal. PET also is used to evaluate heart muscle function in patients with coronary artery disease or cardiomyopathy.

### Description

PET involves injecting a patient with a radiopharmaceutical similar to glucose. An hour after injection of this tracer, a PET scanner images a specific metabolic function by measuring the concentration and distribution of the tracer throughout the body.

When it enters the body, the tracer courses through the bloodstream to the target organ, where it emits positrons. The positively charged positrons collide with negatively charged electrons, producing gamma rays. The gamma rays are detected by photo-multiplier-scintillator combinations positioned on opposite sides of the patient. These signals are processed by the computer and images are generated.

## KEY TERMS

**Electron**—One of the small particles that make up an atom. An electron has the same mass and amount of charge as a positron, but the electron has a negative charge.

**Gamma ray**—A high-energy photon emitted by radioactive substances.

**Half-life**—The time required for half of the atoms in a radioactive substance to disintegrate.

**Photon**—A light particle.

**Positron**—One of the small particles that make up an atom. A positron has the same mass and amount of charge as an electron, but the positron has a positive charge.

PET provides an advantage over CT and MRI because it can determine if a lesion is malignant. The two other modalities provide images of anatomical structures, but often cannot provide a determination of malignancy. CT and MRI show structure, while PET shows function. PET has been used in combination with CT and MRI to identify abnormalities with more precision and indicate areas of most active metabolism. This additional information allows for more accurate evaluation of cancer treatment and management.

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## Post-surgical infections

### Definition

Post-surgical infections are any kind of infection that occurs in the immediate post-operative period. They are an extremely common complication of any type of surgical procedure, striking about 600,000 of the 30 million individuals who undergo surgery annually.

### Description

A mnemonic called the three W's is often used to remember the most common targets of post-surgical infection:

- Wind—Infections of the respiratory system
- Water—Infections of the urinary system
- Wound—Infections involving the incision and surgical site

Other areas prone to infection after surgery include the intravenous site or the site of any other type of port.

There are several reasons why there is a high risk of respiratory infection following surgery:

- The use of **general anesthesia** suppresses the functioning of the mucociliary ladder, allowing mucus and organisms to accumulate
- Suppression of the gag reflex may allow aspiration of saliva into the respiratory tract

- Intubation may inadvertently introduce organisms into the respiratory tract
- Pain following surgery may interfere with an individual's ability to breathe deeply and to cough in order to clear their respiratory tract of excess secretions
- Pain medications further suppress an individual's tendency to breathe deeply

Respiratory infections usually manifest themselves through fever, cough, sputum production, shortness of breath, low blood oxygen. Suspected respiratory infections may be diagnosed through **chest x ray** and sputum culture.

Urinary tract infections are common because of the frequent use of a catheter during surgery, or through the post-operative period. **Post-surgical pain** and the side effects of anesthesia and pain medications may also result in urinary retention, requiring repeated in-and-out catheterization, increasing the risk of urinary tract infection.

Urinary tract infections usually manifest themselves through painful, frequent urine. Urine may appear bloody or cloudy. Suspected urinary tract infections may be diagnosed through **urinalysis** or **urine culture**.

About 2-5% of all surgical patients develop infections at the site of their operation. The following factors increase the risk of wound infection after surgery:

- Patient's age (elderly and newborns have higher risk)
- Weakened immune system
- Skin disease
- Malnutrition
- Co-existing diseases (such as diabetes, cancer)
- Operations involving areas that are already infected
- Transplants
- Implants
- Inadequate **bowel preparation**
- Lengthy surgery
- Use of drains
- Hemorrhage or hematoma during surgery
- Unintentional nick in bowel
- Use of blood transfusion
- Inappropriate use of **antibiotics**
- Poor sterile technique

Wound, incision, or surgical site infections usually manifest themselves as increased pain and tenderness at the site, redness, swelling, pus production, bleeding, and poor wound healing. Diagnosis is often made by

swabbing the area and culturing the pus to identify the specific organism.

Antibiotics are chosen based on either presumptive knowledge of the most common type of organism to cause infection in a given post-surgical setting, or based on the results of cultures of infected material. Antibiotics may be given orally or intravenously, and multiple antibiotics may be required, depending on the organism types and the severity of the infection.

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## Post-surgical pain

### Definition

Post-surgical pain is a complex response to tissue trauma during surgery that stimulates hypersensitivity of the central nervous system. The result is pain in areas not directly affected by the surgical procedure. Post-operative pain may be experienced by an inpatient or outpatient. It can be felt after any surgical procedure, whether it is minor dental surgery or a triple-bypass heart operation.

### Purpose

Postoperative pain increases the possibility of post-surgical complications, raises the cost of medical care, and most importantly, interferes with recovery and return to normal activities of daily living. Management of post-surgical pain is a basic patient right. When pain is controlled or removed, a patient is better able to participate in activities such as walking or eating, which will encourage his or her recovery. Patients will also sleep better, which aids the healing process.

## Description

Pain is recognized in two different forms: physiologic pain and clinical pain. Physiologic pain comes and goes, and is the result of experiencing a high-intensity sensation. It often acts as a safety mechanism to warn individuals of danger (e.g., a burn, animal scratch, or broken glass). Clinical pain, in contrast, is marked by hypersensitivity to painful stimuli around a localized site, and also is felt in non-injured areas nearby. When a patient undergoes surgery, tissues and nerve endings are traumatized, resulting in incision pain. This trauma overloads the pain receptors that send messages to the spinal cord, which becomes overstimulated. The resultant central sensitization is a type of posttraumatic stress to the spinal cord, which interprets any stimulation—painful or otherwise—as unpleasant. That is why a patient may feel pain in movement or physical touch in locations far from the surgical site.

Patients handle post-operative pain in highly individualized ways. Health care professionals have observed that some patients report that they are in extreme pain after surgery, demanding large doses of pain medications while others seem to do well with much less medication. Several theories have been put forth to account for this discrepancy. For example, differences in body size seemed to require differing amounts of medication, but this theory did not explain differences in pain perception among patients of the same build. Emotional well-being was considered a better indicator of the ability to tolerate pain. It has been theorized that patients with stronger support systems and better attitudes actually perceive less pain than others. Some health care professionals have even speculated that extreme pain was not real in many cases, but was a way to seek attention.

Clear biological evidence proving that individuals are born with varying thresholds of pain perception was only recently discovered. Psychiatrist and radiologist Jon-Kar Zubieta, from the Mental Health Research Institute at the University of Michigan, found that variations in an amino acid in a newly discovered gene, which codes for an enzyme that accesses neurotransmitters in the brain, produce different levels of pain perception. Only three combinations produce the variation. One individual may be able to fully access and metabolize the opioid neurotransmitters that reduce the sensation of pain. This person would have a higher threshold of pain tolerance and a lower level of pain perception. Another might not be able to do so at all, and that individual would experience more intense pain from the same stimulus. A third person might be able to tolerate a moderate amount of pain.

## KEY TERMS

**Epidural catheter**—A thin plastic tube, through which pain medication is delivered, inserted into the patient's back before surgery.

**Intubation**—Placing a tube in the patient's airway to maintain adequate oxygen intake.

**Opioids**—Narcotic pain medications.

**NSAIDs**—Nonsteroidal anti-inflammatory drugs, popular over-the-counter pain relievers.

**Patient-controlled analgesia (PCA)**—The patient administers a dose of pain medication by pressing a button on a pump, which delivers the medication through a tube attached to either an IV or an epidural catheter.

**Subcutaneous**—Under the skin.

This variation in genes not only shows that individuals do indeed experience pain at different levels, but it also points to differences in how people behave toward other stressors. Genetic variation may be a factor in the impact of long-term illness and depression that often accompanies chronic pain.

Since pain perception is highly subjective, it is important for the health care team to be aware of pain sensitivity differences in patients, and to value patient self-reports as reliable tools for pain assessment. The most common self-report system in use is the pain intensity scale. The patient is asked to identify where the pain falls on a scale of 0 “no pain at all” to 10 “the worst pain in the world.” This scale, however, does have limitations. The Short-Form McGill Questionnaire, which uses sensory words or synonyms, may allow the patient to communicate more accurate, descriptive information about pain and may be a better tool in planning **pain management** strategies.

It is clear that there is a real need for providing different approaches to post-surgical pain management. A variety of interventions may be used before, during, and after surgery. Most of these methods involve medications given orally, intravenously, intramuscularly, or topically (via the skin). Some must be administered by a health care professional, others can be administered by the patient.

## Pain management methods

### *Presurgery pain management*

The goal of post-surgical pain management is to reduce the amount pain a patient experiences after



surgery. New research has suggested that preventing the nervous system from being overtaxed by pain from the trauma of surgery may lead to a less painful post-operative experience. Pretreated patients may require less post-surgical medications, and they may recover more quickly, possibly experiencing pain-free days far sooner than patients who have used traditional post-surgical pain methods.

Also, in view of improved, less-invasive surgical techniques and the insurance industry's attempts to trim rising medical costs by reducing the length of hospital stays, many patients have no longer been required to remain in the hospital overnight after a surgery. Recently, outpatient (also called ambulatory) surgery has become the procedure of choice for many complex surgeries, such as **hysterectomy** and prostatectomy. After ambulatory surgery the must be made comfortable enough to return home and given tools to manage his or her own pain.

Preemptive analgesia introduces anesthetic drugs near the spinal cord or, sometimes, in nerve blocks in specific regions of the body. An epidural catheter, a thin plastic tube through which pain medication is delivered, is inserted into the patient's back before surgery. The patient may also receive **general anesthesia** and post-surgical pain medications as needed. Sometimes, the epidural catheter remains in place for several hours or days after surgery, and is attached to a pump so the patient can administer medication on demand.

In other cases, peripheral nerve blocks are used to limit sensation in specific regions of the body. By injecting local anesthetic near a nerve or nerve plexus that supplies the area where the surgery will be performed, all sensation is blunted and the affected area is numbed and feels "asleep." Some patients remain awake, but sedated, during surgery; others are given general anesthesia. Two important advantages to the use of peripheral nerve blocks in patients who are awake during surgery is the avoidance of the side effects of general anesthesia (nausea and vomiting) and complications that could occur during intubation, the placement of a tube in the patient's airway. The use of peripheral nerve blocks alone may be best suited to surgical procedures involving the arms, legs, and shoulders.

### *Pain management during surgery*

General anesthesia is the standard for pain management during surgery. Topical local anesthetics are also sometimes used to numb the surgical site before any incisions are made. This is the method used frequently with laparoscopic procedures. In a **laparoscopy**, the surgeon inserts a laparoscope (an instrument that has

a tiny video camera attached) through a small incision. Other small incisions are made into which the surgeon inserts **surgical instruments**, and in this way the surgeon repairs or removes diseased or damaged tissues. Local anesthetics minimize pain trauma to the surgical site and the central nervous system.

### *Post-surgery pain management*

In most hospitals during the past century, post-surgical pain management consisted only of the administration of **analgesics** and narcotics immediately after surgery. These drugs were usually given by intravenous or intramuscular injection, or by mouth. This is still the most common method for managing post-operative pain.

Management of these drugs, nevertheless, has variant applications. Some hospitals insist on a routine of scheduled medications, rather than giving medications as needed. The health care staff in these instances state that when patients take medications before the pain appears, the body does not over-react to the pain stimulus. Therefore, staying ahead of the pain is critical.

Other hospitals advocate continuous around-the-clock dosing through the use of a pump-type device that immediately delivers medication into the veins (intravenously, the most common method), under the skin (subcutaneously), or between the dura mater and the skull (epidurally). A health care provider programs the device with the specific dosage to deliver at each request made by the patient, as well as the total permitted during the time for which the device is set (commonly eight hours, sometimes 12, especially if the health care providers are working 12-hour shifts). Some of these devices are very sophisticated and even monitor themselves, ringing an alarm bell if there is an indication that they might be malfunctioning. The patient administers the dose by pushing a button, and is encouraged to keep a steady supply of medication within his or her system. This is called **patient-controlled analgesia (PCA)**.

PCA provides pain medication at the patient's need. However, because opium-like pain-relievers (opioids) are the medications these pumps deliver, there has been some concern about possible narcotic addiction. The pumps are calibrated to a maximum dosage, and are limited to a maximum dose every eight (or twelve) hours. The health care staff checks the equipment regularly, and records the number of times the patient pushed the pump button during the previous period. If the patient has pushed the button more times than allowed, the pump refuses to administer more medication. The patient should notify the

health care staff if a specific medication is ineffective. In some cases, the patient needs encouragement to use the pump more, if necessary.

Nonsteroid anti-inflammatory analgesics (NSAIDs) are best used for continuous around-the-clock pain relief. This prevents the extremes in pain perception that occur with on-demand dosing; sometimes the patient feels no pain and extreme pain at other times. Opioids are best given on a schedule or in a computerized pump, which can prevent overdoses.

Another method used post-surgically is the On-Q or the “pain relief ball.” It is a balloon-type device that administers non-narcotic medication to the incision site through a small catheter. When the incision site is closed, the catheter is attached to the surgical site and the balloon or pump is either taped to the patient’s skin, carried in a pocket or pouch, or attached to the patient’s clothing. The pump numbs the incision site by flooding it with anesthetic. Recent tests show that On-Q reduces narcotic use by 40% in cesarean patients, and eliminates all narcotics in 43% of hysterectomy patients.

#### *Alternative non-medical methods*

Some non-medical methods can help reduce post-operative pain. Patient education about the surgical procedure and the expected after-care necessary can help reduce stress, which can affect the perception of pain. Education, like visualization, prepares the mind for surgery and recovery. The patient knows what to expect, thereby removing fear of the unknown. Education also enlists the patient’s cooperation and may encourage a feeling of control and empowerment, which reduces stress, fear, and helplessness. These factors can contribute to less perceived pain. Therefore, both education and visualization can be helpful in minimizing pain perception and encouraging a positive attitude after surgery, which can promote healing.

Meditation and deep breathing techniques also can reduce stress. These techniques can lower blood pressure and increase oxygen levels, which are critical to a healthy recovery. Hypnosis before and after surgery may calm the mind and emotions, and mute the perception of pain.

#### *Multiple methods*

Multimodal analgesia uses more than one method of pain management. Multiple methods can actually reduce the amount of medications necessary to relieve pain, and can minimize uncomfortable side effects. Using presurgical, surgical, and post-surgical techniques allows the patient to come out of surgery with the pain already

under control. He or she does not have to experience the shock of intense pain at the incision site or elsewhere in the body. Some pain is probable; however, a patient should not be in intense pain after surgery. Pain management should occur before pain appears rather than in reaction to pain.

Further knowledge about multimodal pain management will be necessary as more outpatient and office-based surgery is done. Finding the right combination of methods for an individual patient is the challenge and responsibility of the health care team.

#### *Opioid-tolerant patients*

Of great concern to health-care professionals is how to provide post-operative pain management to patients who are opioid tolerant. These patients require higher and more frequent doses of narcotics for pain relief. They may also need to stay on the narcotics longer, and gradually step back down to their presurgery levels.

Patients who are opioid tolerant are not necessarily illegal drug users, but may be taking medications in combination with a narcotic, such as oxycodone/acetaminophen or acetaminophen/codeine. Patients who take opioid medications regularly may be treating pain for conditions like cancer, fibromyalgia, arthritis, or traumatic physical injuries.

It is important for anesthesiologists to aggressively treat pain for opioid-tolerant patients in the **recovery room**, where they can be closely monitored. Patient-controlled pain administration or continuous infusion, either in an IV or in an epidural catheter, has the best chance of controlling post-surgical pain together with the pain caused by preexisting conditions. When the patient is able to take medications orally, NSAIDs can supplement the use of opioid analgesia, sometimes reducing the total amount of opioids used. Newer, COX-2 inhibitors have proven effective in reducing pain without many of the side effects that NSAIDs possess (liver complications, kidney impairment, intestinal tract irritation, and bleeding), and seem to be a good fit for many opioid-tolerant patients.

#### **Preparation**

Before having any surgery, the patient should talk with the physician, surgeon, and if possible, the anesthesiologist in order to gain a full understanding of the procedure and what to expect immediately following surgery. It is important to develop a pain management plan with the health care team, and for the patient to be open about medication use, including opioids. Usually the patient will meet the anesthesiologist the day

of the surgery to discuss pain management options for the operation. Being informed about the surgical procedure and anesthesia options will give the patient an opportunity to ask questions and respond accurately to those asked by the anesthesiologist.

The physician should take a complete medical history, and order tests to determine the patient's current liver and kidney functions. The patient should not eat or drink before surgery. This helps minimize the side effects of general anesthesia and pain medications, such as nausea and vomiting. If the patient cannot reach a comfort level with the prescribed medication regime, he or she should discuss this with the health-care staff and physician.

### Normal results

After surgery, a patient should not have to endure severe pain. A reasonable comfort level can be reached in most cases. Prudent pain management will allow the patient to eat, sleep, move, and begin doing normal activities even while in the hospital, and especially when returning home. Recovery may take several weeks after surgery; however, the patient should be made comfortable as possible with a regime of oral pain medications.

### Risks

Pain medications may have unpleasant side effects. In many people, narcotics cause nausea, vomiting, and impaired mental functioning. NSAIDs can cause kidney failure, intestinal bleeding, and liver dysfunction, although these side-effects are not common with short-term use. The NSAID ketorolac has been associated with acute renal (kidney) failure even when given for minor oral surgery in an outpatient setting. Early screening for kidney problems and close monitoring for kidney failure or dehydration can prevent most of these problems.

There are adequate safeguards in place, especially in patient-controlled analgesic pumps, to prevent addiction to narcotics; however, some patients do become addicted.

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## Postoperative care

### Definition

Postoperative care is the management of a patient after surgery. This includes care given during the immediate postoperative period, both in the **operating room** and postanesthesia care unit (PACU), as well as during the days following surgery.

### Purpose

The goal of postoperative care is to prevent complications such as infection, to promote healing of the surgical incision, and to return the patient to a state of health.

### Description

Postoperative care involves assessment, diagnosis, planning, intervention, and outcome evaluation. The extent of postoperative care required depends on the individual's presurgical health status, type of surgery, and whether the surgery was performed in a day-surgery setting or in the hospital. Patients who have procedures done in a day-surgery center usually require only a few hours of care by health care professionals before they are discharged to go home. If postanesthesia or postoperative complications occur within these hours, the patient must be admitted to the hospital. Patients who are admitted to the hospital

may require days or weeks of postoperative care by hospital staff before they are discharged.

### *Postanesthesia care unit (PACU)*

The patient is transferred to the PACU after the surgical procedure, anesthesia reversal, and extubation (if it was necessary). The amount of time the patient spends in the PACU depends on the length of surgery, type of surgery, status of regional anesthesia (e.g., spinal anesthesia), and the patient's level of consciousness. Rather than being sent to the PACU, some patients may be transferred directly to the critical care unit. For example, patients who have had coronary artery bypass grafting are sent directly to the critical care unit.

In the PACU, the anesthesiologist or the nurse anesthetist reports on the patient's condition, type of surgery performed, type of anesthesia given, estimated blood loss, and total input of fluids and output of urine during surgery. The PACU nurse should also be made aware of any complications during surgery, including variations in hemodynamic (blood circulation) stability.

Assessment of the patient's airway patency (openness of the airway), **vital signs**, and level of consciousness are the first priorities upon admission to the PACU. The following is a list of other assessment categories:

- surgical site (intact dressings with no signs of overt bleeding)
- patency (proper opening) of drainage tubes/drains
- body temperature (hypothermia/hyperthermia)
- patency/rate of intravenous (IV) fluids
- circulation/sensation in extremities after vascular or orthopedic surgery
- level of sensation after regional anesthesia
- pain status
- nausea/vomiting

The patient is discharged from the PACU when he or she meets established criteria for discharge, as determined by a scale. One example is the Aldrete scale, which scores the patient's mobility, respiratory status, circulation, consciousness, and pulse oximetry. Depending on the type of surgery and the patient's condition, the patient may be admitted to either a general surgical floor or the **intensive care unit**. Since the patient may still be sedated from anesthesia, safety is a primary goal. The patient's call light should be in the hand and side rails up. Patients in a day surgery setting are either discharged from the PACU to the unit, or are directly discharged home after they

## KEY TERMS

**Ambulate**—To move from place to place (walk).

**Auscultation**—The act of listening to sounds arising within organs as an aid to diagnosis and treatment.

**Catheter**—A tubular medical device inserted into canals, vessels, passageways, or body cavities to permit injection or withdrawal of fluids, or to keep a passage open.

**Deep vein thrombosis**—Potentially life-threatening blood clot in one of the deep veins of the body, and often in the legs secondary to immobility after surgery. Symptoms include pain, warmth, swelling, and redness.

**Dehiscence**—Separation of a surgical incision or rupture of a wound closure.

**Ileus**—Obstruction in or immobility of the intestines. Symptoms include nausea and vomiting, absent bowel sounds, abdominal pain, and abdominal distension.

**Incentive spirometer**—Device that is used postoperatively to prevent lung collapse and promote maximum inspiration. The patient inhales until a preset volume is reached, then sustains the volume by holding his or her breath for three to five seconds.

**Oximetry**—Measuring the degree of oxygen saturation of circulating blood.

**PACU**—The postanesthesia care unit, where the patient is cared for after surgery.

**Patency**—The quality or state of being open or unobstructed.

**Patient-controlled analgesia pump**—A pump that the patient uses to self-administer medication to control pain.

**Pulmonary embolism**—Potentially life-threatening blockage of a pulmonary artery by fat, air, or a blood clot that originated elsewhere in the body. Symptoms include acute shortness of breath and sudden chest pain.

have urinated, gotten out of bed, and tolerated a small amount of oral intake.

### *First 24 hours*

After the hospitalized patient transfers from the PACU, the nurse taking over his or her care should assess the patient again, using the same previously mentioned categories. If the patient reports "hearing" or



feeling pain during surgery (under anesthesia) the observation should not be discounted. The anesthesiologist or nurse anesthetist should discuss the possibility of an episode of awareness under anesthesia with the patient. Vital signs, respiratory status, pain status, the incision, and any drainage tubes should be monitored every one to two hours for at least the first eight hours.

**Body temperature** must be monitored, since patients are often hypothermic after surgery, and may need a warming blanket or warmed IV fluids. Respiratory status should be assessed frequently, including assessment of lung sounds (auscultation) and chest excursion, and presence of an adequate cough. Fluid intake and urine output should be monitored every one to two hours. If the patient does not have a urinary catheter, the bladder should be assessed for distension, and the patient monitored for inability to urinate. The physician should be notified if the patient has not urinated six to eight hours after surgery. If the patient had a vascular or neurological procedure performed, circulatory status or neurological status should be assessed as ordered by the surgeon, usually every one to two hours. The patient may require medication for nausea or vomiting, as well as pain.

Patients with a **patient-controlled analgesia** pump may need to be reminded how to use it. If the patient is too sedated immediately after the surgery, the nurse may push the button to deliver pain medication. The patient should be asked to rate his or her pain level on a pain scale in order to determine his or her acceptable level of pain. Controlling pain is crucial so that the patient may perform coughing, deep breathing exercises, and may be able to turn in bed, sit up, and, eventually, walk.

Effective preoperative teaching has a positive impact on the first 24 hours after surgery. If patients understand that they must perform respiratory exercises to prevent pneumonia; and that movement is imperative for preventing blood clots, encouraging circulation to the extremities, and keeping the lungs clear; they will be much more likely to perform these tasks. Understanding the need for movement and respiratory exercises also underscores the importance of keeping pain under control. Respiratory exercises (coughing, deep breathing, and incentive spirometry) should be done every two hours. The patient should be turned every two hours, and should at least be sitting on the edge of the bed by eight hours after surgery, unless contraindicated (e.g., after **hip replacement**). Patients who are not able to sit up in bed due to their surgery will have sequential compression devices on their legs until they are able to move about. These are stockings that inflate with air in order to simulate the effect of walking on the calf

muscles, and return blood to the heart. The patient should be encouraged to splint any chest and abdominal incisions with a pillow to decrease the pain caused by coughing and moving. Patients should be kept NPO (nothing by mouth) if ordered by the surgeon, at least until their cough and gag reflexes have returned. Patients often have a dry mouth following surgery, which can be relieved with oral sponges dipped in ice water or lemon ginger mouth swabs.

Patients who are discharged home after a day surgery procedure are given prescriptions for their pain medications, and are responsible for their own pain control and respiratory exercises. Their families (or caregivers) should be included in preoperative teaching so that they can assist the patient at home. The patient should be reminded to call his or her physician if any complications or uncontrolled pain arise. These patients are often managed at home on a follow-up basis by a hospital-connected visiting nurse or **home care** service.

### *After 24 hours*

After the initial 24 hours, vital signs can be monitored every four to eight hours if the patient is stable. The incision and dressing should be monitored for the amount of drainage and signs of infection. The surgeon may order a dressing change during the first postoperative day; this should be done using sterile technique. For home-care patients this technique must be emphasized.

The hospitalized patient should be sitting up in a chair at the bedside and ambulating (walking) with assistance by this time. Respiratory exercises are still be performed every two hours, and incentive spirometry values should improve. Bowel sounds are monitored, and the patient's diet gradually increased as tolerated, depending on the type of surgery and the physician's orders.

The patient should be monitored for any evidence of potential complications, such as leg edema, redness, and pain (deep vein thrombosis), shortness of breath (pulmonary embolism), dehiscence (separation) of the incision, or ileus (intestinal obstruction). The surgeon should be notified immediately if any of these occur. If dehiscence occurs, sterile saline-soaked dressing packs should be placed on the wound.

### **Preparation**

Patients receive a great deal of information on postoperative care. They may be offered pain medication in preparation for any procedure that is likely to cause discomfort. Patients may receive educational

materials such as handouts and video tapes, so that they will have a clear understanding of what to expect postoperatively.

### Aftercare

Aftercare includes ensuring that patients are comfortable, either in bed or chair, and that they have their call lights accessible. After dressing changes, blood-soaked **dressings** should be properly disposed of in a biohazard container. Pain medication should be offered before any procedure that might cause discomfort. Patients should be given the opportunity to ask questions. In some cases, they may ask the nurse to demonstrate certain techniques so that they can perform them properly once they return home.

### Normal results

The goal of postoperative care is to ensure that patients have good outcomes after surgical procedures. A good outcome includes recovery without complications and adequate **pain management**. Another objective of postoperative care is to assist patients in taking responsibility for regaining optimum health.

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Potassium test see **Electrolyte tests**

## Power of attorney

### Definition

Power of attorney, also known as durable medical power of attorney, is a legal mechanism that empowers a designated person to make medical decisions for a patient should the patient be unable to make the decisions due to incapacitation.

### Purpose

Power of attorney assures that a patient's wishes are acknowledged in the medical setting. Along with other legal documents such as a **living will** and a **do not resuscitate (DNR) order**, the power of attorney designates the agent or person who is legally authorized to act for the patient in the medical setting. All three mechanisms are a part of what is known as advanced medical directives. The purpose of advanced directives is to have the patient's wishes for medical care carried out even when the patient is incapacitated and can no longer make his or her wishes known.

### Description

The patient's agent is the person appointed by the patient to represent him or her in medical situations where decisions must be made. This surrogate, through the power of attorney authorization, has all of the rights that the patient has with respect to deciding on medical procedures. These include the rights to refuse treatment, to agree to treatment, or to have treatment withdrawn.

Guided by a living will, which is a document developed in advance that reflects the patient's wishes, the agent acts on behalf of the patient with providers, administrators, and other legal agents. In most states, surrogates can act for the patient on any medical procedure, including a decision to refuse life support procedures such as resuscitation. States differ, however, on whether health agents can invoke a **DNR order**.

In the difficult times that families experience with a seriously ill or terminally ill family member, health agents play a major role in making decisions and stipulating what the patient's wishes are with respect to his or her treatment or palliative care needs. Health agents can work with or without a living will. The crucial feature of the power of attorney is that it empowers the patient's agent to respond to changes in the patient's health and to make flexible decisions. It is the health agent, rather than the patient, who must be apprised of all medical options, weigh the risk and benefits, and make a decision based on the specific situation.

## KEY TERMS

**Advanced medical directives**—Documents prepared in advance of medical care that reflect the wishes of patients for or against medical procedures should they become incapacitated.

**Health care agent**—Also known as the surrogate or patient representative, this is the person who has power of attorney to have the patient's wishes carried out if the patient is incapacitated.

**Living will**—A document that is usually included in advanced medical directives containing explicit medical procedures that patients' wishes to have or to refuse should they become incapacitated.

## Preparation

The person who has the medical power of attorney for a patient is only as good as his or her level of understanding of the patient and level of respect for the patient's wishes. There are some specific steps that can be taken to prepare the health care agent for power of attorney responsibilities. These steps include:

- The patient must think about medical treatments he or she would or would not like to have in different medical situations such as accidents, acute and life-threatening injuries, nursing home care, etc.
- If possible, the patient should write down his or her medical wishes and have these developed into a living will.
- The patient will want to convey these medical wishes to family and friends, as well as the identity of the person who will have power of attorney.
- Whether a written document is drafted or not, it is important that the patient have discussions with the designated agent so that his or her wishes can be carried out if the need arises. Not all elements of the medical decisions required can be known in advance. Hence, it is very important that the health agent knows the patient, knows the patient's wishes and rationale, and understands fully what is of value to the patient. Family and health providers should also be informed of the patient's wishes.

Medical decisions likely to be faced in severe health emergencies include options for **cardiopulmonary resuscitation** (CPR), diagnostic tests, administration of drugs, surgery, the use of life-supporting technologies, and organ and tissue use. However, there are also other decisions that can may require decisions from the agent. These may include family

members, and how much say they will have in decision making, issues of visitation, and other issues only somewhat related to the medical care. It is important that the agent understand and honor the wishes of the patient in all of these areas.

Once the initial steps for the advanced instructions are in place, an official medical power of attorney form for the state of residence or health care must be filled out. These may be two different states. It is important to have a medical power of attorney for any and all states in which medical care might be provided.

## Normal results

All medical directives, whether the living will, power of attorney, or **do not resuscitate order**, are respected by all health personnel in whatever medical setting the chosen state stipulates. These generally include hospitals, emergency rooms, emergency vehicles, and short- or long-term care facilities such as **hospice** care. Many states also include the home. The medical directives become a part of the patient's medical record and must be honored by any and all health personnel involved in the patient's treatment or care.

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Prednisone see **Corticosteroids**

Preoperative autologous blood donation  
see Autologous **blood donation**

## Preoperative care

### Definition

Preoperative care is the preparation and management of a patient prior to surgery. It includes both physical and psychological preparation.

### Purpose

Patients who are physically and psychologically prepared for surgery tend to have better surgical outcomes. Preoperative teaching meets the patient's need for information regarding the surgical experience, which in turn may alleviate most of his or her fears. Patients who are more knowledgeable about what to expect after surgery, and who have an opportunity to express their goals and opinions, often cope better with postoperative pain and decreased mobility. Preoperative care is extremely important prior to any invasive procedure, regardless of whether the procedure is minimally invasive or a form of major surgery.

Preoperative teaching must be individualized for each patient. Some people want as much information as possible, while others prefer only minimal information because too much knowledge may increase their anxiety. Patients have different abilities to comprehend medical procedures; some prefer printed information, while others learn more from oral presentations. It is important for the patient to ask questions during preoperative teaching sessions.

### Description

Preoperative care involves many components, and may be done the day before surgery in the hospital, or during the weeks before surgery on an outpatient basis. Many surgical procedures are now performed in a day surgery setting, and the patient is never admitted to the hospital.

#### *Physical preparation*

Physical preparation may consist of a complete medical history and physical exam, including the patient's surgical and anesthesia background. The patient should inform the physician and hospital staff if he or she has ever had an adverse reaction to anesthesia (such as anaphylactic shock), or if there is a family history of malignant hyperthermia. Laboratory tests may include **complete blood count**, electrolytes, **prothrombin time**, activated **partial thromboplastin time**, and **urinalysis**. The patient will most likely have an **electrocardiogram (EKG)** if he or she has a history of cardiac disease, or is over 50 years of age. A

## KEY TERMS

**Activated partial thromboplastin time (APTT)**—A lab test that detects coagulation defects in the intrinsic clotting cascade. Used to regulate heparin dosing.

**Ambulate**—Move from place to place (walk).

**Anaphylactic shock**—A systemic reaction that is often severe and occasionally fatal due to a second exposure to a specific antigen (i.e., wasp venom or penicillin) after previous sensitization that results in symptoms (particularly respiratory symptoms, fainting, itching, and hives).

**Anesthesia**—A safe and effective means of alleviating pain during a medical procedure.

**Complete blood count (CBC)**—A lab test that determines the number of red and white blood cells per cubic millimeter of blood.

**Electrocardiogram (EKG)**—A graphic record showing the electrical activity of the heart.

**Incentive spirometer**—Device that is used postoperatively to prevent lung collapse and promote maximum inspiration. The patient inhales until a preset volume is reached, then sustains the volume by holding the breath for three to five seconds.

**Patient-controlled analgesia pump**—A pump that the patient uses to self-administer medication to control pain.

**Prothrombin time (PT)**—A lab test that detects coagulation defects in the extrinsic clotting cascade. Used to regulate coumadin dosing.

**chest x ray** is done if the patient has a history of respiratory disease. Part of the preparation includes assessment for risk factors that might impair healing, such as nutritional deficiencies, steroid use, radiation or chemotherapy, drug or alcohol abuse, or metabolic diseases such as diabetes. The patient should also provide a list of all medications, vitamins, and herbal or food supplements that he or she uses. Supplements are often overlooked, but may cause adverse effects when used with general anesthetics (e.g., St. John's wort, valerian root). Some supplements can prolong bleeding time (e.g., garlic, ginkgo biloba).

Latex allergy has become a public health concern. Latex is found in most sterile surgical gloves, and is a common component in other medical supplies including **general anesthesia** masks, tubing, and multi-dose medication vials. It is estimated that 1–6% of the



general population and 8–17% of health care workers have this allergy. Children with disabilities are particularly susceptible. This includes children with spina bifida, congenital urological abnormalities, cerebral palsy, and Dandy-Walker syndrome. At least 50% of children with spina bifida are latex-sensitive as a result of early, frequent surgical exposure. There is currently no cure available for latex allergy, and research has found that the allergy accounts for up to 19% of all anaphylactic reactions during surgery. The best treatment is prevention, but immediate symptomatic treatment is required if the allergic response occurs. Every patient should be assessed for a potential latex reaction. Patients with latex sensitivity should have their chart flagged with a caution label. Latex-free gloves and supplies must be used for anyone with a documented latex allergy.

Bowel clearance may be ordered if the patient is having surgery of the lower gastrointestinal tract. The patient should start the bowel preparation early the evening before surgery to prevent interrupted sleep during the night. Some patients may benefit from a sleeping pill the night before surgery.

The night before surgery, skin preparation is often ordered, which can take the form of scrubbing with a special soap (i.e., Hibiclens), or possibly hair removal from the surgical area. Shaving hair is no longer recommended because studies show that this practice may increase the chance of infection. Instead, adhesive barrier drapes can contain hair growth on the skin around the incision.

### *Psychological preparation*

Patients are often fearful or anxious about having surgery. It is often helpful for them to express their concerns to health care workers. This can be especially beneficial for patients who are critically ill, or who are having a high-risk procedure. The family needs to be included in psychological preoperative care. Pastoral care is usually offered in the hospital. If the patient has a fear of **dying** during surgery, this concern should be expressed, and the surgeon notified. In some cases, the procedure may be postponed until the patient feels more secure.

Children may be especially fearful. They should be allowed to have a parent with them as much as possible, as long as the parent is not demonstrably fearful and contributing to the child's apprehension. Children should be encouraged to bring a favorite toy or blanket to the hospital on the day of surgery.

Patients and families who are prepared psychologically tend to cope better with the patient's postoperative

course. Preparation leads to superior outcomes since the goals of recovery are known ahead of time, and the patient is able to manage postoperative pain more effectively.

### *Informed consent*

The patient's or guardian's written consent for the surgery is a vital portion of preoperative care. By law, the physician who will perform the procedure must explain the risks and benefits of the surgery, along with other treatment options. However, the nurse is often the person who actually witnesses the patient's signature on the consent form. It is important that the patient understands everything he or she has been told. Sometimes, patients are asked to explain what they were told so that the health care professional can determine how much is understood.

Patients who are mentally impaired, heavily sedated, or critically ill are not considered legally able to give consent. In this situation, the next of kin (spouse, adult child, adult sibling, or person with medical **power of attorney**) may act as a surrogate and sign the consent form. Children under age 18 must have a parent or guardian sign.

### *Preoperative teaching*

Preoperative teaching includes instruction about the preoperative period, the surgery itself, and the postoperative period.

Instruction about the preoperative period deals primarily with the arrival time, where the patient should go on the day of surgery, and how to prepare for surgery. For example, patients should be told how long they should be NPO (nothing by mouth), which medications to take prior to surgery, and the medications that should be brought with them (such as inhalers for patients with asthma).

Instruction about the surgery itself includes informing the patient about what will be done during the surgery, and how long the procedure is expected to take. The patient should be told where the incision will be. Children having surgery should be allowed to "practice" on a doll or stuffed animal. It may be helpful to demonstrate procedures on the doll prior to performing them on the child. It is also important for family members (or other concerned parties) to know where to wait during surgery, when they can expect progress information, and how long it will be before they can see the patient.

Knowledge about what to expect during the postoperative period is one of the best ways to improve the patient's outcome. Instruction about expected activities

can also increase compliance and help prevent complications. This includes the opportunity for the patient to practice coughing and deep breathing exercises, use an incentive spirometer, and practice splinting the incision. Additionally, the patient should be informed about early ambulation (getting out of bed). The patient should also be taught that the respiratory interventions decrease the occurrence of pneumonia, and that early leg exercises and ambulation decrease the risk of blood clots.

Patients hospitalized postoperatively should be informed about the tubes and equipment that they will have. These may include multiple intravenous lines, drainage tubes, **dressings**, and monitoring devices. In addition, they may have sequential compression stockings on their legs to prevent blood clots until they start ambulating.

**Pain management** is the primary concern for many patients having surgery. Preoperative instruction should include information about the pain management method that they will utilize postoperatively. Patients should be encouraged to ask for or take pain medication before the pain becomes unbearable, and should be taught how to rate their discomfort on a pain scale. This instruction allows the patients, and others who may be assessing them, to evaluate the pain consistently. If they will be using a **patient-controlled analgesia** pump, instruction should take place during the preoperative period. Use of alternative methods of pain control (distraction, imagery, positioning, mindfulness meditation, music therapy) may also be presented.

Finally, the patient should understand long-term goals such as when he or she will be able to eat solid food, go home, drive a car, and return to work.

### Preparation

It is important to allow adequate time for preparation prior to surgery. The patient should understand that he or she has the right to add or strike out items on the generic consent form that do not pertain to the specific surgery. For example, a patient who is about to undergo a **tonsillectomy** might choose to strike out (and initial) an item that indicates sterility might be a complication of the operation.

### Normal results

The anticipated outcome of preoperative care is a patient who is informed about the surgical course, and copes with it successfully. The goal is to decrease complications and promote recovery.

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## Preparing for surgery

### Definition

Preparing for a planned surgery (also called **elective surgery**) includes selecting a surgery center and surgeon to perform the procedure, scheduling the surgery, undergoing **presurgical testing**, meeting with health-care professionals and the **surgical team**, receiving education about the procedure, receiving and following all of the appropriate preoperative instructions, and signing a consent form.

### Purpose

Preparing for surgery helps the patient understand what to expect before surgery and ensures the patient is physically and psychologically ready for the surgery.

### Description

Most patients go to the surgery center or hospital the same day as the scheduled surgery; thus, many of the steps involved in preparing for surgery will take place from one to four weeks before the scheduled surgery. Many surgeries are performed on an outpatient basis, which means that the patient goes home the same day as the surgery.

### Selecting a surgeon and surgery center

**SURGEON.** A surgeon, along with a multi-disciplinary team of surgical specialists, will perform the surgery.

The surgeon should be board certified by the American Board of Surgery, as well as certified by the medical specialty board or boards related to the type of surgery performed. Certification from a medical specialty board means that the surgeon has completed an approved educational training program (including three to seven years of full-time training in an accredited residency program). Certification also includes an evaluation, including an examination that assessed the surgeon's knowledge, skills, and experience necessary to perform high-quality patient care in that specialty.

There are 24 certifying boards recognized by the American Board of Member Specialties (ABMS) and the American Medical Association (AMA). Most of the ABMS boards issue time-limited certificates, valid for six to 10 years. This requires physicians to become re-certified to maintain their board certification—a process that includes a credential review, continuing education in the specialty, and additional examinations. Even though board certification is not required for an individual physician to practice medicine, most hospitals require that a certain percentage of their staff be board certified.

The letters FACS (Fellow of the American College of Surgeons) after a surgeon's name are a further indication of a surgeon's qualifications. Those who become Fellows of the American College of Surgeons have passed a comprehensive evaluation of their **surgical training** and skills; they also have demonstrated their commitment to high standards of ethical conduct. This evaluation is conducted according to national standards that were established to ensure that patients receive the best possible surgical care.

A surgeon's membership in professional societies is also an important consideration. Professional societies provide an independent forum for medical specialists to discuss issues of national interest and mutual concern. Examples of professional societies include the Society of Thoracic Surgeons (STS) and the American College of Physicians—American Society of Internal Medicine (ACP-ASIM).

To find information about a surgeon's qualifications, the patient can call a state or county medical association for assistance. A reference book is also available: *The Official ABMS Directory of Board Certified Medical Specialists* that lists all surgeons who are certified by approved boards. This publication also contains brief information about each surgeon's medical education and training, and it can be found in many libraries.

**SURGERY CENTER.** The surgeon will arrange for the procedure to be performed in a hospital where he or

## KEY TERMS

**Case manager**—A health-care professional who can provide assistance with a patient's needs beyond the hospital.

**Discharge planner**—A health-care professional who helps patients arrange for health and home care needs after they go home from the hospital.

**Electrocardiogram (ECG, EKG)**—A test that records the electrical activity of the heart using small electrode patches attached to the skin on the chest.

**Infectious disease team**—A team of physicians who help control the hospital environment to protect patients against harmful sources of infection.

**Informed consent**—An educational process between health-care providers and patients intended to instruct the patient about the nature and purpose of the procedure or treatment, the risks and benefits of the procedure, and alternatives, including the option of not proceeding with the test or treatment.

**Inpatient surgery**—Surgery that requires an overnight stay of one or more days in the hospital.

**NPO**—A term that means nothing by mouth. NPO refers to the time after which the patient is not allowed to eat or drink prior to a procedure or treatment.

**Outpatient surgery**—Also called same-day or ambulatory surgery. The patient arrives for surgery and returns home on the same day.

she has staff privileges. The patient should make sure the hospital has been accredited by the Joint Commission on Accreditation of Healthcare Organizations, a professionally sponsored program that stimulates a high quality of patient care in health-care facilities. Joint Commission accreditation means the hospital voluntarily sought accreditation and met national health and safety standards. There is also an accreditation option that is available for **ambulatory surgery centers**.

Selecting a surgery center that has a multidisciplinary team of specialists is important. The surgery team should include surgeons, infectious disease specialists, pharmacologists, and advanced care registered nurses. Other surgical team members may include fellows and residents, clinical coordinators, physical therapists, respiratory therapists, registered dietitians, social workers, and financial counselors.

Choosing a surgery center with experience is important. Some questions to consider when choosing a surgery center or hospital include:

- How many surgeries are performed annually and what are the outcomes/survival rates of those surgeries?
- How do the surgery center's outcomes compare with the national average?
- Does the surgery center offer treatment for a patient's specific condition? How experienced is the staff in treating that condition?
- What is the center's success record in providing the specific medical treatment or procedure?
- Does the surgery center have experience treating patients the same age as the inquiring patient?
- Does the surgery center explain the patient's rights and responsibilities?
- Does the surgery center have a written description of its services and fees?
- How much does the patient's type of treatment cost at this surgery center?
- Is financial help available?
- Who will be responsible for the patient's specific care plan while he or she is in the hospital?
- If the center is far from the patient's home, will accommodations be provided for caregivers?
- What type of services are available during the patient's hospital stay?
- Will a discharge plan be developed before the patient goes home from the hospital?
- Does the hospital provide training to help the patient care for his or her condition at home?

### *Scheduling the surgery*

Depending on the nature of the surgery, it may be scheduled within days or weeks after the surgery is determined to be the appropriate treatment option for the patient. The patient's surgery time may not be determined until the business day before the scheduled surgery. The patient may be instructed to call the surgical center to find out the time of the scheduled surgery.

The time the patient is told to report to the surgery center (arrival time) is not the time when the surgery will take place. Patients are told to arrive at the surgery center far enough in advance (usually about two hours prior to the scheduled surgery time) so they can be properly prepared for surgery. In some cases, the patient's surgery may need to be rescheduled if another patient requires **emergency surgery** at the patient's scheduled time.

The patient should ask the health-care providers if the scheduled surgery will be performed on an outpatient or inpatient basis. Outpatient means the patient goes home the same day as the surgery; inpatient means a hospital stay is required.

### *Presurgical testing*

Presurgical testing, also called preoperative testing or surgical consultation, includes a review of the patient's medical history, a complete **physical examination**, a variety of tests, patient education, and meetings with the health-care team. The review of the patient's medical history includes an evaluation of the patient's previous and current medical conditions, surgeries and procedures, medications, and any other health conditions such as allergies that may impact the surgery. Presurgical testing is generally scheduled within one week before the surgery.

The patient may find it helpful to bring along a family member or friend to the presurgical testing appointments. This caregiver can help the patient remember important details to prepare for surgery.

After attending the surgical consultation, the patient may desire to seek a **second opinion** to confirm the first doctor's treatment recommendations. The patient should check with his or her insurance provider to determine if the second opinion consultation is covered.

### *Meeting with the surgical team*

During the surgical consultation, the patient meets with the surgeon or a member of the surgeon's health-care team to discuss the surgery and other potential treatment options for the patient's medical condition. At some time before the surgery, the patient will meet with other health-care providers, including the anesthesiologist, nurse clinicians, and sometimes a dietitian, social worker, or rehabilitation specialist.

### *Patient education*

The surgical team will ensure that the patient understands the potential benefits and risks of the procedure as well as what to expect before the procedure and during the recovery. Patient education may include one-on-one instruction from a health-care provider, educational sessions in a group setting, or self-guided learning videos or modules. Informative and instructional handouts are usually provided to explain specific presurgical requirements.

Some surgery centers offer services such as guided imagery and relaxation tapes, massage therapy, aromatherapy, or other complementary techniques to reduce a patient's level of stress and anxiety before a



surgical procedure. Guided imagery is a form of focused relaxation that coaches the patient to visualize calm, peaceful images. Several research studies have proven that guided imagery can significantly reduce stress and anxiety before and after surgical and medical procedures and help the patient recover more rapidly. Guided imagery and relaxation tapes are available at many major bookstores and from some surgery centers. The patient may be able to listen to the tapes during the procedure, depending on the type of procedure being performed.

### *Preoperative instructions*

Preoperative instructions include information about reserving blood products for surgery, taking or discontinuing medications before the surgery, eating and drinking before surgery, quitting smoking, limiting activities before surgery, and preparing items to bring to the hospital the day of surgery.

### **BLOOD TRANSFUSIONS AND BLOOD DONATION.**

Blood transfusions may be necessary during surgery. A blood **transfusion** is the delivery of whole blood or blood components to replace blood lost through trauma, surgery, or disease. About one in three hospitalized patients will require a blood transfusion. The surgeon can provide an estimate of how much blood the patient's procedure may require.

To decrease the risk of infection and immunologic complications, some surgery centers offer a preoperative **blood donation** program. Autologous blood (from the patient) is the safest blood available for transfusion, since there is no risk of disease transmission. Methods of autologous donation or collection include:

- Intraoperative blood collection: the blood lost during surgery is processed, and the red blood cells are re-infused during or immediately after surgery.
- Preoperative donation: the patient donates blood once a week for one to three weeks before surgery. The blood is separated and the blood components needed are re-infused during surgery.
- Immediate preoperative hemodilution: the patient donates blood immediately before surgery to decrease the loss of red blood cells during surgery. Immediately after donating, the patient receives fluids to compensate for the amount of blood removed. Since the blood is diluted, fewer red blood cells are lost from bleeding during surgery.
- Postoperative blood collection: blood lost from the surgical site right after surgery is collected and re-infused after the surgical site has been closed.

The surgeon determines what type of blood collection process, if any, is appropriate.

**MEDICATION GUIDELINES.** Depending on the type of surgery scheduled, certain medications may be prescribed or restricted before the surgery. The health-care team will provide specific guidelines. If certain medications need to be restricted before surgery, the patient will receive a complete list of the medications (including prescription, over-the-counter, and herbal medications) to avoid taking before the scheduled surgery.

If the physician advises the patient to take prescribed medication within 12 hours before surgery, it should be taken with small sips of water.

The patient should not bring any medications to the hospital; all necessary medications, as ordered by the doctor, will be provided in the hospital.

**EATING AND DRINKING BEFORE SURGERY.** Before most surgeries, the patient is advised not to eat or drink anything after midnight the evening before the surgery. This includes no smoking and no gum chewing. The patient should not drink any alcoholic beverages for at least 24 hours before surgery, unless instructed otherwise. If the patient has diabetes or if the surgery is to be performed on a child, the patient should ask the health-care team for specific guidelines about eating and drinking before surgery.

### *Smoking cessation*

Patients who will undergo any surgical procedure are encouraged to quit smoking and stop using tobacco products at least two weeks before the procedure, and to make a commitment to be a nonsmoker after the procedure. Ideally, the patient should quit smoking at least eight weeks prior to surgery. Quitting smoking before surgery helps the patient recover more quickly from surgery. There are several **smoking cessation** programs available in the community. The patient should ask a health-care provider for more information if he or she needs help quitting smoking.

### *Activity before surgery*

The patient should eat right, rest, and **exercise** as normal before surgery, unless given other instructions. The patient should try to get enough sleep to build up energy for the surgery. The health-care team may advise the patient to scrub the planned surgical site with a special disinfecting soap the evening before the surgery.

**MAKING PLANS FOR HOME AND WORK.** The patient should make arrangements ahead of time for someone to care for children and take care of any other necessary activities at home such as getting the mail or newspapers. The patient should inform family members about the scheduled surgery in advance, so they can provide help and support before, during, and after surgery.

The patient should ask the health-care team what supplies may be needed after surgery during **recovery at home** so these items can be purchased or rented ahead of time. Some supplies that may be needed include an adaptive chair for the toilet or bathtub, or supplies for changing the wound dressing at home. Ask the health care providers if **home care** assistance (in which a visiting nurse visits the home to provide medical care) will be needed after surgery.

### *Items to bring to the hospital*

The patient should bring a list of current medications, allergies, and appropriate medical records upon admission to the surgery center. The patient should also bring a prepared list of questions to ask.

The patient should not bring valuables such as jewelry, credit cards or other items. A small amount of cash (no more than \$20) may be packed to purchase items such as newspapers or magazines.

Women should not wear nail polish or makeup the day of surgery.

If a hospital stay is expected after surgery, the patient should only pack what is needed. Some essential items include a toothbrush, toothpaste, comb or brush, deodorant, razor, eyeglasses (if applicable), slippers, robe, pajamas, and one change of comfortable clothes to wear when going home. The patient should also bring a list of family members' names and phone numbers to contact in an emergency.

### *Transportation*

The patient should arrange for transportation home, since the effects of anesthesia and other medications given before surgery make it unsafe to drive.

### *Preoperative preparation*

Upon arriving at the hospital or surgery center, the patient will be required to complete paperwork and show an insurance identification card, if insured. An identification bracelet that includes the patient's name and doctor's name will be placed on the patient's wrist.

**INFORMED CONSENT.** The health-care provider will review the **informed consent** form and ask the patient to sign it. Informed consent is an educational process between health-care providers and patients. Before any procedure is performed, the patient is asked to sign a consent form. Before signing the form, the patient should understand the nature and purpose of the procedure or treatment, the risks and benefits of the procedure, and alternatives, including the option of not proceeding with the procedure. Signing the informed

consent form indicates that the patient permits the surgery or procedure to be performed. During the discussion about the procedure, the health-care providers are available to answer the patient's questions about the consent form or procedure.

**ADVANCED DIRECTIVES.** The health-care provider will ask the patient if he or she has any advance directives to be included in the patient's file. Advance directives are legal documents that increase a patient's control over medical decisions. A patient may decide medical treatment in advance, in the event that he or she becomes physically or mentally unable to communicate his or her wishes. Advance directives either state what kind of treatment the patient wants to receive (**living will**), or authorize another person to make medical decisions for the patient when he or she is unable to do so (durable **power of attorney**). Advance directives are not required and may be changed or canceled at any time. Any change should be written, signed and dated in accordance with state law, and copies should be given to the physician and to others who received original copies. Advance directives can be revoked either in writing or by destroying the document. Advance directives are not do-not-resuscitate (DNR) orders. A **DNR order** indicates that a person—usually with a terminal illness or other serious medical condition—has decided not to have **cardiopulmonary resuscitation** (CPR) performed in the event that his or her heart or breathing stops.

**TESTS AND PREOPERATIVE EVALUATION.** Some routine tests will be performed, including blood pressure, temperature, pulse, and weight checks; blood tests; **urinalysis**; **chest x ray**; and **electrocardiogram** (ECG). A brief physical exam will be performed. In some cases, an enema may be required. The health-care team will ask several questions to evaluate the patient's condition and to complete the final preparations for surgery. The patient should inform the health-care team if he or she drinks alcohol on a daily basis so precautions can be taken to avoid complications during and after surgery.

**FINAL SURGICAL PREPARATION.** Preoperative preparation generally includes these steps:

- The patient changes into a hospital gown.
- The patient removes (as applicable) contact lenses and glasses, dentures, hearing aids, nail polish, and jewelry.
- The patient empties his or her bladder.
- The health-care providers clean and possibly shave the area on the body where the surgery will be performed.
- The patient may receive medication to aid relaxation.

- An intravenous catheter will be placed in a vein in the patient's arm to deliver fluids, medications, or blood during surgery.
- In some hospitals, the patient may wait in an area called a holding area until the operating room and surgical team are ready. Depending on the hospital's policy, one or two of the patient's family members may wait with the patient.
- The patient is taken to the operating room in a wheelchair or on a bed (also called a gurney) where monitors are placed to evaluate the patient's condition during surgery.
- Anesthesia is administered; the type of anesthesia administered will depend upon the procedure, the patient's general health, and medications.
- A catheter may be placed in the patient's bladder to drain urine.
- The patient's vital signs, including the blood oxygen level, electrical activity of the heart, blood pressure, pulse, temperature, breathing, mental status, and level of consciousness, are continuously monitored during and after the surgery.

### Information for families

While the patient is in surgery, the family members wait in a designated waiting area. Some hospitals or surgery centers offer a pager to the patient's family so they can be contacted for updates about the progress of the surgery. It may be helpful for the patient to select a spokesperson from the family to communicate with the health-care providers. This may improve communication with the health-care providers as well as to other family members. The patient should also communicate his or her wishes regarding the spokesperson's telephone communications to other family members.

Educational classes may be available for family members to learn more about the patient's surgery and what to expect during the recovery.

When the surgery is complete, the surgeon usually contacts the family members to provide information about the surgery. If a problem or complication occurs during surgery, the family members are notified immediately.

### Normal results

Patients who receive proper preparation for surgery, including physical and psychological preparation, experience less anxiety and are more likely to make a quicker recovery at home, with fewer complications. Patients who perceive their surgical and

## QUESTIONS TO ASK THE DOCTOR

- Will I have to have blood transfusions during the surgery?
- Do I take my medications the day of the surgery?
- Can I eat or drink the day of the surgery? If not, how long before the surgery should I stop eating and drinking?
- How long does my type of surgery typically last?
- How long will I have to stay in the hospital after surgery?
- What kind of pain or discomfort will I experience after the surgery and what can I take to I relieve it? What type of bruising, swelling, scarring, or pain should be expected after surgery?
- What types of resources are available to me during my hospital stay, and during my recovery at home?
- After I go home from the hospital, how long will it take me to recover?
- What are the signs of infection, and what types of symptoms should I report to my doctor?
- How should I care for my incision?
- What types of medications will I have to take after surgery? How long will I have to take them?
- When will I be able I resume my normal activities? When will I be able to drive? When will I be able to return to work?
- What lifestyle changes (including diet, weight management, exercise, and activity changes) are recommended after the surgery to improve my condition?
- How often do I need to see my doctor or surgeon for follow-up visits after surgery?
- Can I receive follow-up care from my primary physician, or do I need to have follow-up visits with the surgeon?

postoperative experiences as positive report that they had minimal pain and nausea, were relaxed, had confidence in the skills of their health-care team, felt they had some control over their care, and returned to their normal activities within the expected timeframe.

### Resources

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- Lucas, Brian. "Preparing Patients for Hip and Knee Replacement Surgery." *Nursing Standard* 22.2 (Sept 19, 2007): 50-58.

#### ORGANIZATIONS

- Agency for Health Care Policy and Research (AHCPR), Publications Clearinghouse. P.O. Box 8547, Silver Spring, MD, 20907. (800) 358-9295. <<http://www/ahcpr.gov>>.
- American Board of Surgery. 1617 John F. Kennedy Boulevard, Suite 860, Philadelphia, PA 19103. (215) 568-4000. <http://www.absurgery.org/>.
- American Association of Nurse Anesthetists (AANA). 222 South Prospect Avenue, Park Ridge, IL 60068-4001. (847) 692-7050. <http://www.aana.com/>.
- American College of Surgeons. 633 N. Saint Clair Street, Chicago, IL 60611-3211. (312) 202-5000. <http://www.facs.org/>.
- American Society of Anesthesiologists (ASA). 520 North Northwest Highway, Park Ridge, IL 60068-2573. (847) 825-5586. <<http://http://www.asahq.org/>>.
- National Heart, Lung and Blood Institute. Information Center. P.O. Box 30105, Bethesda, MD 20824-0105. (301) 251-2222. <http://www.nhlbi.nih.gov>.

Angela M. Costello  
Robert Bockstiegel

Pressure sores see **Bedsores**

## Presurgical testing

### Definition

Presurgical or preoperative testing refers to the preparation and management of a patient before surgery.

### Purpose

Presurgical testing, sometimes called preoperative testing, prepares a patient for surgery psychologically and physically.

### Demographics

The U.S. Department of Health and Human Services' National Center for Health Statistics reported

more than 44.9 million inpatient surgical procedures (requiring an overnight hospital stay) performed in the United States in 2005. About 50 million outpatient surgical procedures (in which the patient goes home the same day of surgery) were performed in that year.

Obstetrical, cardiovascular, digestive, musculoskeletal, and neurological surgeries are among the majority of the inpatient surgical procedures performed. The majority of outpatient surgeries were performed on the digestive system, eyes, musculoskeletal system, female reproductive organs, and urinary system.

In recent years there has been a change in attitude toward routine presurgical testing. In the years following World War II, administering routine laboratory tests to patients before surgery became part of normal clinical procedure. It was thought that such testing would help doctors to detect abnormalities before surgery that might lead to complications during or after the operation. Until the 1980s few surgeons evaluated either the clinical or the cost-effectiveness of these tests. In the mid-1980s, however, some researchers began to publish papers showing that preoperative testing was not only expensive but also did not necessarily benefit patients. One study published in the *Journal of the American Medical Association* in 1985 noted that 60% of a sample group of 2000 patients had had laboratory tests ordered for no apparent reason. Of the abnormal test findings, only 0.22% influenced preoperative management of the patients.

Newer recommendations for presurgical testing of healthy patients undergoing **elective surgery** are as follows:

- Consider a complete patient history and thorough physical examination the most important part of preoperative testing.
- The patient's hemoglobin level should be tested before for major surgery with significant expected blood loss or CBC count if the cost is not substantially increased.
- Serum creatinine level (a blood test) should be tested in people older than 40 years.
- Electrocardiogram (ECG or EKG) for patients over 40.
- Chest x-ray for patients older than 60.
- It is not necessary to repeat any laboratory test if the results were normal within 4 months of the scheduled surgery and if there has been no change in the patient's health.

Patients with heart disease or lung disease, or undergoing **emergency surgery**, require more complete evaluation.



## KEY TERMS

**Biopsy**—The removal of a small sample of tissue for analysis to determine a diagnosis.

**Bone densitometry test**—A test that quickly and accurately measures the density of bone.

**Catheter**—A small, flexible tube used to deliver fluids or medications.

**Chest x ray**—A diagnostic procedure in which a small amount of radiation is used to produce an image of the structures of the chest (heart, lungs, and bones) on film.

**Echocardiogram**—An imaging procedure used to create a picture of the heart's movement, valves and chambers. The test uses high-frequency sound waves that come from a hand wand placed on the chest. Echocardiogram may be used in combination with Doppler ultrasound to evaluate the blood flow across the heart's valves.

**Electrocardiogram (ECG, EKG)**—A test that records the electrical activity of the heart using small electrode patches attached to the skin on the chest.

**Pulmonary function test**—A test that measures the capacity and function of the lungs, as well as the blood's ability to carry oxygen. During the test, patient breathes into a device called a spirometer.

## Description

A planned surgery usually involves a surgical consultation, presurgical testing, the surgery itself, and **recovery at home**.

During the surgical consultation, the patient meets with the surgeon or a member of the surgeon's health-care team to discuss the surgery and other potential treatment options for the patient's medical condition. A thorough review of the patient's medical history and a complete physical exam are performed at this time. The medical review includes an evaluation of the patient's previous and current medical conditions, surgeries and procedures, medications, and any other health conditions, such as allergies, that may impact the surgery.

The **surgical team** will ensure that the patient understands the potential benefits and risks of the procedure. Patient education may include one-on-one instruction from a health care provider, educational sessions in a group setting, or self-guided learning videos or modules. Informative and instructional

handouts are usually provided to explain specific presurgical requirements.

After attending the surgical consultation, the patient may desire a **second opinion** to confirm the first doctor's treatment recommendations.

## Diagnosis/Preparation

Presurgical testing includes a variety of tests, patient education, and meetings with the health care team to inform the patient about what to expect before the procedure and during the recovery. Presurgical testing is generally scheduled within one week before the surgery.

Several tests are performed before surgery to provide complete information about the patient's overall health, to prepare the patient for anesthesia (as applicable), and to identify and treat any potential problems ahead of time. Each surgery patient does not have the same presurgery tests. In addition to checking the patient's **vital signs** (temperature, blood pressure, and pulse), more common tests include:

- blood tests
- urine tests
- chest x rays
- pulmonary function tests
- computed tomography scan (CT or CAT scan)
- heart function tests that may include an electrocardiogram or echocardiogram

If the patient recently had these tests performed (within the past six months), he or she can request the test results be forwarded to the surgical center.

Before some surgical procedures, such as valve surgery, a complete dental exam is needed to reduce the risk of infection. Other precautions will be taken before the surgery to reduce the patient's risk of infection.

**Informed consent** is an educational process between health-care providers and patients. Before any procedure is performed, the patient is asked to sign a consent form. Before signing the form, the patient should understand the nature and purpose of the diagnostic procedure or treatment, the risks and benefits of the procedure, and alternatives, including the option of not proceeding with the test or treatment. During the discussion about the procedure, the health-care providers are available to answer the patient's questions about the consent form or procedure.

Advance directives are legal documents that increase a patient's control over medical decisions. A patient may decide medical treatment in advance, in the event that he or she becomes physically or mentally unable to communicate his or her wishes. Advance directives either state

what kind of treatment the patient wants to receive (**living will**), or authorize another person to make medical decisions for the patient when he or she is unable to do so (**durable power of attorney**).

Advance directives are not required and may be changed or canceled at any time. Any change should be written, signed, and dated in accordance with state law, and copies should be given to the physician and to others who received original copies. Advance directives can be revoked either in writing or by destroying the document.

Advance directives are not a do-not-resuscitate (DNR) order, which indicates that a person—usually with a terminal illness or other serious medical condition—has decided not to have **cardiopulmonary resuscitation** (CPR) performed in the event that his or her heart or breathing stops.

Patients who will undergo any surgical procedure are encouraged to quit smoking and stop using tobacco products at least two weeks before the procedure, and to make a commitment to be a nonsmoker after the procedure. Quitting smoking before surgery helps the patient recover more quickly from surgery. There are several **smoking cessation** programs available in the community. The patient should ask a health-care provider for more information if he or she needs help quitting smoking.

The presurgical evaluation may include meetings with the anesthesiologist, surgeon, nurse clinicians, and other health-care providers who will manage the patient's care during and after surgery, such as a dietitian, social worker, or rehabilitation specialist.

The patient's surgery time may not be determined until the business day before the scheduled surgery. The patient may be instructed to call the surgical center to find out the time of the scheduled surgery.

Patients are told to come to the surgery center far enough in advance (usually about two hours prior to the scheduled surgery time) so they can be properly prepared for surgery. In some cases, the patient's surgery may need to be rescheduled if another patient requires emergency surgery at the patient's scheduled time.

Some surgery centers offer services such as guided imagery and relaxation tapes, massage therapy, or other complementary techniques to reduce a patient's level of stress and anxiety before a surgical procedure.

Guided imagery is a form of focused relaxation that coaches the patient to visualize calm, peaceful images. Several research studies have proven that guided imagery can significantly reduce stress and anxiety before and after surgical and medical procedures and help the patient recover more rapidly. Guided

imagery tapes are available at many major bookstores and from some surgery centers. The patient listens to the guided imagery tapes on his or her own CD or tape player before and after the surgery. The patient may even be able to continue listening to the tapes during the procedure, depending on the type of procedure being performed.

Blood transfusions may be necessary during surgery. A blood **transfusion** is the delivery of whole blood or blood components to replace blood lost through trauma, surgery, or disease. About one in three hospitalized patients will require a blood transfusion. The surgeon can provide an estimate of how much blood the patient's procedure may require.

To decrease the risk of infection and immunologic complications, some surgery centers offer a preoperative **blood donation** program. Autologous blood (blood taken from the patient) is the safest blood available for transfusion, since there is no risk of disease transmission. Methods of autologous donation or collection include:

- Intraoperative blood collection: The blood lost during surgery is processed and the red blood cells are reinfused during or immediately after surgery.
- Preoperative donation: The patient donates blood once a week for about one to three weeks before surgery. The blood is separated, and the blood components needed are reinfused during surgery.
- Immediate preoperative hemodilution: The patient donates blood immediately before surgery to decrease the loss of red blood cells during surgery. After donating, the patient receives fluids to compensate for the amount of blood removed. Since the blood is diluted, fewer red blood cells are lost from bleeding during surgery.
- Postoperative blood collection: Blood lost from the surgical site right after surgery is collected and reinfused after the surgical site has been closed.

The surgeon determines what type of blood collection process, if any, is appropriate.

Depending on the type of surgery scheduled, certain medications may be prescribed or restricted before the surgery. The health-care team will provide specific guidelines. If certain medications need to be restricted before surgery, the patient will receive a complete list of the medications (including prescription, over-the-counter, and herbal medications) to avoid taking before the scheduled surgery.

Prescribed medications that need to be taken within 12 hours before surgery should be swallowed with small sips of water.

Before most surgeries, the patient is advised not to eat or drink anything after midnight the evening before the surgery. This fast includes no smoking and no gum chewing. The patient should not drink any alcoholic beverages for at least 24 hours before surgery, unless instructed otherwise.

Most patients are admitted to the surgery center or hospital the same day as the scheduled surgery. The patient should bring a list of current medications, allergies, and appropriate medical records upon admission to the surgery center.

The patient should arrange for transportation home, since the effects of anesthesia and other medications given before surgery make it unsafe to drive.

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- American Hospital Association (AHA). One North Franklin, Chicago, IL 60606 3421. (312) 422 3000. [http://www.aha.org/aha\\_app/index.jsp](http://www.aha.org/aha_app/index.jsp).
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## Private insurance plans

### Definition

Private insurance plans include all forms of health insurance that are not funded by the government.

### Purpose

These plans are intended to protect their beneficiaries from the high costs that may be incurred for health care. Most private insurance plans in the United States are employment-based.

Of the nearly 243 million Americans who are covered by private health insurance, approximately nine in 10 (215 million, or 88%) are enrolled in employment-based plans.

### Description

Private health insurance plans may be purchased on an individual or group basis. Most group plans are offered by large employers, although some are available through voluntary associations. Individual policies are usually more expensive than group policies. Furthermore, they may have additional coverage restrictions.

## KEY TERMS

**Co-insurance**—The percentage of health care charges that an insurance company pays after the beneficiary pays the deductible. Most co-insurance percentages are 70–90%.

**Deductible**—An amount of money that an insured person is required to pay on each claim made on an insurance policy.

**Indemnity**—Protection, as by insurance, against damage or loss.

**Indemnity plans**—Private health insurance plans that allow the policyholder to choose any physician or hospital when health care is needed.

**Long-term care (LTC) insurance**—A type of private health insurance intended to cover the cost of long-term nursing home or home health care.

**Medigap**—A group of 10 standardized private health insurance policies intended to cover the coinsurance and deductible costs not covered by Medicare.

**Portability**—A feature that allows employees to transfer health insurance coverage or other benefits from one employer to another when they change jobs.

**Preferred provider organizations (PPOs)**—Private health insurance plans that require beneficiaries to select their health care providers from a list approved by the insurance company.

**Premium**—The amount paid by an insurance policyholder for insurance coverage. Most health insurance policy premiums are payable on a monthly basis.

There are several major categories of private health insurance in the United States.

### *Indemnity plans*

Indemnity plans are private insurance plans that allow beneficiaries to choose any physician or hospital when they need medical care. Most indemnity plans have a deductible, or amount that the policyholder must pay before the plan will cover any costs. After the deductible has been satisfied, indemnity plans pay a co-insurance percentage, most often 70–90% of the charges. The beneficiary pays the remainder of the bill.

### *Preferred provider organization (PPO) plans*

PPO plans are similar to indemnity plans in that they usually have both a deductible and a co-insurance percentage. Unlike indemnity plans, PPOs offer a list of

physicians and hospitals from which enrollees must select in order to receive the plan's maximum benefit. PPOs tend to be less expensive than indemnity plans because health care providers are often willing to reduce their fees in order to participate in these plans. Many large companies have moved their insured employees into PPOs because of their cost effectiveness.

A person enrolled in a PPO can choose to seek care from a non-network provider. This is called going out of network. Some people find this beneficial because it allows continuity of care from an existing provider. Enrollees may also propose their physician for membership in the PPO so that continuity of service may be provided.

### *Health maintenance organization (HMO) plans*

HMOs usually have no deductible. Beneficiaries are charged a small co-payment, typically between \$5 and \$25 per visit, and the plan covers all other charges. The list of preferred providers is generally smaller than that of a PPO. In most HMOs, each beneficiary selects a primary care physician who is responsible for all health care needs. Referrals to specialists must be made through the primary care physician. Like PPOs, HMOs are usually able to charge lower premiums because their participating health care providers agree to accept substantially reduced fees.

### *Long-term care (LTC) insurance*

**Long-term care insurance**, or LTC, is a type of private health insurance intended to cover the cost of custodial or nursing **home care**. It can be very expensive, and persons considering this form of insurance should not purchase it if the premiums cause financial hardship in the present.

### *Medigap insurance plans*

**Medicare** does not offer complete health insurance protection. Medigap insurance is a type of plan intended to supplement Medicare coverage. There are 10 standard Medigap benefit packages. These are identified by the letters A through J, and are available in most states, United States territories, and the District of Columbia. Medigap policies pay most or all of the co-insurance amounts charged by Medicare. Some Medigap policies cover Medicare deductibles.

### *Medical savings accounts (MSAs)*

Medical savings accounts are not health insurance plans in the strict sense, but offer a partial alternative to expensive individual private insurance plans. MSAs are similar to Individual Retirement Accounts (IRAs),



and have been considered a significant tax break for self-employed individuals. They were created as a four-year pilot project by the Health Insurance Portability and Accountability Act (HIPAA) of 1996. Effective December 31, 2000, the federal government issued an extension on these accounts for two years. The extension is currently renewed every year.

An MSA must be combined with a qualified high-deductible private health plan. Without an MSA, a self-employed individual can deduct qualified medical expenses only under the itemized deductions of a 1040 tax form, and the expenses must exceed 7.5% of the adjusted gross income.

### *The cost of health insurance*

The cost of private health insurance has risen steadily over the past two decades, largely because of the rising cost of health care in the United States. Between 1980 and 1995, the total amount spent on health care in the United States each year rose from \$247.2 billion to \$1.04 trillion, more than a 400% increase. Between 1995 and 2006, the amount doubled again, to more than \$2 trillion per year. The reasons for the escalating costs include the following:

- Increased longevity. The life expectancy of most Americans is approximately 76 years. When older people join an insured group, the entire group's health care risks and costs rise.
- Advances in medical technology. New technology is often expensive.

The rising costs of health insurance over the past 30 years have caused many employers to curtail or drop health insurance as an employee benefit. The cost of health insurance premiums increased from \$16.8 billion in 1970 to \$310 billion in 1995. By 2006, employers were spending \$11,400 per year to insure a family of four. Many employers have increased the amount of money employees are expected to contribute toward their health care. Others, particularly smaller businesses, do not offer health insurance at all. A 1997 study found that only 34% of workers in smaller businesses were covered through their employers, whereas 82% of employees in the largest companies were covered. Experts feel that this trend will continue. Workers in large-employer health insurance plans generally have policies that cover more health services, have lower deductibles, and offer more opportunities to enroll in HMOs.

### *Uninsured persons*

The U.S. Census Bureau reported in 1997 that 43.4 million people in the United States, or 16.1% of

the population, had no health insurance coverage. Between 1998 and 1999, both the number and proportion of uninsured Americans declined slightly, to 42.6 million and 15.5% respectively. As of 2005, the federal government estimated that nearly 47 million Americans, or 16 percent of the population, were without health insurance.

Some workers do not have health insurance because they cannot afford it. In the 1950s, employer-based health insurance served most American families reasonably well because many workers were employed by large firms and remained with them for life. The trend over the past two decades is employment by small firms that do not offer health insurance as a benefit, and a tendency to change employers every few years. Most uninsured workers are self-employed, work only part-time, or hold low-wage jobs that do not give them access to lower-cost employer-sponsored group plans. Workers in these three categories do not qualify for coverage by government programs for low-income people.

The other major category of uninsured people includes those who cannot purchase private insurance at affordable rates because they are likely to need expensive medical services. Those who have a high risk of developing cancer or are HIV-positive may not be able to obtain coverage from any insurance company. As early as the 1980s, some insurance companies began introducing clauses that excluded or restricted benefits for persons with pre-existing conditions. These clauses denied private insurance to anyone already diagnosed with a serious medical condition. One of the goals of the Health Insurance Portability and Accountability Act (HIPAA) of 1996 was to help workers who could not change jobs because they had family members with serious health problems. In the past, they would have been denied health insurance by the preexisting condition clauses in the new employer's plan. HIPAA requires employer-sponsored insurance plans to accept transfers from other plans without imposing preexisting condition clauses.

An individual private health insurance plan can be expensive and restrictive. It may, however, be the only choice for a consumer who is not employed; self-employed; or is a new hire at a company and must wait several months or more before the company's coverage takes effect.

### *Tax credit proposals*

One approach to the rising costs of private health insurance that is gaining bipartisan political support is to offer tax credits that would allow more Americans

to purchase health insurance. The present federal tax code favors workers who already have employer-sponsored health insurance. Supporters of the tax credit approach maintain that it would give workers a wider choice of health plans, create greater portability of health insurance, and encourage groups other than employment-based populations (e.g., church groups, unions, fraternal organizations) to sponsor insurance plans for their members.

*See also* Long-term insurance.

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20004, Phone: (202) 778 3200, Fax: (202) 331 7487. <http://www.ahip.org/>.

American Association of Retired Persons (AARP). 601 E. Street NW, Washington, DC 20049. (800) 424 3410, <http://www.aarp.org/>.

American College of Healthcare Executives. One North Franklin, Suite 1700, Chicago, IL 60606 4425. (312) 424 2800. Fax: 312 424 0023. <http://www.ache.org/>.

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PRK see **Photorefractive keratectomy (PRK)**

Proctosigmoidoscopy see **Sigmoidoscopy**

## Prophylaxis, antibiotic

### Definition

A prophylaxis is a measure taken to maintain health and prevent the spread of disease. Antibiotic prophylaxis is the focus of this article and refers to the use of **antibiotics** to prevent infections.

### Purpose

Antibiotics are well known for their ability to treat infections. But some antibiotics also are prescribed to prevent infections. This usually is done only in certain situations or for people with particular medical problems.

For example, people with abnormal heart valves have a high risk of developing heart valve infections even after only minor surgery. This happens because bacteria from other parts of the body get into the bloodstream during surgery and travel to the heart valves. To prevent these infections, people with heart valve problems often take antibiotics before having any kind of surgery, including dental surgery.

Antibiotics also may be prescribed to prevent infections in people with weakened immune systems such as those with AIDS or people who are having chemotherapy treatments for cancer. But even healthy people with strong immune systems may occasionally be given preventive antibiotics—if they are having certain kinds of surgery that carry a high risk of infection, or if they are traveling to parts of the world where they are likely to get an infection that causes diarrhea, for example.

In all of these situations, a physician should be the one to decide whether antibiotics are necessary. Unless a physician says to do so, it is not a good idea to take antibiotics to prevent ordinary infections.

Because the overuse of antibiotics can lead to resistance, drugs taken to prevent infection should be used only for a short time.

### Description

Among the drugs used for antibiotic prophylaxis are amoxicillin (a type of penicillin) and **fluoroquinolones** such as ciprofloxacin (Cipro) and trovafloxacin (Trovan). These drugs are available only with a physician's prescription and come in tablet, capsule, liquid, and injectable forms.

For surgical prophylaxis, the cephalosporin antibiotics are usually preferred. This class includes cefazolin (Ancef, Kefzol), cefamandole (Mandol), cefotaxime (Claforan), and others. The choice of drug depends on its spectrum and the type of bacteria that are most likely to be encountered. For example, surgery on the intestines, which have many anaerobic bacteria, might call for cefoxitin (Mefoxin), while in heart surgery, where there are no anaerobes, cefazolin might be preferred.

### Recommended dosage

The recommended dosage depends on the type of antibiotic prescribed and the reason it is being used. For the correct dosage, the patient is advised to check with the physician or dentist who prescribed the medicine or the pharmacist who filled the prescription. The patient is recommended to be sure to take the medicine

## KEY TERMS

**AIDS**—Acquired immunodeficiency syndrome. A disease caused by infection with the human immunodeficiency virus (HIV). In people with this disease, the immune system breaks down, opening the door to other infections and some types of cancer.

**Antibiotic**—A medicine used to treat infections.

**Chemotherapy**—Treatment of an illness with chemical agents. The term is typically used to describe the treatment of cancer with drugs.

**Immune system**—The body's natural defenses against disease and infection.

exactly as prescribed, and not to take more or less than directed, and to take the medicine only for as long as the physician or dentist says to take it.

The recommended dose of prophylactic antibiotic for surgery has varied with studies. At one time, it was common to give a dose of antibiotic when the patient was called to the **operating room**, and to continue the drug for 48 hours after surgery. More recent studies indicate that a single antibiotic dose, given immediately before the start of surgery, may be just as effective in preventing infection, while reducing the risk of drug side effects.

### Precautions

The warnings listed below refer primarily to the effects of the drugs when taken in multiple doses. When prophylactic antibiotics are used as a single dose, adverse effects are very unlikely. The only exceptions are for people who are allergic to the antibiotic used. Since **cephalosporins** are closely related to penicillins, people who are allergic to penicillins should avoid cephalosporin antibiotics.

If the medicine causes nausea, vomiting, or diarrhea, the patient is advised to check with the physician or dentist who prescribed it as soon as possible. Patients who are taking antibiotics before surgery should not wait until the day of the surgery to report problems with the medicine. The physician or dentist needs to know right away if problems occur.

For other specific precautions, the patient is advised to see the entry on the type of drug prescribed such as penicillins or fluoroquinolones.

### Side effects

Antibiotics may cause a number of side effects. For details, the patient is advised to see entries on

specific types of antibiotics. Anyone who has unusual or disturbing symptoms after taking antibiotics should get in contact with the prescribing physician.

### Interactions

Whether used to treat or to prevent infection, antibiotics may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes antibiotics for any reason should inform the physician about all the other medicines he or she is taking and should ask whether any possible interactions may interfere with drugs' effects. For details of drug interactions, the candidate is advised to see entries on specific types of antibiotics.

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Prostaglandins see **Uterine stimulants**

Prostate-specific antigen test see **Tumor marker tests**

Prostate resection see **Transurethral resection of the prostate**

Prostatectomy, open see **Open prostatectomy**

## Prothrombin time

### Definition

The prothrombin time test belongs to a group of blood tests that assess the clotting ability of blood. The test is also known as the pro time or PT test.

### Purpose

The PT test is used to monitor patients taking certain medications as well as to help diagnose clotting disorders.

### Diagnosis

Patients who have problems with delayed blood clotting are given a number of tests to determine the cause of the problem. The prothrombin test specifically evaluates the presence of factors VIIa, V, and X, prothrombin, and fibrinogen. Prothrombin is a protein in the liquid part of blood (plasma) that is converted to thrombin as part of the clotting process. Fibrinogen is a type of blood protein called a globulin; it is converted to fibrin during the clotting process. A drop in the concentration of any of these factors will cause the blood to take longer to clot. The PT test is used in combination with the **partial thromboplastin time (PTT)** test to screen for hemophilia and other hereditary clotting disorders.

### Monitoring

The PT test is also used to monitor the condition of patients who are taking warfarin (Coumadin). Warfarin is a drug that is given to prevent clots in the deep veins of the legs and to treat pulmonary embolism. It interferes with blood clotting by lowering the liver's production of certain clotting factors.

### Description

A sample of the patient's blood is obtained by venipuncture. The blood is collected in a tube that contains sodium citrate to prevent the clotting process from starting before the test. The blood cells are separated from the liquid part of blood (plasma). The PT test is performed by adding the patient's plasma to a protein in the blood (thromboplastin) that converts prothrombin to thrombin. The mixture is then kept in a warm water bath at 37°C for one to two minutes. Calcium chloride is added to the mixture in order to counteract the sodium citrate and allow clotting to proceed. The test is timed from the addition of the calcium chloride until the plasma clots. This time is called the prothrombin time.

### Preparation

The doctor should check to see if the patient is taking any medications that may affect test results. This precaution is particularly important if the patient is taking warfarin, because there are a number of



## KEY TERMS

**Disseminated intravascular coagulation (DIC)**—A condition in which spontaneous bleeding and clot formation occur throughout the circulatory system. DIC can be caused by transfusion reactions and a number of serious illnesses.

**Fibrin**—The protein formed as the end product of the blood clotting process when fibrinogen interacts with thrombin.

**Fibrinogen**—A type of blood protein called a globulin that interacts with thrombin to form fibrin.

**Plasma**—The liquid part of blood, as distinct from blood cells.

**Prothrombin**—A protein in blood plasma that is converted to thrombin during the clotting process.

**Thrombin**—An enzyme in blood plasma that helps to convert fibrinogen to fibrin during the last stage of the clotting process.

**Thromboplastin**—A protein in blood that converts prothrombin to thrombin.

**Warfarin**—A drug given to control the formation of blood clots. The PT test can be used to monitor patients being treated with warfarin.

medications that can interact with warfarin to increase or decrease the PT time.

## Aftercare

Aftercare consists of routine care of the area around the puncture site. Pressure is applied for a few seconds and the wound is covered with a bandage.

## Risks

The primary risk is mild dizziness and the possibility of a bruise or swelling in the area where the blood was drawn. The patient can apply moist warm compresses.

## Normal results

The normal prothrombin time is 11–15 seconds, although there is some variation depending on the source of the thromboplastin used in the test. (For this reason, laboratories report a normal control value along with patient results.) A prothrombin time within this range indicates that the patient has normal amounts of clotting factors VII and X.

## Abnormal results

A prolonged PT time is considered abnormal. The prothrombin time will be prolonged if the concentration of any of the tested factors is 10% or more below normal plasma values. A prolonged prothrombin time indicates a deficiency in any of factors VII, X, V, prothrombin, or fibrinogen. It may mean that the patient has a vitamin K deficiency, a liver disease, or disseminated intravascular coagulation (DIC). The prothrombin time of patients receiving warfarin therapy will also be prolonged—usually in the range of one and one half to two times the normal PT time. A PT time that exceeds approximately two and a half times the control value (usually 30 seconds or longer) is grounds for concern, as abnormal bleeding may occur.

## Morbidity and mortality rates

Morbidity rates are excessively miniscule. The most common problems are minor bleeding and bruising. Since neither are reportable events, morbidity can only be estimated. Mortality is essentially zero.

## Alternatives Resources

There are no alternatives to a prothrombin time.

## Precautions

The only precaution needed is to clean the venipuncture site with alcohol.

## Side effects

The most common side effects of a prothrombin time test are minor bleeding and bruising.

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# Proton pump inhibitors

## Definition

The proton pump inhibitors are a group of drugs that reduce the secretion of gastric (stomach) acid. They act by binding with the enzyme  $H^+$ ,  $K(+) - ATPase$ , *hydrogen/potassium adenosine triphosphatase*, which is sometimes referred to as the proton pump. This enzyme causes parietal cells of the stomach lining to produce acid.

Although they perform much the same functions as the histamine H-2 receptor blockers, the proton pump inhibitors reduce stomach acid more and over a longer period.

## Purpose

Proton pump inhibitors are used to treat ulcers; gastroesophageal reflux disease (GERD), a condition in which backward flow of acid from the stomach causes heartburn and injury of the food pipe (esophagus); and conditions in which the stomach produces too much acid, such as Zollinger-Ellison syndrome. Omeprazole is used in combination with other medications to treat recurrent ulcers caused by *helicobacter pylori* infections.

Two of the proton pump inhibitors, lansoprazole and omeprazole, have been used to improve pancreatic enzyme absorption in cystic fibrosis patients with intestinal malabsorption.

Proton pump inhibitors may be used to protect against the ulcerogenic effects of non-steroidal anti-inflammatory drugs and to help heal ulcers caused by these drugs.

## Description

There are five drugs in this class: esomeprazole (Nexium), lansoprazole (Prevacid), omeprazole (Prilosec), pantoprazole (Protonix), and rabeprazole (AcipHex). They act in a similar manner, and their cautions and adverse effects are similar.

The products are generally formulated as enteric-coated granules. Absorption does not start until the granules have left the stomach and reached the intestine, so the onset of action is delayed about an hour, subject to gastric emptying time. Since they act slowly, proton pump inhibitors are not a suitable alternative to antacids which have a rapid effect.

Although these drugs are eliminated from the body relatively quickly, usually within 90 minutes of absorption, they all work for over 24 hours after a dose. This is because the factor that determines duration of action is how long it takes the body to replace the  $H^+$ ,  $K(+) - ATPase$ . There is some build up over time. For example, a single dose of lansoprazole reduces stomach acid by 71%, but after a week of regular dosing, the acid reduction rises to 80%.

For treatment of recurrent ulcers, the proton pump inhibitors are part of combination therapy that uses an antibiotic (occasionally two **antibiotics**) and proton pump inhibitor. There are a number of regimens, and while they may vary in the selection of specific drugs, or even types of drugs used, usually they include a proton pump inhibitor. The cure rates are all within similar ranges for these regimens.

## Recommended dosage

Dose varies with the indication. The following are commonly prescribed doses:

- Esomeprazole: 20 to 40 mg once a day.
- Lansoprazole: 15 to 30 mg once a day.
- Omeprazole: 20 to 40 mg once a day.
- Pantoprazole: 40 mg once or twice a day.
- Rabeprazole: 20 mg once a day. In hypersecretory conditions, doses as high as 60 mg twice daily have been reported.

In the above examples, the lower dose is usually adequate for GERD, while the higher dose may be required for ulcer therapy or hypersecretory conditions.

## Precautions

Proton pump inhibitors should not be given to any patient who has shown a reaction to any of the components of the drug or a related drug. Proton pump inhibitors should also not be given to patients with severe liver disease.

Omeprazole is pregnancy category C, while esomeprazole, lansoprazole, rabeprazole, and pantoprazole are category B. As of 2008, there are no adequate and well-controlled studies concerning the effects of these drugs on pregnant women. These drugs should be used during pregnancy only if the potential benefit justifies the risk to the fetus. Because the proton pump inhibitors are excreted into breast milk, they should not be used by women who are breastfeeding their babies.

The proton pump inhibitors may mask the symptoms of stomach cancer.

## Side effects

The proton pump inhibitors are relatively safe drugs. The most commonly observed adverse effects are constipation, diarrhea, dizziness, headache, skin itch, and skin rash. Less often, the following adverse effects have been reported: abdominal pain with cramps, appetite changes, and nausea.

The following adverse effects are extremely rare but have been reported with this class of drugs:

- acute pancreatitis
- anxiety
- cough
- depression
- drug toxin-related hepatitis
- erythema multiforme

## KEY TERMS

**Antacid**—A substance that counteracts or neutralizes acidity, usually of the stomach. Antacids have a rapid onset of action compared to histamine H-2 receptor blockers and proton pump inhibitors, but they have a short duration of action and require frequent dosing.

**Cystic fibrosis**—A hereditary disease that appears in early childhood, involves functional disorder of digestive glands, and is marked especially by faulty digestion due to a deficiency of pancreatic enzymes, by difficulty in breathing due to mucus accumulation in airways, and by excessive loss of salt in the sweat.

**Enteric coat**—A coating put on some tablets or capsules to prevent their disintegration in the stomach. The contents of coated tablets or capsules will be released only when the dose reaches the intestine. This may be done to protect the drug from stomach acid, to protect the stomach from drug irritation, or to delay the onset of action of the drug.

**GERD**—A chronic condition in which the lower esophageal sphincter allows gastric acids to reflux into the esophagus, causing heartburn, acid indigestion, and possible injury to the esophageal lining.

**Malabsorption**—Defective or inadequate absorption of nutrients from the intestinal tract.

**Parietal cells**—Cells of the gastric glands that secrete hydrochloric acid.

**Recurrent ulcer**—Stomach ulcers that return after apparently complete healing. These ulcers appear to be caused by helicobacter pylori infections and can generally be successfully treated with a combination of antibiotics and gastric acid reducing compounds, particularly the proton pump inhibitors.

- flu-like symptoms
- myalgia
- Stevens-Johnson syndrome
- thrombocytopenia
- toxic epidermal necrolysis
- ulcerative colitis
- upper respiratory hypersensitivity reaction
- upper respiratory infection
- vomiting

## Interactions

Proton pump inhibitors should not be used in conjunctions with the anti-retroviral (anti-AIDS) drug atazanavir (Rayataz). The conjunction may reduce the effectiveness of the atazanavir. Proton pump inhibitors should not be used in combination with the anti-fungal drugs itraconazole or ketoconazole. This combination may reduce the effectiveness of the anti-fungal drugs.

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### ORGANIZATIONS

- American College of Clinical Pharmacy. <http://www.accp.com/>.
- American College of Clinical Pharmacology. <http://www.accp1.org>.
- American College of Physicians. 190 N Independence Mall West, Philadelphia, PA 19106 1572. (800) 523 1546, x2600, or (215) 351 2600. <http://www.acponline.org>.
- American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464 5000. <http://www.ama-assn.org>.

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PSA test see **Tumor marker tests**

Psyllium see **Laxatives**

Pubo-vaginal sling see **Sling procedure**

Pulmonary embolism see **Venous thrombosis prevention**

## Pulse oximeter

### Definition

The pulse oximeter is a photoelectric instrument for measuring oxygen saturation of blood.

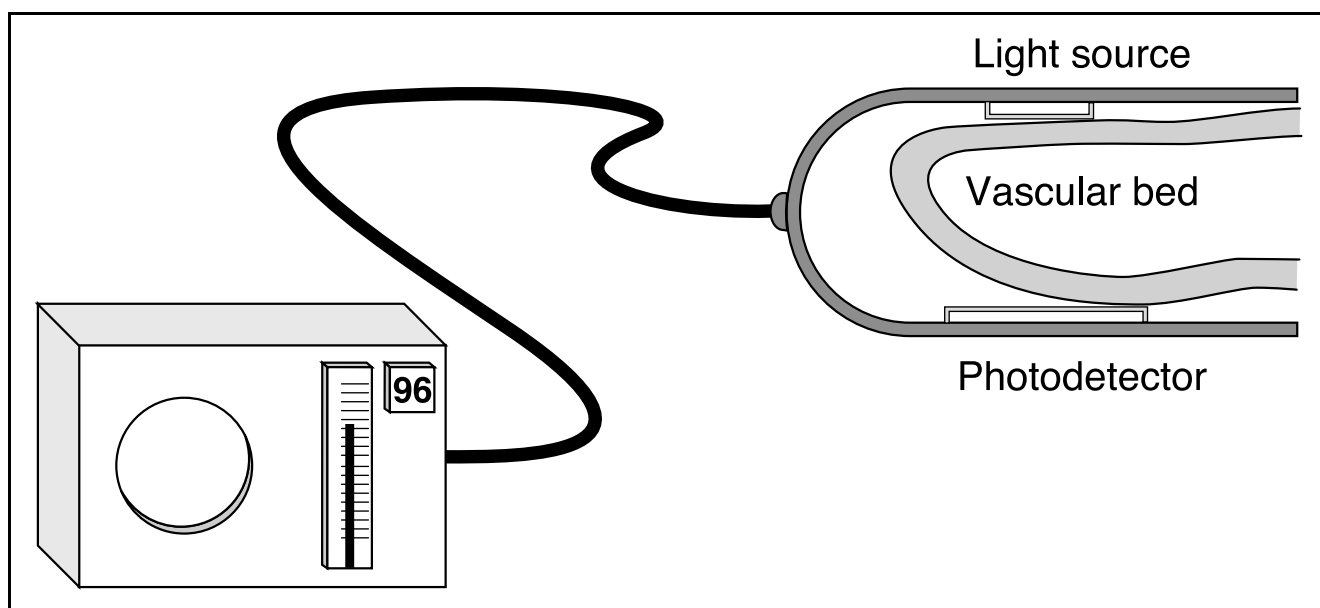
### Purpose

A pulse oximeter measures the amount of oxygen present in blood by registering pulsations within an arteriolar bed (an area between arteries and capillaries). It is a noninvasive method widely used in hospitals on newborns, persons with pulmonary disorders, and individuals undergoing pulmonary and cardiac procedures. Oxygen levels can be estimated during **exercise**, surgery, or other medical procedures, or while a person is asleep.

### Description

The oximeter consists of a light-emitting diode (LED), a photodetector probe containing a permanent or disposable sensor, alarms for pulse rate and oxygen levels, a display screen, and cables. The device works by emitting beams of red and infrared light that are passed through a pulsating arteriolar bed. Sensors detect the amount of light absorbed by oxyhemoglobin and deoxyhemoglobin in the red blood cells. The ratio of red to infrared light measured by the photodetector indicates the amount of oxygen present in the





**A pulse oximeter uses infrared light and a photo sensor to detect the amount of oxygen in a patient's blood.** (Illustration by Argosy. Cengage Learning, Gale.)

## KEY TERMS

**Arteriolar bed**—An area in which arterioles cluster between arteries and capillaries.

**Arterioles**—The smallest branches of arteries.

**Capillaries**—Tiny blood vessels with a diameter of a red blood cell through which a single layer of cells flows.

**Deoxyhemoglobin**—Hemoglobin with oxygen removed.

**Hemoglobin**—The iron-containing protein in the blood that transports oxygen from the lungs to all parts of the body.

**Oxyhemoglobin**—Hemoglobin combined with oxygen.

blood. The sensor is attached to the body over the arteriolar area in the ear, the fingertip, the big toe, or across the bridge of the nose. Clip sensors can be used on fingers or the earlobe.

The pulse oximeter is widely used in most hospitals and in research laboratories that study pulmonary function. Oximeters are used in hospital settings such as intensive care units, pulmonary units, and in health care centers. Portable hand-held devices are available,

and are used to spot check patients and for in-home use under the supervision of a physician.

## Usage

Several steps can be taken to improve the accuracy of readings. If possible, the patient should not smoke 24 hours prior to pulse oximetry. Fingernail polish should be removed if the oximeter will be attached to the finger. For people with poor circulation, hands should be slowly warmed with warm towels before attaching the oximeter. Abnormally high or low temperatures, as well as reduced hemoglobin, can influence the amount of oxygen adhering to the hemoglobin within the red blood cells, altering the reading. The sensor should be wrapped securely around the finger to prevent outside light from interfering with the reading, which could render it invalid. The device must not be used near flammable anesthetics.

## Resources

### BOOKS

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### ORGANIZATIONS

American Academy of Family Physicians. P. O. Box 11210, Shawnee Mission, KS 66207. (913)906 6000. <http://www.aafp.org>.

American Academy of Pediatrics. 141 Northwest Point Boulevard, Elk Grove Village, IL 60007 1098. (847) 434 4000. <http://www.aap.org>.  
American College of Physicians. 190 N Independence Mall West, Philadelphia, PA 19106 1572. (800) 523 1546 or (215) 351 2600. <http://www.acponline.org>.

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## Pyloroplasty

### Definition

Pyloroplasty is a surgical procedure in which the pylorus valve at the lower portion of the stomach is cut and resutured, relaxing and widening its muscular opening (pyloric sphincter) into the duodenum (first part of the small intestine). Pyloroplasty is a treatment for patients at high risk for gastric or peptic ulcer disease (PUD).

### Purpose

Pyloroplasty surgery enlarges the opening through which stomach contents are emptied into the intestine, allowing the stomach to empty more quickly. A pyloroplasty is performed to treat the complications of PUD or when medical treatment has not been able to control PUD in high-risk patients.

### Demographics

Nearly four million people in the United States have PUD; about five adults in 100,000 will develop an ulcer. About 1.7% of children being treated in general pediatric practices are diagnosed with PUD. The presence of ulcer-causing *Helicobacter pylori* bacteria occurs in 10% of the population in industrialized countries and is believed to cause 80–90% of primary ulcers. In the United States, *H. pylori* infection occurs

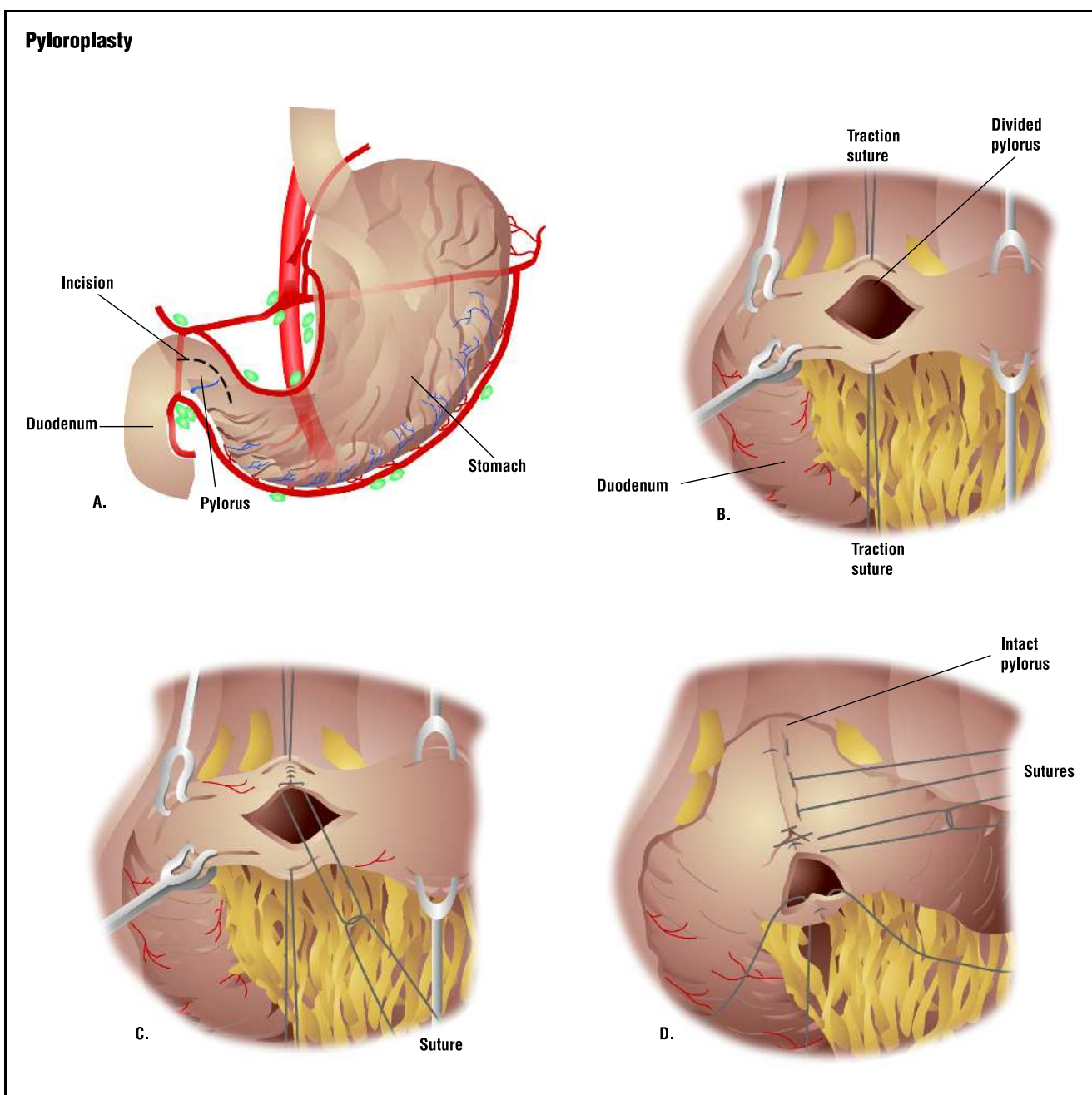
more frequently in black and Hispanic populations than in white. The frequency of secondary ulcers (caused by other existing conditions) is not known as it depends on the frequency of other illnesses, chronic diseases, and drug use. Primary and secondary PUD can occur in patients of all ages. Primary PUD is rare in children under age 10, increasing during adolescence. Secondary PUD is more prevalent in children under age six.

### Description

Peptic ulcer disease develops when there is an imbalance between normal conditions that protect the lining (mucosa) of the stomach and the intestines and conditions that disrupt normal functioning of the lining. Protective factors include the water-soluble mucosal gel layer, the production of bicarbonate in the lining to balance acidity, the regulation of gastric acid (stomach acid) secretion, and blood flow in the lining. The aggressive factors that work against this protective gastric-wall system are excessive acid production, *H. pylori* bacterial infection, and a reduced blood flow (ischemia) in the mucosal lining. These aggressive factors can cause inflammation and ulcer development. A peptic ulcer is a type of sore or hole (perforation) that forms on the lining of the stomach (gastric ulcer) or intestine (duodenal ulcer), when the lining has been eaten away by stomach acid and digestive juices. Peptic ulcers can be primary, caused by *H. pylori* infection, or secondary, caused by excess acid production, stress, use of medications, and other underlying conditions that disrupt the gastric environment. Although *H. pylori* is believed to cause the majority of all ulcers, not all people infected with it develop ulcers. In high-risk individuals, the bacteria more readily disturb the balance between good factors and destructive factors, upsetting the protective function of the stomach and intestine lining. An ulcer develops when the lining can no longer protect the organs. Secondary ulcers are usually found in the stomach; primary ulcers can be in the stomach or intestine.

Other factors that contribute to mucosal inflammation and ulceration include:

- alcohol and caffeine use
- non-steroidal anti-inflammatory drugs (NSAIDs)
- aspirin
- cigarette smoking
- exposure to certain irritating chemicals
- emotional disturbances and prolonged stress
- traumatic injuries and burns



In a pyloroplasty, an incision is made in the area that connects the stomach to the duodenum (small intestine), called the pylorus (A). The pylorus is divided laterally (B), and then stitched longitudinally (C and D), allowing for a larger connection. (Illustration by GGS Information Services. Cengage Learning, Gale.)

- respiratory failure
- blood poisoning
- critical illnesses that create imbalances in body chemistry

Symptoms of gastric or peptic ulcer include burning pain, nausea, vomiting, loss of appetite, bloating, burping, and losing weight.

When PUD is diagnosed or high risk established, medical treatment will begin to treat *H. pylori* infection if present and to restore balanced conditions in the mucosal lining. Any underlying condition may be treated simultaneously, including respiratory disorders, fluid imbalance, or stomach and digestive disorders. Medications may be prescribed to help correct gastric disturbances and control gastric acid secretion.

## KEY TERMS

**Gastric (or peptic) ulcer**—An ulcer (sore or hole) in the stomach lining, duodenum, or other part of the gastrointestinal system.

**Pyloric sphincter**—A broad band of muscle in the pylorus valve at the bottom end of the stomach.

**Pylorus**—The valve at the bottom end of the stomach that releases food from the stomach into the intestines.

**Vagotomy**—A surgical procedure in which the nerves that stimulate stomach acid production and gastric motility (movement) are cut.

Certain drugs that are prescribed for other conditions, especially NSAIDs, may be discontinued if they are known to cause inflammation. Adult patients may be advised to discontinue alcohol and caffeine use and to stop smoking.

When medical treatment alone is not able to improve the conditions that cause PUD, a pyloroplasty procedure may be recommended, particularly for patients with stress ulcers, perforation of the mucosal wall, and gastric outlet obstruction. The surgery involves cutting the pylorus lengthwise and resuturing it at a right angle across the cut to relax the muscle and create a larger opening from the stomach into the intestine. The enlarged opening allows the stomach to empty more quickly. A pyloroplasty is sometimes done in conjunction with a **vagotomy** procedure in which the vagus nerves that stimulate stomach acid production and gastric motility (movement) are cut. This may delay gastric emptying and pyloroplasty will help correct that effect.

## Diagnosis

Diagnosis begins with an accurate history of prior illnesses and existing medical conditions as well as a family history of ulcers or other gastrointestinal (stomach and intestines) disorders. A complete history and comprehensive diagnostic testing may include:

- location, frequency, duration, and severity of pain
- vomiting and description of gastric material
- bowel habits and description of stool
- all medications, including over-the-counter products
- appetite, typical diet, and weight changes
- family and social stressors
- alcohol consumption and smoking habits

- heart rate, pulse, and blood pressure
- chest examination and x ray, if necessary
- palpation (pressing with the hands) of the abdomen
- rectal examination and stool testing
- pelvic examination in sexually active females
- examination of testicles and inguinal (groin) area in males
- testing for the presence of *Helicobacter pylori*
- complete blood count and blood chemistry profile
- urinalysis
- imaging studies of gastrointestinal system (x ray, other types of scans)
- biopsy of stomach lining using a tube-like telescopic instrument (endoscope)

## Preparation

Before surgery, standard preoperative blood and urine tests will be performed and various x rays may be ordered. The patient will not be permitted to eat or drink anything after midnight the night before the procedure. When the patient is admitted to the hospital, cleansing enemas may be ordered to empty the intestine. If nausea or vomiting are present, a suction tube may be used to empty the stomach.

## Aftercare

The patient will spend several hours in a recovery area after surgery where blood pressure, pulse, respiration, and temperature will be monitored. The patient's breathing may be shallower than normal because of the effect of anesthesia and the patient's reluctance to breathe deeply and experience pain at the site of the surgical incision. The patient will be shown how to support the site while breathing deeply or coughing, and will be given pain medication as needed. Fluid intake and output will be measured. The operative site will be observed for any sign of redness, swelling, or wound drainage. Intravenous fluids are usually given for 24–48 hours until the patient is gradually permitted to eat a special light diet and as bowel activity resumes. About eight hours after surgery, the patient may be allowed to walk a little, increasing movement gradually over the next few days. The average hospital stay, dependent upon the patient's overall recovery status and any underlying conditions, ranges from six to eight days.

## Risks

Potential complications of this abdominal surgery include excessive bleeding, surgical wound infection, incisional hernia, recurrence of gastric ulcer, chronic



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A pyloroplasty surgery is performed by a general surgeon in a hospital or medical center operating room.

diarrhea, and malnutrition. After the surgery, the surgeon should be informed of an increase in pain, and of any swelling, redness, drainage, or bleeding in the surgical area. The development of headache, muscle aches, dizziness, fever, abdominal pain or swelling, constipation, nausea or vomiting, rectal bleeding, or black stools should also be reported.

### Normal results

Complete healing is expected without complications. Recovery and a return to normal activities should take from four to six weeks.

### Morbidity and mortality rates

Successful treatment of *Helicobacter pylori* has improved morbidity and mortality rates, and the prognosis for PUD, with proper treatment and avoidance of causative factors, is excellent. Pyloroplasty is rarely performed in primary ulcer disease. Morbidity and mortality are higher in patients with secondary ulcers because of underlying illness that complicates both PUD and surgical treatment.

### Resources

#### BOOKS

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## QUESTIONS TO ASK THE DOCTOR

- How will this surgery be performed?
- What is your experience with this procedure? How often do you perform this procedure?
- Why must I have the surgery?
- What are my options if I opt not have the surgery?
- How can I expect to feel after surgery?
- What are the risks involved in having this surgery?
- How quickly will I recover? When can I return to school or work?
- What are my chances of getting this condition again?
- What can I do to avoid getting this condition again?

### ORGANIZATIONS

American Gastroenterological Association. 7910 Woodmont Ave., Seventh Floor, Bethesda, MD 20814. (301) 654 2055. <http://www.gastro.org>.

National Institute of Diabetes and Digestive and Kidney Disorders. 31 Center Drive, Bethesda, MD 20892. (301) 496 7422. <http://www.niddk.nih.gov>.

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Pylorus repair see **Pyloroplasty**



## Quadrantectomy

### Definition

Quadrantectomy is a surgical procedure in which a “quadrant” (approximately one-fourth) of the breast, including tissue surrounding a cancerous tumor, is removed. It is also called a partial or segmental **mastectomy**.

### Purpose

Quadrantectomy is a type of breast-conserving surgery used as a treatment for breast cancer. Prior to the advent of breast-conserving surgeries, total mastectomy (complete removal of the breast) was considered the standard surgical treatment for breast cancer. Procedures such as quadrantectomy and **lumpectomy** (removing the tissue directly surrounding the tumor) have allowed doctors to treat cancer without sacrificing the entire affected breast.

### Demographics

The American Cancer Society estimates that approximately 211,300 new cases of breast cancer are diagnosed annually in the United States, and 39,800 women die as a result of the disease. Approximately one in eight women will develop breast cancer at some point in her life. The risk of developing breast cancer increases with age: women ages 30–40 have a one in 252 chance; ages 40–50 have a one in 68 chance; ages 50–60 have a one in 35 chance; and ages 60–70 have a one in 27 chance.

In the 1990s, the incidence of breast cancer was higher among white women (113.1 cases per 100,000 women) than African American women (100.3 per 100,000). The **death** rate associated with breast cancer, however, was higher among African American women (29.6 per 100,000) than Caucasian women (22.2 per 100,000). Rates were lower among Hispanic women

(14.2 per 100,000), Native American women (12.0), and Asian women (11.2 per 100,000).

### Description

The patient is usually placed under **general anesthesia** for the duration of the procedure. In some instances, a local anesthetic may be administered with sedation to help the patient relax.

During quadrantectomy, a margin of normal breast tissue, skin, and muscle lining is removed around the periphery of the tumor. This decreases the risk of any abnormal cells being left behind and spreading locally or to other parts of the body (a process called metastasis). The amount removed is generally about one-fourth of the size of the breast (hence, the “quadrant” in quadrantectomy). The remaining tissue is then reconstructed to minimize any cosmetic defects, and then sutured closed. Temporary drains may be placed through the skin to remove excess fluid from the surgical site.

Some patients may have the lymph nodes removed from under the arm (called the axillary lymph nodes) on the same side as the tumor. Lymph nodes are small, oval- or bean-shaped masses found throughout the body that act as filters against foreign materials and cancer cells. If cancer cells break away from their primary site of growth, they can travel to and begin to grow in the lymph nodes first, before traveling to other parts of the body. Removal of the lymph nodes is therefore a method of determining if a cancer has begun to spread. To remove the nodes, a second incision is made in the area of the armpit and the fat pad that contains the lymph nodes is removed. The tissue is then sent to a pathologist, who extracts the lymph nodes from the fatty tissue and examines them for the presence of cancer cells.

### Diagnosis/Preparation

Breast tumors may be found during self-examination or an examination by a health care professional. In

## KEY TERMS

**Mammogram**—A set of x rays taken of the front and side of the breast; used to diagnose various abnormalities of the breast.

**Pathologist**—A medical doctor who specializes in the diagnosis of diseases from the microscopic analyses of cells and tissues.

other cases, they are visualized during a routine mammogram. Symptoms such as breast pain, changes in breast size or shape, redness, dimpling, or irritation may be an indication that medical attention is warranted.

Prior to surgery, the patient is instructed to refrain from eating or drinking after midnight on the night before the operation. The physician will tell the patient what will take place during and after surgery, as well as expected outcomes and potential complications of the procedure.

## Aftercare

The patient may return home the same day or remain in the hospital for one to two days after the procedure. Discharge instructions will include how to care for the incision and drains, what activities to restrict (i.e., driving and heavy lifting), and how to manage post-operative pain. Patients are often instructed to wear a well-fitting support bra for at least a week following surgery. A follow-up appointment to remove **stitches** and drains is usually scheduled 10–14 days after surgery.

If lymph nodes are removed, specific steps should be taken to minimize the risk of developing lymphedema of the arm, a condition in which excess fluid is not properly drained from body tissues, resulting in chronic swelling. This swelling can sometimes become severe enough to interfere with daily activity. Prior to being discharged, the patient will learn how to care for the arm, and how to avoid infection. She will also be told to avoid sunburn, refrain from heavy lifting, and to be careful not to wear tight jewelry and elastic bands.

Most patients undergo radiation therapy as part of their complete treatment plan. The radiation usually begins immediately or soon after quadrantectomy, and involves a schedule of five days of treatment a week for five to six weeks. Other treatments, such as chemotherapy or hormone therapy, may also be prescribed depending on the size and stage of the patient's cancer.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Quadrantectomy is usually performed by a general surgeon, breast surgeon, or surgical oncologist. Radiation therapy is administered by a radiation oncologist, and chemotherapy by a medical oncologist. The surgical procedure is frequently done in a hospital setting (especially if lymph nodes are to be removed at the same time), but specialized outpatient facilities are sometimes preferred.

## Risks

Risks associated with the surgical removal of breast tissue include bleeding, infection, breast asymmetry, changes in sensation, reaction to the anesthesia, and unexpected scarring.

Some of the risks associated with removal of the lymph nodes include excessive bleeding, infection, pain, excessive swelling, and damage to nerves during surgery. Nerve damage may be temporary or permanent, and may result in weakness, numbness, tingling, and drooping. Lymphedema is also a risk whenever lymph nodes have been removed; it may occur immediately following surgery or months to years later.

## Normal results

Most patients will not experience recurrences of the cancer following a treatment plan of quadrantectomy and radiation therapy. One study followed patients for a period of 20 years after breast-conserving surgery, and found that only 9% experienced recurrence of the cancer.

## Morbidity and mortality rates

Following removal of the axillary lymph nodes, there is approximately a 10% risk of lymphedema and a 20% risk of abnormal skin sensations. Approximately 17% of women undergoing breast-conserving surgery have a poor cosmetic result (e.g., asymmetry or distortion of shape). The risk of complications associated with general anesthesia is less than 1%.

## Alternatives

A full mastectomy, in which the entire affected breast is removed, is one alternative to quadrantectomy. A **simple mastectomy** removes the entire breast, while a radical mastectomy removes the entire breast

## QUESTIONS TO ASK THE DOCTOR

- Why is quadrantectomy recommended?
- What methods of anesthesia and pain relief will be used?
- Where will the incision be located, and how much tissue will be removed?
- Will a lymph node dissection be performed?
- Is sentinel node biopsy appropriate in this case?
- Is postsurgical radiation therapy recommended?

plus parts of the chest muscle wall and the lymph nodes. In terms of recurrence and survival rates, breast-conserving surgery has been shown to be equally effective as mastectomy in treating breast cancer.

A new technique that may eliminate the need for removing many axillary lymph nodes is called sentinel node biopsy. When lymph fluid moves out of a region, the “sentinel” lymph node is the first node it reaches. The theory behind **sentinel lymph node biopsy** is that if cancer is not present in the sentinel node, it is unlikely to have spread to other nearby nodes. This procedure may allow individuals with early stage cancers to avoid the complications associated with partial or radical removal of lymph nodes if there is little or no chance that cancer has spread to them.

## Resources

### BOOKS

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### ORGANIZATIONS

American Cancer Society. 1599 Clifton Rd. NE, Atlanta, GA 30329 4251. (800) 227 2345. <http://www.cancer.org>.

Society of Surgical Oncology. 85 W. Algonquin Rd., Suite 550, Arlington Heights, IL 60005. (847) 427 1400. <http://www.surgonc.org>.

### OTHER

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Stephanie Dionne Sherk





# R

## Radical neck dissection

### Definition

Radical neck dissection is a surgical operation used to remove cancerous tissue in the head and neck.

### Purpose

The purpose of radical neck dissection is to remove lymph nodes and other structures in the head and neck that are likely or known to be malignant. Variations on neck dissections exist, depending on the extent of the cancer. A radical neck dissection removes the most tissue. It is performed when the cancer has spread widely in the neck. A modified neck dissection removes less tissue, and a selective neck dissection even less.

### Demographics

Experts estimate that there are approximately 5,000–10,000 radical neck dissections in the United States each year. Men and women undergo radical neck dissections at about the same rate.

### Description

Cancers of the head and neck (sometimes inaccurately called throat cancer) often spread to nearby tissues and into the lymph nodes. Removing these structures is one way of controlling the cancer.

Of the 600 lymph nodes in the body, approximately 200 are in the neck. Only a small number of these are removed during a neck dissection. In addition, other structures such as muscles, veins, and nerves may be removed during a radical neck dissection. These include the sternocleidomastoid muscle (one of the muscles that functions to flex the head), internal jugular (neck) vein, submandibular gland

(one of the salivary glands), and the spinal accessory nerve (a nerve that helps control speech, swallowing, and certain movements of the head and neck). The goal is always to remove all the cancer, but to save as many components surrounding the nodes as possible.

An incision is made in the neck, and the skin is pulled back (retracted) to reveal the muscles and lymph nodes. The surgeon is guided in what to remove by tests performed prior to surgery and by examination of the size and texture of the lymph nodes.

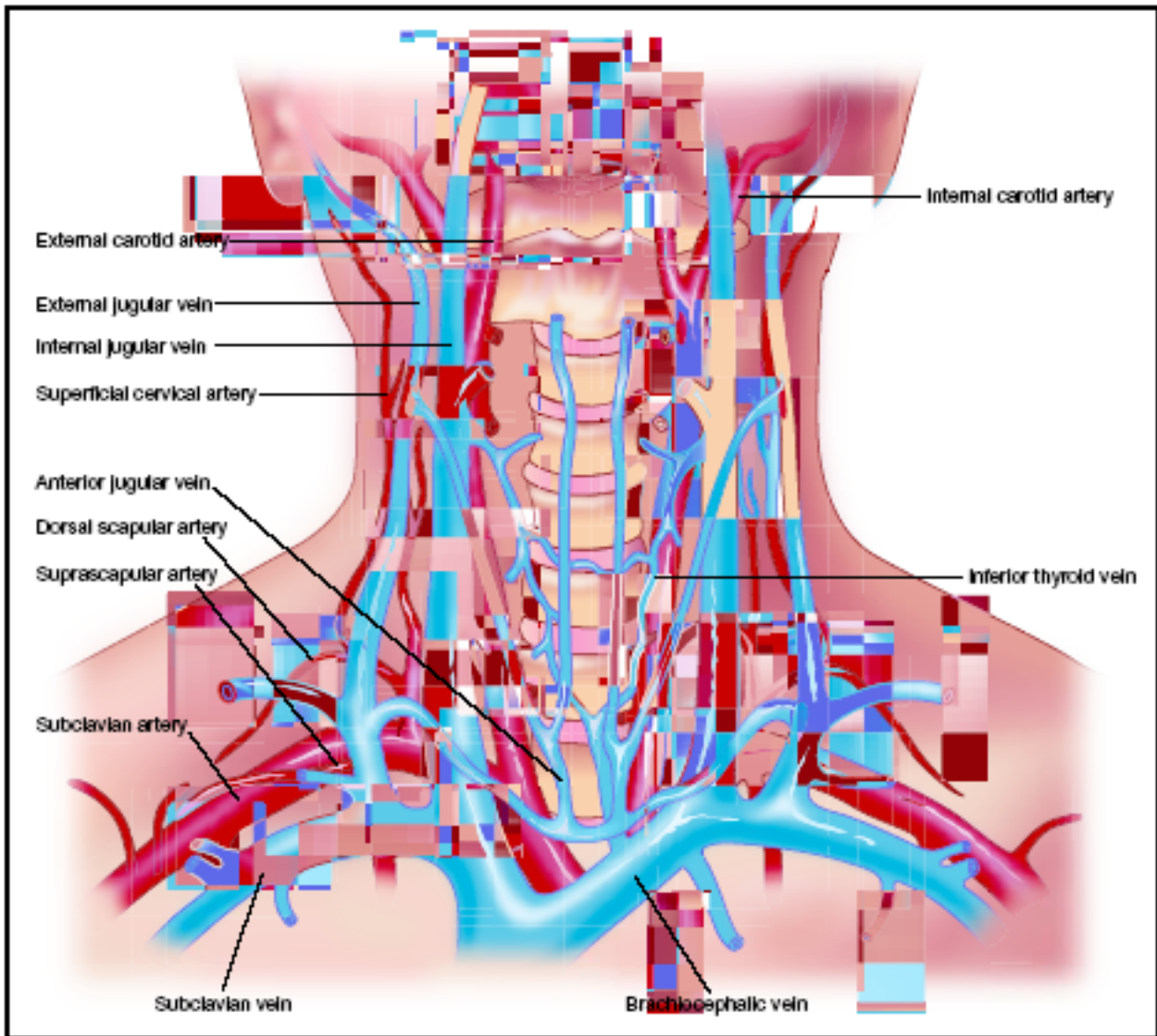
### Diagnosis/Preparation

This operation should not be performed if cancer has metastasized (spread) beyond the head and neck, or if the cancer has invaded the bones of the cervical vertebrae (the first seven bones of the spinal column) or the skull. In these cases, the surgery will not effectively contain the cancer.

Radical neck dissection is a major operation. Extensive tests are performed before the operation to try to determine where and how far the cancer has spread. These may include lymph node biopsies, computed tomography (CT) scans, **magnetic resonance imaging** (MRI) scans, and barium swallows. In addition, standard preoperative blood and **liver function tests** are performed, and the candidate will meet with an anesthesiologist before the operation. The candidate should tell the anesthesiologist about all drug allergies and all medication (prescription, non-prescription, or herbal) that are presently being taken.

### Aftercare

A person who has had a radical neck dissection will stay in the hospital several days after the operation, and sometimes longer if surgery to remove the primary tumor was performed at the same time. Drains are inserted under the skin to remove the fluid that accumulates in the neck area. Once the drains are removed



**Major veins and arteries in the neck.** (Illustration by Electronic Illustrators Group.)

and the incision appears to be healing well, people are usually discharged from the hospital, but will require follow-up doctor visits. Depending on how many structures are removed, a person who has had a radical neck dissection may require physical therapy to regain use of the arm and shoulder.

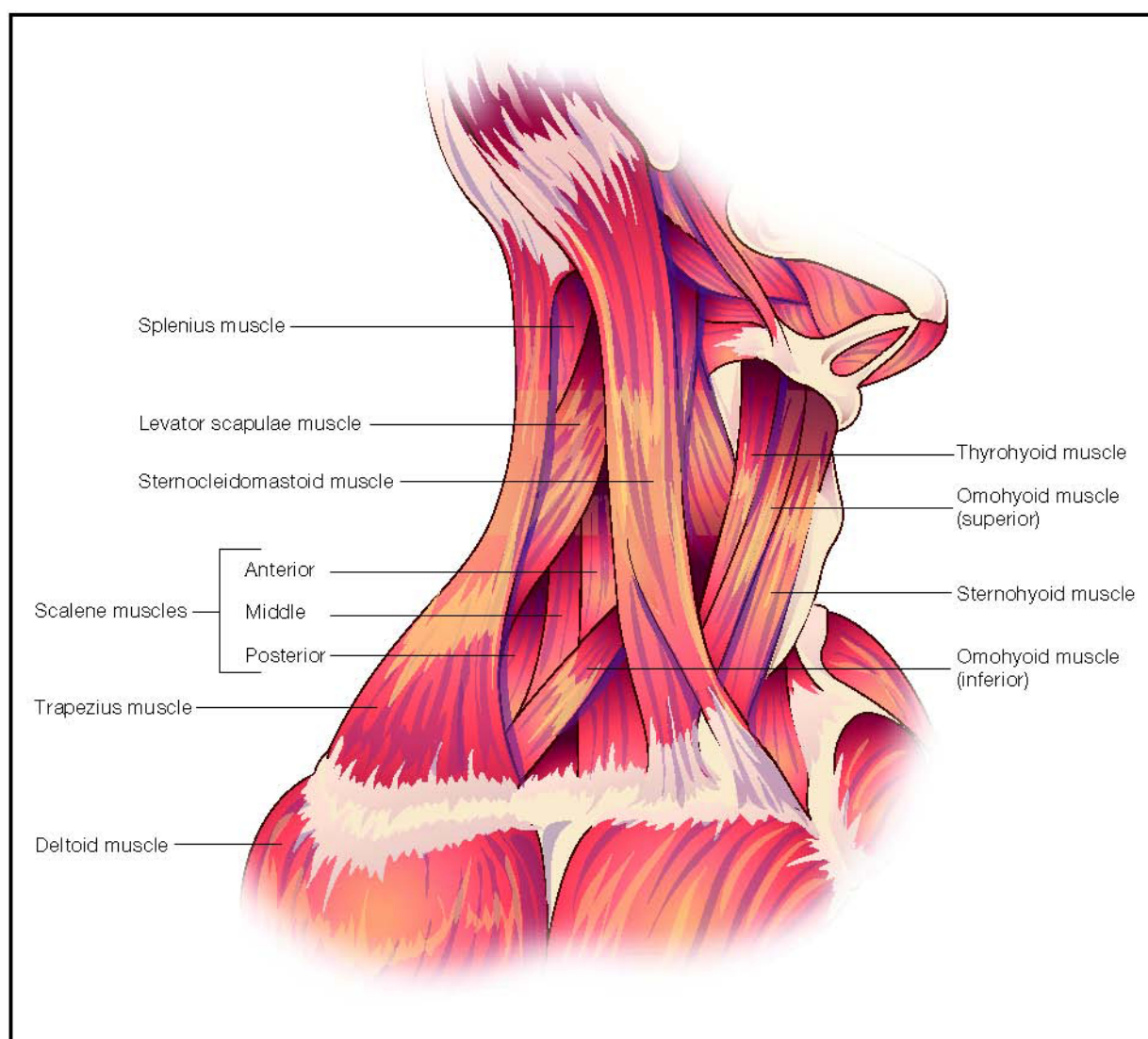
### Risks

The greatest risk in a radical neck dissection is damage to the nerves, muscles, and veins in the neck. Nerve damage can result in numbness (either temporary or permanent) to different regions on the neck and loss of function (temporary or permanent) to

parts of the neck, throat, and shoulder. The more extensive the neck dissection, the more function a person is likely to lose. As a result, it is common following radical neck dissection for people to have stooped shoulders, limited ability to lift one or both arms, and limited head and neck rotation and flexion due to the removal of nerves and muscles. Other risks are the same as for all major surgery: potential bleeding, infection, and allergic reaction to anesthesia.

### Normal results

Normal lymph nodes are small and show no cancerous cells under a microscope. Abnormal lymph



**Major muscles of the neck.** (Illustration by Electronic Illustrators Group.)

nodes may be enlarged and show malignant cells when examined under a microscope.

### Morbidity and mortality rates

The mortality rate for radical neck dissection can be as high as 14%.

Morbidity rates are somewhat higher and are due to bleeding, post-surgery infection, and medicine errors.

### Alternatives

Alternatives to radical neck dissection depend on the reason for the proposed surgery. Most alternatives

are far less acceptable. Radiation and chemotherapy may be used instead of a radical neck dissection in the case of cancer. Alternatives for some surgical procedures may reduce scarring, but are not as effective in the removal of all pathological tissue. Chemotherapy and radiation or altered fractionated radiotherapy are reasonable alternatives.

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## KEY TERMS

**Barium swallow**—Barium is used to coat the throat to highlight the tissues lining the throat, allowing them to be visualized using x-ray pictures.

**Computed tomography (CT or CAT) scan**—Using x rays taken from many angles and computer modeling, CT scans help locate and estimate the size of tumors and provide information on whether they can be surgically removed.

**Lymph nodes**—Small, bean-shaped collections of tissue found in lymph vessels. They produce cells and proteins that fight infection and filter lymph. Nodes are sometimes called lymph glands.

**Lymphatic system**—Primary defense against infection in the body; the tissues, organs, and channels (similar to veins) that produce, store, and transport lymph and white blood cells to fight infection.

**Magnetic resonance imaging (MRI)**—Uses magnetic fields and computers to create detailed cross-sectional pictures of the interior of the body.

**Malignant**—Cancerous. Cells tend to reproduce without normal controls on growth and form tumors or invade other tissues.

**Metastasize**—Spread of cells from the original site of a cancer to other parts of the body where secondary tumors are formed.

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American College of Surgeons. 633 North St. Clair Street, Chicago, IL 60611 32311. (312) 202 5000, Fax: (312) 202 5001. E mail: [postmaster@facs.org](mailto:postmaster@facs.org). <http://www.facs.org>.

American Academy of Otolaryngology Head and Neck Surgery. One Prince St., Alexandria, VA 22314 3357. (703) 836 4444. <http://www.entnet.org/index2.cfm>.

American Cancer Society. 1599 Clifton Road NE, Atlanta, GA 30329. (800) 227 2345. <http://www.cancer.org>.

American Osteopathic College of Otolaryngology Head and Neck Surgery. 405 W. Grand Avenue, Dayton, OH 45405. (937) 222 8820 or (800) 455 9404, Fax: (937) 222 8840. [info@aocoohns.org](mailto:info@aocoohns.org).

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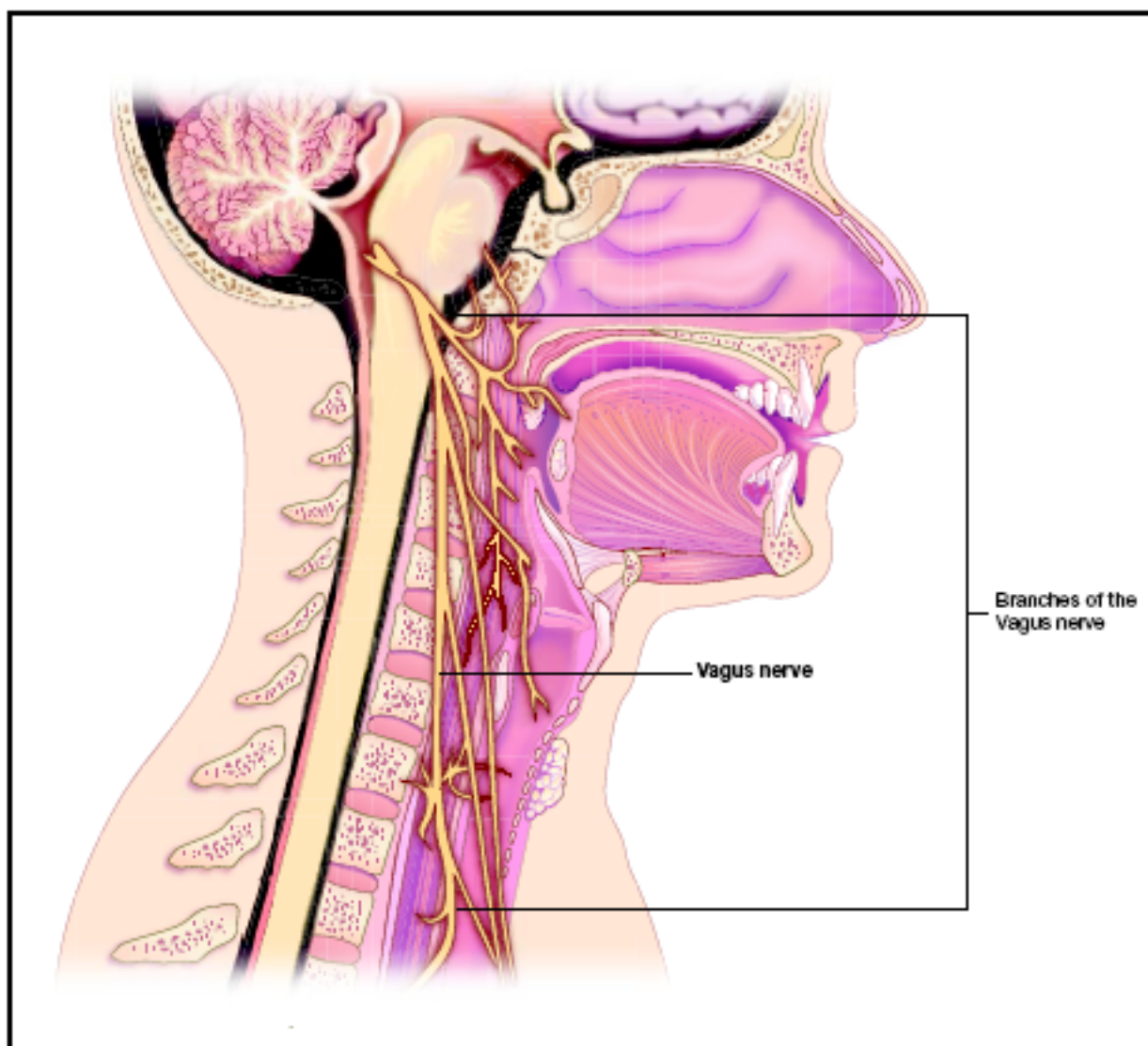
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Branches of the vagus nerve. (Illustration by Electronic Illustrators Group.)

### WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A radical neck dissection is usually performed by a surgeon with specialized training in otolaryngology, head and neck surgery. Occasionally, a general surgeon will perform a radical neck dissection. The procedure is performed in a hospital under general anesthesia.

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L. Fleming Fallon, Jr, MD, DrPH

Radical prostatectomy see **Open prostatectomy**

Radioimmunoassay see **Immunoassay tests**

Reconstructive surgery see **Plastic, reconstructive, and cosmetic surgery**

## QUESTIONS TO ASK THE DOCTOR

- What tests will be performed to determine if the cancer has spread?
- Which parts of the neck will be removed?
- How will a radical neck dissection affect daily activities after recovery?
- What is the likelihood that all of the cancer can be removed with a radical neck dissection?
- Are the involved lymph nodes on one or both sides of the neck?
- What will be the resulting appearance after surgery?
- How will my speech and breathing be affected?
- Is the surgeon board certified in otolaryngology head and neck surgery?
- How many radical neck procedures has the surgeon performed?
- What is the surgeon's complication rate?

## Recovery at home

### Definition

Recovery at home after surgery may require certain dietary and environmental restrictions, recommended rest and limitations to physical activities, and other required or restricted activities as recommended by a physician or surgeon.

### Purpose

Postoperative recovery at home should promote physical healing and rest and recovery from the stress of surgery. For patients who undergo **orthopedic surgery**, the home recovery period will also involve rehabilitation to regain diminished musculoskeletal functioning. Emotional and psychological recovery from life-altering surgeries may also begin during the home recovery period.

### Description

When patients are discharged from either an ambulatory surgical facility or a hospital, they will receive written instructions from their physician containing restrictions, requirements, and recommendations for their postoperative recovery at home. A nurse will usually review these instructions verbally with the patient and answer any questions and concerns. They may also

call one or up to several days after a surgical discharge to follow up on how the patient is feeling and answer any questions about home recovery.

Restrictions and recommendations outlined in home recovery instructions may include:

- **Driving restrictions.** A patient may be prohibited from driving for a period of time due to functional limitations or to medication that impairs driving ability.
- **Work restrictions.** Depending on the nature of the patient's job, he or she may be required to stay home from work or request alternate duties until recovery is complete.
- **Social restrictions.** Patients at high risk of complications from infection, such as an organ transplant patient, may be advised to avoid anyone with a cold or flu and to stay away from crowds or social gatherings during the initial recovery period.
- **Medication recommendations.** Prescription and/or over the counter drugs may be recommended on an as-needed basis for pain and nausea. Other drugs may also be required.
- **Dietary limitations.** Certain types of gastrointestinal procedures and other surgeries may require a restricted diet during the recovery period. Alcohol may also be prohibited, particularly if pain medication has been prescribed.
- **Ambulation recommendations.** The doctor will note if the patient should refrain from lifting heavy objects, climbing stairs, having sex, or participating in other potentially strenuous activities.
- **Exercise recommendations.** If movement, stretches, or exercise is encouraged as part of recovery, that fact will also be noted.
- **Incision care.** Patients are instructed on how to care for their incision and educated on signs of infection (i.e., redness, warmth, swelling, fever, odor).
- **Home care needs.** Some patients may require a visiting nurse or live-in health aide for a period of time as they recover from surgery.
- **Adaptive equipment.** Assistive or adaptive devices such as crutches, a walker, prosthetics, or bed or bathroom hand rails may be necessary.
- **Follow-up with physician.** A patient may be instructed to call the doctor's office to schedule a follow-up appointment. The patient should also be given criteria for warning signs and symptoms that may occur with the procedure, and when to call the physician if the symptoms appear.
- **Other required medical appointments.** If a patient has undergone orthopedic surgery or another procedure that requires rehabilitation, he or she may need

## KEY TERMS

**Ambulation**—To walk or move from place to place.

**Ambulatory care**—An outpatient facility; designed for patients who do not require inpatient hospital treatment or care.

**Prosthetics**—A custom-built artificial limb or other body part.

**Orthopedic**—Related to the musculoskeletal system, including the bones, joints, muscles, ligaments, and tendons.

to see a physical or occupational therapist to regain range of motion, strength, and mobility. Depending on the type of surgery performed, the expertise of other medical professionals may also be required.

The postoperative period is also a time of emotional healing. Patients who face a long recovery and rehabilitation may feel depressed or anxious about their situation. Providing a patient with realistic goals and expectations for recovery both before and after the surgery can help avoid feelings of failure or let down when things do not progress as quickly as the patient had hoped. Realistic recovery expectations can also prevent a patient from doing too much too early and potentially hindering the healing process.

Certain life-altering surgeries, such as an **amputation** or a **mastectomy**, carry their own set of emotional issues. Counseling, therapy, or participation in a patient support group may be an important part of postoperative recovery as a patient adjusts to the new post-surgical life.

## Preparation

Discharge recommendations for home recovery are typically explained to the patient before he or she is allowed to leave the hospital or ambulatory care facility. In some cases, the patient may be required to sign paperwork indicating that he or she has both received and understood **home care** instructions.

Depending on the surgical procedure undergone, a patient may be taught some home care techniques while still in the hospital. Physical therapy exercises, **incision care**, and use of assistive devices such as crutches or splints are a few self-care skills that may be demonstrated and practiced in an inpatient environment.

A physical and emotional support system is a crucial part of a successful home recovery. Faced with restrictions to movement, driving, and possibly

more, a patient needs someone at home to help with the daily tasks of independent living. If family or friends are not nearby or available, a visiting nurse or home healthcare aide should be hired before the patient is discharged to home recovery.

## Normal results

Following home care instructions can help to speed a patient's recovery time and ensure the safe resumption of normal activities. In some cases, the familiar, comforting home environment may even speed the healing process or improve the degree of recovery. One study of patients 64 and older undergoing hip surgery found that patients who were allowed to undergo rehabilitation at home had significantly better outcomes than those who underwent rehabilitation as hospital inpatients. On average, the former had better physical capacity and independent living skills when assessed six months after surgery.

Some studies have also indicated that gender may have an impact on the success and speed of postoperative home recovery. Some studies have found that women recover more rapidly than men. However, animal and laboratory studies have found that progesterone and estrogen may be involved in the period immediately after surgery or injury. This would indicate that women may have a natural advantage in recovery. Scientists continue to study the recovery process to try to understand it and help patient recovery as quickly and completely as possible.

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National Association for Home Care and Hospice. 228 Seventh Street SE, Washington, DC 20003. (202) 547 7424. <http://www.nahc.org>.



Visiting Nurses Association of America, 99 Summer Street,  
Suite 1700, Boston, Massachusetts 02110. (617) 737  
3200. <http://www.vnaa.org>.

Paula Ford-Martin  
Robert Bockstiegel

## Recovery room

### Definition

The recovery room, also called a post-anesthesia care unit (PACU), is a space a patient is taken to after surgery to safely regain consciousness from anesthesia and receive appropriate **postoperative care**.

### Description

Patients who have had surgery or diagnostic procedures requiring anesthesia or sedation are taken to the recovery room, where their **vital signs** (e.g., pulse, blood pressure, temperature, blood oxygen levels) are monitored closely as the effects of anesthesia wear off. The patient may be disoriented when he or she regains consciousness, and the recovery room nursing staff will work to ease their anxiety and ensure their physical and emotional comfort.

The recovery room staff will pay particular attention to the patient's respiration, or breathing, as the patient recovers from anesthesia. A **pulse oximeter**, a clamp-like device that attaches to a patient's finger and uses infrared light to measure the oxygen saturation level of the blood, is usually used to assess respiratory stability. If the oxygen saturation level is too low, supplemental oxygen may be administered through a nasal cannula or face mask. Intravenous fluids are also frequently administered in the recovery room.

Because **general anesthesia** can cause a patient's core **body temperature** to drop several degrees, retaining body heat to prevent hypothermia and encourage good circulation is also an important part of recovery room care. Patients may be wrapped in blankets warmed in a heater or covered with a forced warm-air blanket system to bring body temperature back up to normal. They may also receive heated intravenous fluids.

The amount of time a patient requires in the recovery room will vary by surgical or diagnostic procedure and the type of anesthesia used. As the patient recovers from anesthesia, their postoperative condition is assessed by the recovery room nursing staff. A physician may order analgesic or antiemetic medication for any

## KEY TERMS

**Fast track**—A protocol for postoperative patients with projected shorter recovery times. Fast-tracking a patient means that they will either bypass PACU completely, or spend a shorter time there with less intensive staff intervention and monitoring.

**Hypothermia**—Low core body temperature of 95°F (35°C) or less.

**Nasal cannula**—A piece of flexible plastic tubing with two small clamps that fit into the nostrils and provide supplemental oxygen flow.

pain or nausea and vomiting, and the surgeon and/or anesthesiologist may come by to examine the patient.

Both hospitals and ambulatory surgical centers have recovery room facilities, which are generally located in close proximity to the **operating room**. A recovery room may be private, or it may be a large, partitioned space shared by many patients. Each patient bay, or space, is equipped with a variety of medical monitoring equipment. To keep the area sterile and prevent the spread of germs, outside visitors may be required to don a gown and cap or may be prohibited completely. Spouses or partners of women who are recovering after caesarean section and the parents of children recovering from surgery are typically excluded from any visitor prohibitions in the recovery room. In fact, parents are usually encouraged to be with their child in recovery to minimize any emotional trauma.

In some ambulatory surgery facilities, patients may have a different postoperative experience if they receive short-acting anesthetic drugs for their procedure. This protocol, known as "fast tracking," involves either shortening the time spent in the PACU or, if clinically indicated, bypassing the PACU altogether and sending the patient directly to what is known as a phase II step-down unit. A step-down unit is a transitional care area where patients can rest and recover before discharge with a lesser degree of monitoring and staff attention than in a PACU.

### Normal results

After the effects of anesthesia have worn off completely and the patient's condition is considered stable, he or she will either be returned to their hospital room (for inpatient surgery) or discharged (for **outpatient surgery**). Patients who are discharged will be briefed on postoperative care instructions to follow at home before they are released.

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### ORGANIZATIONS

American Society of Anesthesiologists. 520 N. Northwest Highway Park Ridge, IL 60068 2573. (847) 825 5586. Fax: (847) 825 1692. <http://www.asahq.org>.

Paula Ford-Martin

Rectal artificial sphincter see **Artificial sphincter insertion**

## Rectal prolapse repair

### Definition

Rectal prolapse repair surgery treats a condition in which the rectum falls, or prolapses, from its normal anatomical position because of a weakening in the surrounding supporting tissues.

### Purpose

A prolapse occurs when an organ falls or sinks out of its normal anatomical place. The pelvic organs normally have tissue (muscle, ligaments, etc.) holding them in place. Certain factors, however, may cause those tissues to weaken, leading to prolapse of the organs. The rectum is the last out of six divisions of the large intestine; the anus is the opening from the rectum through which stool exits the body. A complete rectal prolapse occurs when the rectum protrudes through the anus. If rectal prolapse is present, but the rectum does not protrude through the anus, it is called occult rectal prolapse, or rectal intussusception. In females, a rectocele occurs when the rectum protrudes into the posterior (back) wall of the vagina.

Factors that are linked to the development of rectal prolapse include age, repeated childbirth, constipation, ongoing physical activity, heavy lifting, prolapse of other pelvic organs, and prior **hysterectomy**. Symptoms of rectal prolapse include protrusion of the rectum during and after defecation, fecal incontinence (inadvertent leakage of feces with physical activity), constipation, and rectal bleeding. Women may

## KEY TERMS

**Perineum**—The area between the vagina and anus in females, and the scrotum and anus in males.

experience a vaginal bulge, vaginal pressure or pain, painful sexual intercourse, and lower back pain.

### Demographics

The overall incidence of rectal prolapse in the United States is approximately 4.2 per 1,000 people. The incidence of the disorder increases to 10 per 1,000 among patients older than 65. Most patients with rectal prolapse are women; the ratio of male-to-female patients is one to six.

### Description

Surgery is generally not performed unless the symptoms of the prolapse have begun to interfere with daily life. Because of the numerous defects that can cause rectal prolapse, there are more than 50 operations that may be used to treat the condition. A perineal or abdominal approach may be used. While abdominal surgery is associated with a higher rate of complications and a longer recovery time, the results are generally longer lasting. Perineal surgery is generally used for older patients who are unlikely to tolerate the abdominal procedure well.

### Abdominal and laparoscopic approach

Rectopexy and anterior resection are the two most common abdominal surgeries used to treat rectal prolapse. The patient is usually placed under **general anesthesia** for the duration of surgery. During rectopexy, an incision into the abdomen is made, the rectum isolated from surrounding tissues, and the sides of the rectum lifted and fixed to the sacrum (lower back-bone) with **stitches** or with a non-absorbable mesh. Anterior resection removes the S-shaped sigmoid colon (the portion of the large intestine just before the rectum); the two cut ends are then reattached. This straightens the lower portion of the colon and makes it easier for stool to pass. Rectopexy and anterior resection may also be performed in combination and may lead to a lower rate of prolapse recurrence.

As an alternative to the traditional laparotomy (large incision into the abdomen), laparoscopic surgery may be performed. **Laparoscopy** is a surgical procedure in which a laparoscope (a thin, lighted tube) and various instruments are inserted into the

abdomen through small incisions. Rectopexy and anterior resection have been performed laparoscopically with good results. A patient's recovery time following laparoscopic surgery is shorter and less painful than following traditional abdominal surgery.

### *Perineal approach*

Perineal repair of rectal prolapse involves a surgical approach around the anus and perineum. The patient may be placed under general or regional anesthesia for the duration of surgery.

The most common perineal repair procedures are the Altemeier and Delorme procedures. During the Altemeier procedure (also called a proctosigmoidectomy), the prolapsed portion of the rectum is resected (removed) and the cut ends reattached. The weakened structures supporting the rectum may be stitched into their anatomical position. The Delorme procedure involves the resection of only the mucosa (inner lining) of the prolapsed rectum. The exposed muscular layer is then folded and stitched up and the cut edges of mucosa stitched together.

A rarely used procedure is anal encirclement. Also called the Thiersch procedure, anal encirclement involves the insertion of a thin circular band of non-absorbable material under the skin of the anus. This narrows the anal opening and prevents the protrusion of the rectum through the opening. This procedure, however, does not address the underlying condition and therefore is generally reserved for patients who are not good candidates for more invasive surgery.

## Diagnosis/Preparation

**Physical examination** is most often used to diagnose rectal prolapse. The patient is asked to strain as if defecating; this increase in intra-abdominal pressure will maximize the degree of prolapse and aid in diagnosis. In some instances, imaging studies such as defecography (x rays taken during the process of defecation) may be administered to determine the extent of prolapse.

Before surgery, an intravenous (IV) line is placed so that fluid and/or medications may be easily administered to the patient. A Foley catheter will be placed to drain urine. **Antibiotics** are usually given to help prevent infection. The patient will be given a bowel prep to cleanse the colon and prepare it for surgery.

## Aftercare

A Foley catheter may remain for one to two days after surgery. The patient will be given a liquid diet

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Rectal prolapse repair is usually performed in a hospital operating room. The surgery may be performed by a general surgeon, a colon and rectal surgeon (who focuses on diseases of the colon, rectum, and anus), or a gastrointestinal surgeon (who focuses on diseases of the gastrointestinal system).

until normal bowel function returns. The recovery time following perineal repair is faster than recovery after abdominal surgery and usually involves a shorter hospital stay (one to three days following perineal surgery, three to seven days following abdominal surgery). The patient will be instructed to avoid activities for several weeks that will cause strain on the surgical site; these include lifting, coughing, long periods of standing, sneezing, straining with bowel movements, and sexual intercourse. High-fiber foods should be gradually added to the diet to avoid constipation and straining that could lead to prolapse recurrence.

## Risks

Risks associated with rectal prolapse surgery include potential complications associated with anesthesia, infection, bleeding, injury to other pelvic structures, recurrent prolapse, and failure to correct the defect. Following a resection procedure, a leak may occur at the site where two cut ends of colon are reattached, requiring surgical repair.

## Normal results

Most patients undergoing rectal prolapse repair will be able to return to normal activities, including work, within four to six weeks after surgery. The majority of patients will experience a significant improvement in symptoms and have a low chance of prolapse recurrence if heavy lifting and straining is avoided.

## Morbidity and mortality rates

The approximate recurrence rates for the most commonly performed surgeries as reported by several studies are as follows:

- Altemeier procedure: 5–54%
- Delorme procedure: 5–26%
- anal encirclement: 25%
- rectopexy: 2–10%

## QUESTIONS TO ASK THE DOCTOR

- What defect is causing the rectal prolapse?
- What surgical procedure is recommended for treatment?
- What are the risks and complications associated with the recommended procedure?
- Are any non-surgical treatment alternatives available?
- How soon after surgery may normal activities be resumed?

- anterior resection: 7–9%
- rectopexy with anterior resection: 0–4%

Abdominal surgeries are associated with a higher rate of complications than perineal repairs; rectopexy, for example, has a morbidity rate of 3–29%, and anterior resection a rate of 15–29%. The complication rate for combined rectopexy and anterior resection is slightly lower at 4–23%. Approximately 25% of patients undergoing anal encirclement will eventually require surgery to treat complications associated with the procedure.

### Alternatives

There are currently no medical therapies available to treat rectal prolapse. In cases of mild prolapse where the rectum does not protrude through the anus, a high-fiber diet, stool softeners, enemas, or **laxatives** may help to avoid constipation, which may make the prolapse worse.

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#### ORGANIZATIONS

American Society of Colon and Rectal Surgeons. 85 W. Algonquin Rd., Suite 550, Arlington Heights, IL 60005. (847) 290 9184. <http://www.fascrs.org>.

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Stephanie Dionne Sherk

## Rectal resection

### Definition

A rectal resection is the surgical removal of a portion of the rectum.

### Purpose

Rectal resections repair damage to the rectum caused by diseases of the lower digestive tract, such as cancer, **diverticulitis**, and inflammatory bowel disease (ulcerative colitis and Crohn's disease). Injury, obstruction, and ischemia (compromised blood supply) may require rectal resection. Masses and scar tissue can grow within the rectum, causing blockages that prevent normal elimination of feces. Other diseases, such as diverticulitis and ulcerative colitis, can cause perforations in the rectum. Surgical removal of the damaged area can return normal rectal function.

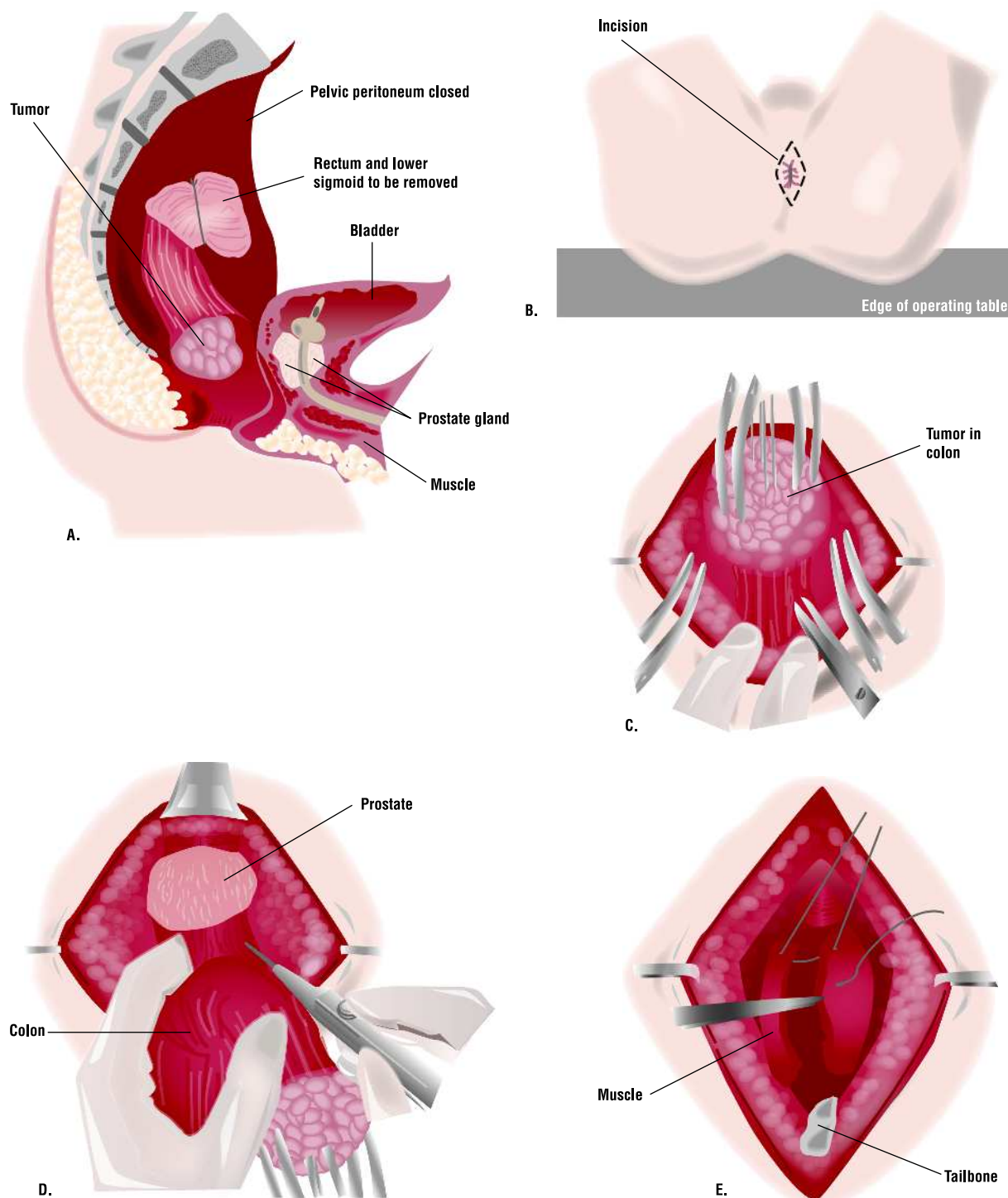
### Demographics

Colorectal cancer affects 140,000 people annually, causing 60,000 deaths. Incidence of the disease in 2001 differed among ethnic groups, with Hispanics having 10.2 cases per 100,000 people and African Americans having 22.8 cases per 100,000. Rectal cancer incidence is a portion of the total colorectal incidence rate. Surgery is the optimal treatment for rectal cancer, resulting in cure in 45% of patients. Recurrence due to surgical failure is low, from 4–8%, when the procedure is meticulously performed.

Crohn's disease and ulcerative colitis, both chronic inflammatory diseases of the colon, each affect approximately 500,000 young adults. Surgery is recommended when medication fails patients with ulcerative colitis. Nearly three-fourths of all Crohn's patients will require surgery to remove a diseased section of the intestine or rectum.



## Rectal resection



A tumor in the rectum or lower colon can be removed by a rectal resection (A). An incision is made around the patient's anus (B). The tumor is pulled down through the incision (C). An attached area of the colon is also removed (D). The area is repaired, leaving an opening for bowel functioning (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Adjuvant therapy**—Treatment used to increase the effectiveness of surgery, usually chemotherapy or radiation used to kill any cancer cells that might be remaining.

**Anastomosis**—The surgical connection of two sections of tubes, ducts, or vessels.

**Diverticuli**—Pouches in the intestinal wall usually created from a diet low in fiber.

**Enema**—Insertion of a tube into the rectum to infuse fluid into the bowel and encourage a bowel movement. Ordinary enemas contain tap water, mixtures of soap and water, glycerine and water, or other materials.

**Intestine**—Commonly called the bowels, divided into the small and large intestine. They extend from the stomach to the anus. The small intestine is about 20 ft (6 m) long. The large intestine is about 5 ft (1.5 m) long.

**Ischemia**—A compromise in blood supply delivered to body tissues that causes tissue damage or death.

**Sigmoid colon**—The last third of the intestinal tract that is attached to the rectum.

## Description

During a rectal resection, the surgeon removes the diseased or perforated portion of the rectum. If the diseased or damaged section is not very large, the separated ends are reattached. Such a procedure is called rectal anastomosis.

## Diagnosis/Preparation

### Diagnostic tests

A number of tests identify masses and perforations within the intestinal tract.

- A lower GI (gastrointestinal) series is a series of x rays of the colon and rectum that can help identify ulcers, cysts, polyps, diverticuli (pouches in the intestine), and cancer. The patient is given a barium enema to coat the intestinal tract, making disease easier to see on the x rays.
- Flexible sigmoidoscopy involves insertion of a sigmoidoscope, a flexible tube with a miniature camera, into the rectum to examine the lining of the rectum and the sigmoid colon, the last third of the intestinal

tract. The sigmoidoscope can also remove polyps or tissue for biopsy.

- A colonoscopy is similar to the flexible sigmoidoscopy, except the flexible tube examines the entire intestinal tract.
- Magnetic resonance imaging (MRI), used both prior to and during surgery, allows physicians to determine the precise margins for the resection, so that all of the diseased tissue can be removed. This also identifies patients who could most benefit from adjuvant therapy such as chemotherapy or radiation.

### Preoperative preparation

To cleanse the bowel, the patient may be placed on a restricted diet for several days before surgery, then placed on a liquid diet the day before, with nothing by mouth after midnight. A series of enemas and/or oral preparations (GoLytely, Colyte, or senna) may be ordered to empty the bowel. Oral anti-infectives (neomycin, erythromycin, or kanamycin sulfate) may be ordered to decrease bacteria in the intestine and help prevent post-operative infection. The operation can be done with an abdominal incision (laparotomy) or using minimally invasive techniques with small tubes to allow insertion of the operating instruments (**laparoscopy**).

### Aftercare

**Postoperative care** involves monitoring blood pressure, pulse, respiration, and temperature. Breathing tends to be shallow because of the effect of the anesthesia and the patient's reluctance to breathe deeply due to discomfort around the surgical incision. The patient is taught how to support the incision during deep breathing and coughing, and given pain medication as necessary. Fluid intake and output is measured, and the wound is observed for color and drainage.

Fluids and electrolytes are given intravenously until the patient's diet can be resumed, starting with liquids, then adding solids. The patient is helped out of bed the evening of the surgery and allowed to sit in a chair. Most patients are discharged in two to four days.

### Risks

Rectal resection has potential risks similar those of other major surgeries. Complications usually occur while the patient is in the hospital and the patient's general health prior to surgery will be an indication of the risk potential. Patients with heart problems and stressed immune systems are of special concern. Both

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Rectal resections are performed by general surgeons and colorectal surgeons as in-patient surgeries under general anesthesia.

during and following the procedure, the physician and nursing staff will monitor the patient for:

- excessive bleeding
- wound infection
- thrombophlebitis (inflammation and blood clot in the veins in the legs)
- pneumonia
- pulmonary embolism (blood clot or air bubble in the lungs' blood supply)
- cardiac stress due to allergic reaction to the general anaesthetic

Symptoms that the patient should report, especially after discharge, include:

- increased pain, swelling, redness, drainage, or bleeding in the surgical area
- flu-like symptoms such as headache, muscle aches, dizziness, or fever
- increased abdominal pain or swelling, constipation, nausea or vomiting, or black, tarry stools

### Normal results

Complete healing is expected without complications. The recovery rate varies, depending on the patient's overall health prior to surgery. Typically, full recovery takes six to eight weeks.

### Morbidity and mortality rates

Mortality has decreased from nearly 28% to under 6%, through the use of prophylactic **antibiotics** before and after surgery.

### Alternatives

If the section of the rectum to be removed is very large, the rectum may not be able to be reattached. Under those circumstances, a **colostomy** would be preformed. The distal end of the rectum would be closed and left to atrophy. The proximal end would be brought through an opening in the abdomen to create an opening, a stoma, for feces to be removed from the body.

## QUESTIONS TO ASK THE DOCTOR

- Am I a good candidate for laparoscopic surgery?
- What kinds of preoperative tests will be required?
- What medications will be given for pain relief after the surgery?
- What will I need to do to prepare for surgery?
- What will my recovery time be and what restrictions will I have?

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American Board of Colon and Rectal Surgery (ABCRS). 20600 Eureka Road, Suite 713, Taylor, MI 48180. (734) 282 9400. <http://www.fascrs.org>.

Mayo Clinic. 200 First St. S.W., Rochester, MN 55905. (507) 284 2511. <http://www.mayoclinic.org>.

Janie Franz

## Red blood cell indices

### Definition

Red blood cell (RBC) indices are calculations derived from the **complete blood count** that aid in the diagnosis and classification of anemia.

### Purpose

Red blood cell indices help classify types of anemia, a decrease in the oxygen carrying capacity of the blood. Healthy people have an adequate number of correctly sized red blood cells containing enough

hemoglobin to carry sufficient oxygen to all the body's tissues. Anemia is diagnosed when either the hemoglobin or **hematocrit** of a blood sample is too low.

### Description

Measurements needed to calculate RBC indices are the red blood cell count, hemoglobin, and hematocrit. The hematocrit is the percentage of blood by volume that is occupied by the red cells. The three main RBC indices are:

- **Mean corpuscular volume (MCV).** The average size of the red blood cells expressed in femtoliters (fl). MCV is calculated by dividing the hematocrit (as percent) by the RBC count in millions per microliter of blood, then multiplying by 10.
- **Mean corpuscular hemoglobin (MCH).** The average amount of hemoglobin inside an RBC expressed in picograms (pg). The MCH is calculated by dividing the hemoglobin concentration in grams per deciliter by the RBC count in millions per microliter, then multiplying by 10.
- **Mean corpuscular hemoglobin concentration (MCHC).** The average concentration of hemoglobin in the RBCs expressed as a percent. It is calculated by dividing the hemoglobin in grams per deciliter by the hematocrit, then multiplying by 100.

The mechanisms by which anemia occurs will alter the RBC indices in a predictable manner. Therefore, the RBC indices permit the physician to narrow down the possible causes of an anemia. The MCV is an index of the size of the RBCs. When the MCV is below normal, the RBCs will be smaller than normal and are described as microcytic. When the MCV is elevated, the RBCs will be larger than normal and are termed macrocytic. RBCs of normal size are termed normocytic.

Failure to produce hemoglobin results in smaller than normal cells. This occurs in many diseases, including iron deficiency anemia, thalassemia (an inherited disease in which globin chain production is deficient), and anemias associated with chronic infection or disease. Macrocytic cells occur when division of RBC precursor cells in the bone marrow is impaired. The most common causes of macrocytic anemia are vitamin B<sub>12</sub> deficiency, folate deficiency, and liver disease. Normocytic anemia may be caused by decreased production (e.g. malignancy and other causes of bone marrow failure), increased destruction (hemolytic anemia), or blood loss. The RBC count is low, but the size and amount of hemoglobin in the cells are normal.

### KEY TERMS

**Anemia**—A variety of conditions in which a person's blood cannot carry as much oxygen as is needed by the tissues.

**Hypochromic**—A descriptive term applied to a red blood cell with a decreased concentration of hemoglobin.

**Macrocytic**—A descriptive term applied to a larger than normal red blood cell.

**Mean corpuscular hemoglobin (MCH)**—A calculation of the average weight of hemoglobin in a red blood cell.

**Mean corpuscular hemoglobin concentration (MCHC)**—A calculation of the average concentration of hemoglobin in a red blood cell.

**Mean corpuscular volume (MCV)**—A measure of the average volume of a red blood cell.

**Microcytic**—A descriptive term applied to a smaller than normal red blood cell.

**Normochromic**—A descriptive term applied to a red blood cell with a normal concentration of hemoglobin.

**Normocytic**—A descriptive term applied to a red blood cell of normal size.

**Red cell distribution width (RDW)**—A measure of the variation in the size of red blood cells.

A low MCH indicates that cells have too little hemoglobin. This is caused by deficient hemoglobin production. Such cells will be pale when examined under the microscope and are termed hypochromic. Iron deficiency is the most common cause of a hypochromic anemia. The MCH is usually elevated in macrocytic anemias associated with vitamin B<sub>12</sub> and folate deficiency.

The MCHC is the ratio of hemoglobin mass in the RBC to cell volume. Cells with too little hemoglobin are lighter in color and have a low MCHC. The MCHC is low in microcytic, hypochromic anemias such as iron deficiency, but is usually normal in macrocytic anemias. The MCHC is elevated in hereditary spherocytosis, a condition with decreased RBC survival caused by a structural protein defect in the RBC membrane.

Cell indices are usually calculated from tests performed on an automated electronic cell counter. However, these counters measure the MCV, which is directly proportional to the voltage pulse produced



as each cell passes through the counting aperture. Electronic cell counters calculate the MCH, MCHC, hematocrit, and an additional parameter called the red cell distribution width (RDW).

The RDW is a measure of the variance in red blood cell size. It is calculated by dividing the standard deviation (a measure of variation) of RBC volume by the MCV and multiplying by 100. A large RDW indicates abnormal variation in cell size, termed anisocytosis. The RDW aids in differentiating anemias that have similar indices. For example, thalassemia minor and iron deficiency anemia are both microcytic and hypochromic anemias, and overlap in MCV and MCH. However, iron deficiency anemia has an abnormally wide RDW, but thalassemia minor does not.

### Diagnosis/Preparation

RBC indices require 3–5 mL of blood collected by vein puncture with a needle. A nurse or phlebotomist usually collects the sample.

### Aftercare

Discomfort or bruising may occur at the puncture site. Pressure to the puncture site until the bleeding stops reduces bruising; warm packs relieve discomfort. Some people feel dizzy or faint after blood has been drawn and should be allowed to lie down and relax until they are stable.

### Risks

Other than potential bruising at the puncture site, and/or dizziness, there are no complications associated with this test. However, certain prescription medications may affect the test results. These drugs include zidovudine (Retrovir), phenytoin (Dilantin), and azathioprine (Imuran). When the hematocrit is determined by centrifugation, the MCV and MCHC may differ from those derived by an electronic cell counter, especially in anemia. Plasma trapped between the RBCs tends to cause an increase in the hematocrit, giving rise to a somewhat higher MCV and lower MCHC.

### Normal results

Normal results for red blood cell indices are as follows:

- MCV: 80–96 fL
- MCH: 27–33 pg
- MCHC: 33–36%
- RDW: 12–15%

## Resources

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Red blood cell test see **Hemoglobin test**

Regional anesthetic see **Anesthesia, local**

Remote surgery see **Telesurgery**

Renal transplant see **Kidney transplantation**

## Reoperation

### Definition

Reoperation is a term used by surgeons for the duplication of a surgical procedure. Repeating surgery may involve surgery at the same site, at another site for the same condition, or to repair a structure that was treated in a previous surgery.

### Purpose

Success for most surgical procedures depends, in large part, upon the lack of a need to repeat the surgery. However, failure of some feature of a procedure may be only one of many reasons that reoperation is necessary. Reasons for repeat surgery depend upon surgical skills, as well as the reason for the primary surgery. Some diseases and conditions necessitate or make probable repeating the operation.

### Cancer

Surgeries for cancer are sometimes repeated because a new tumor or more surrounding tissue has been affected by the original malignancy. This is often the case with breast surgery for cancer that involves breast conservation management. Often it is necessary to re-excise the site of the previously biopsied primary cancer. In the case of breast cancer, only 50% of re-excision specimens show residual tumor. If cancer cell

## KEY TERMS

**Reoperation**—The repeat of a surgical procedure required for a variety of reasons, from surgical failure, replacement of failed component parts, or treatment of progressive disease.

**Surgical revision**—The failure of a procedure, which requires surgery be performed to improve the result.

are found with the re-excision, this may change the treatment protocol. Colon cancer sometimes involves more surgeries to resect newly affected areas beyond the previous primary site.

### *Coronary artery surgery*

Currently, about 10% of coronary artery procedures are reoperations due to the progression of the disease into native vessels between operations, as well as to treat diseased vein grafts. The mortality associated with reoperation is significantly higher than that of the original bypass procedures. In one study, patients undergoing their first coronary artery bypass graft (CABG) had a mortality rate of 1.7% versus 5.2% for elective reoperation.

### *Orthopedic surgeries*

Arthroplasty—the operative restoration of a joint like the elbow, knee, hip, or shoulder, often involves components that need repair. Infections of the joint may also require reoperation with the complete removal of all prostheses and cement. Re-implantation is repeated after a six-week course of **antibiotics**. Other bone surgeries that have a high reoperation rate are back surgeries, including spinal surgeries involving discectomy in which discs are fused together to reduce pain. Due to scarring or infection, there may be a need for reoperation. As the frequency of repeat back surgeries increases, the chance of a satisfactory result drops precipitously.

### *Gastrointestinal surgeries*

Crohn's disease surgeries are often repeated. Operations that cut and stitch only the area of obstruction, called stricturoplasty, often have repeat operations if the affected area is the small intestine. Another gastrointestinal surgery that often requires reoperation is fundoplication or flap wrapping of the lower part of the esophagus to prevent the reflux of acid from the stomach back into the esophagus. Folding

the loose valve above the stomach in such a way as to tighten its ability to close treats the condition known as gastroesophageal reflux disease (GERD). The surgery has a high failure rate of between 30% after five years and 63% after 10 years. Reoperation may be required because of surgical failure, breakdown of tissue, injury to nearby organs, or an excessively wrapped fundus that leads to trouble swallowing.

### *Vasectomy and penile prostheses*

These surgeries often have complications that lead to reoperation, largely due to surgical failure.

## Normal results

In general, reoperation is more difficult and involves more risks than the original procedure. It requires more operative time; more blood is lost; and the incidences of infection and clots are higher. Advancements in design and improvements in cementing techniques for component failure in **arthroplasty** have improved the results of reoperation.

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Replantation of digits see **Finger reattachment**

Replantation, tooth see **Tooth replantation**

## Retinal cryopexy

### Definition

Retinal cryopexy, also called retinal **cryotherapy**, is a procedure that uses intense cold to induce a chorioretinal scar and to destroy retinal or choroidal tissue.

## Purpose

The retina is the very thin membrane in the back of the eye that acts like the “film” in a camera. It is held against the inside back portion of the eye by pressure from fluid within the eye. In the front part of the eye, the retina is firmly attached at a ring just behind the lens called the pars plana. In the back part of the eye, the retina is continuous with the optic nerve. In between the pars plana and the optic nerve the retina has no fixed attachments. The retina collects information from the images projected on it from the eye lens and sends it along the optic nerve to the brain, where the information is interpreted and experienced as sight.

Several disorders can affect the retina and retinal cryopexy is used to treat the following conditions:

- retinal breaks or detachments
- retinal ischemia (retinal tissue that lacks oxygen)
- neovascularization (proliferation of blood vessels in the retina)
- Coats’ disease (abnormal retinal blood vessels that cause loss of vision)
- retinoblastoma (intraocular tumors)

## Demographics

Disease and disorders affecting the retina cause the majority of the visual disability and blindness in the United States. Retinal detachment occurs in one in 10,000 Americans each year, with middle-aged and older individuals being at higher risk than the younger population. Coats’ disease usually affects children, especially boys, in the first 10 years of life, but it can also affect young adults. The condition affects central vision, typically in only one eye. Severity can range from mild vision loss to total retinal detachment and blindness. No cause has yet been identified for Coats’ disease. According to the National Cancer Institute, retinoblastoma accounts for approximately 11% of cancers developing in the first year of life, and for 3% of the cancers developing among children younger than 15 years. In the United States, approximately 300 children and adolescents below the age of 20 are diagnosed with retinoblastoma each year. The majority of cases occur among young children, with 63% of all retinoblastoma occurring before the age of two years.

## Description

Usually, retinal cryopexy is administered under **local anesthesia**. The procedure involves placing a metal probe against the eye. When a foot pedal is depressed, the tip of the cryopexy probe becomes

## KEY TERMS

**Chorioretinal**—Relating to the choroid coat of the eye and retina.

**Choroid**—Middle layer of the eye, between the retina and sclera.

**Coats’ disease**—Also called exudative retinitis, a chronic abnormality characterized by the deposition of cholesterol on the outer retinal layers.

**Ophthalmoscope**—An instrument for viewing the interior of the eye, particularly the retina. Light is thrown into the eye by a mirror (usually concave) and the interior is then examined with or without the aid of a lens.

**Retina**—Light-sensitive layer of the eye.

**Retinoblastoma**—Malignant tumor of the retina.

**Sclera**—The tough white outer coat of the eyeball.

very cold as a result of the rapid expansion of very cold gases (usually nitrous oxide) within the probe tip. When the probe is placed on the eye, the formation of water crystals followed by rapid thawing results in tissue destruction. This is followed by healing and scar tissue formation.

In the case of retinal detachment, treatment calls for irritating the tissue around each of the retinal tears. Cryopexy stimulates scar formation, sealing the edges of the tear. This is typically done by looking into the eye using the indirect ophthalmoscope while pushing gently on the outside of the eye using the cryopexy probe, producing a small area of freezing that involves the retina and the tissues immediately underneath it. Using multiple small freezes like this, each of the tears is surrounded. Irritated tissue forms a scar, which brings the retina back into contact with the tissue underneath it.

## Diagnosis/Preparation

The earlier the retinal disorder diagnosis is confirmed, the greater the chance of successful outcome. Diagnosis is based on symptoms and a thorough examination of the retina. An ophthalmoscope is used to examine the retina. This is a small, hand-held instrument consisting of a battery-powered light and a series of lenses that is held up to the eye. The ophthalmologist is able to see the retina and check for abnormalities by shining the light into the eye and looking through the lens. Eye drops are placed in the eyes to dilate the pupils and help visualization. Afterward, an

indirect ophthalmoscope is used. This instrument is worn on the specialist's head, and a lens is held in front of the patient's eye. It allows a better view of the retina. Examination with a slit lamp microscope may also be done. This microscope enables the ophthalmologist to examine the different parts of the eye under magnification. After instilling drops to dilate the pupil, the slit lamp is used to detect retinal tears and detachment. A visual acuity test is also usually performed to assess vision loss. This test involves reading letters from a standard eye chart.

Additional diagnostic procedures are used in the case of Coats' disease and retinoblastoma. Ultrasonography helps in differentiating Coats' disease from retinoblastoma. CT scan may be used to characterize the intraocular features of Coats' disease. MRI is another very useful diagnostic tool used to distinguish retinoblastoma from Coats' disease.

### Aftercare

After the procedure, patients are taken to a **recovery room**, and observed for 30–60 minutes. Tylenol or pain medication is usually given. Healing typically takes 10–14 days. Vision may be blurred briefly, and the operated eye is usually red and swollen for some time following cryopexy. Cold compresses applied to the eyelids relieve some of the discomfort. Most patients are able to walk the day after surgery and are discharged from the hospital within a week. After discharge, patients are advised to gently cleanse their eyelids every morning, and as necessary, using warm tap water and cotton balls or tissues. Day surgery patients are usually allowed to go home two hours after the surgery is complete.

### Risks

Risks involved in retinal cryopexy include infection, perforation of the eye with the anesthetic needle, bleeding, double vision, and glaucoma. All of these complications however, are quite uncommon.

### Normal results

If treated early, the outcome of cryopexy for Coats' disease may be successful in preventing progression and in some cases can improve vision, but this is less effective if the retina has completely detached. For retinal reattachments, the retina can be repaired in about 90% of cases. Early treatment almost always improves the vision of most patients with retinal detachment. Some patients, however, require more than one cryopexy procedure to repair the damage.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Retinal cryopexy is performed in the treating physician's office or in a hospital setting depending on the condition motivating the surgery. The physician is usually an ophthalmologist, specialized in the treatment of retinal disorders. An ophthalmologist is a physician who specializes in the medical and surgical care of the eyes and visual system and in the prevention of eye disease and injury. He has completed four or more years of college premedical education, four or more years of medical school, one year of internship, and three or more years of specialized medical and surgical and refractive training and experience in eye care.

### Morbidity and mortality rates

Survival rates for children with retinoblastoma are favorable, with more than 93% alive five years after diagnosis. Males and females have similar five-year survival rates for the period 1976–1994, namely 93 and 94% respectively. African American children had slightly lower survival rates (86%) than Caucasian children (94%).

### Alternatives

Several alternatives to retinal cryopexy are available, depending on the condition being treated. A few examples include:

- **Laser photocoagulation.** This type of surgery induces a therapeutic effect by destroying outer retinal tissue, thus reducing the oxygen requirements of the retina, and increasing oxygen delivery to the remaining retina through alterations in oxygen diffusion from the choroid. It is used for repairing retinal tears.
- **Pneumatic retinopexy.** This procedure is used to reattach retinas. After numbing the eye with a local anesthesia, the surgeon injects a small gas bubble into the inside of the eye. The bubble presses against the retina, flattening it against the back wall of the eye. Since the gas rises, this treatment is most effective for detachments located in the upper portion of the eye.
- **Scleral buckle.** With this technique, a tiny sponge or silicone band is attached to the outside of the eye, pressing inward and holding the retina in position. After removing the vitreous gel from the eye



## QUESTIONS TO ASK THE DOCTOR

- How is retinal cryopexy performed?
- Why is the surgery required?
- Will my vision improve?
- What are the risks of retinal cryopexy?
- Is the procedure painful?
- How long will it take to recover from the surgery?
- How much retinal cryopexies do you perform each year?

(vitrectomy), the surgeon seals a few areas of the retina into position with laser or cryotherapy.

- Radiation therapy. For neuroblastomas, this treatment uses high-energy radiation to kill or shrink cancer cells.
- Chemotherapy. Another alternative for neuroblastoma. Chemotherapy uses drugs to kill cancer cells. The drugs are delivered through the bloodstream, and spread throughout the body to the cancer site.

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American Academy of Ophthalmology. P.O. Box 7424, San Francisco, CA 94120-7424. (415) 561-8500. <http://www.aao.org/index.html>.

New England Ophthalmological Society (NEOS). P.O. Box 9165, Boston, MA 02114. (617) 227-6484. <http://www.neos-eyes.org/>.

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Retinal detachment surgery see **Scleral buckling**

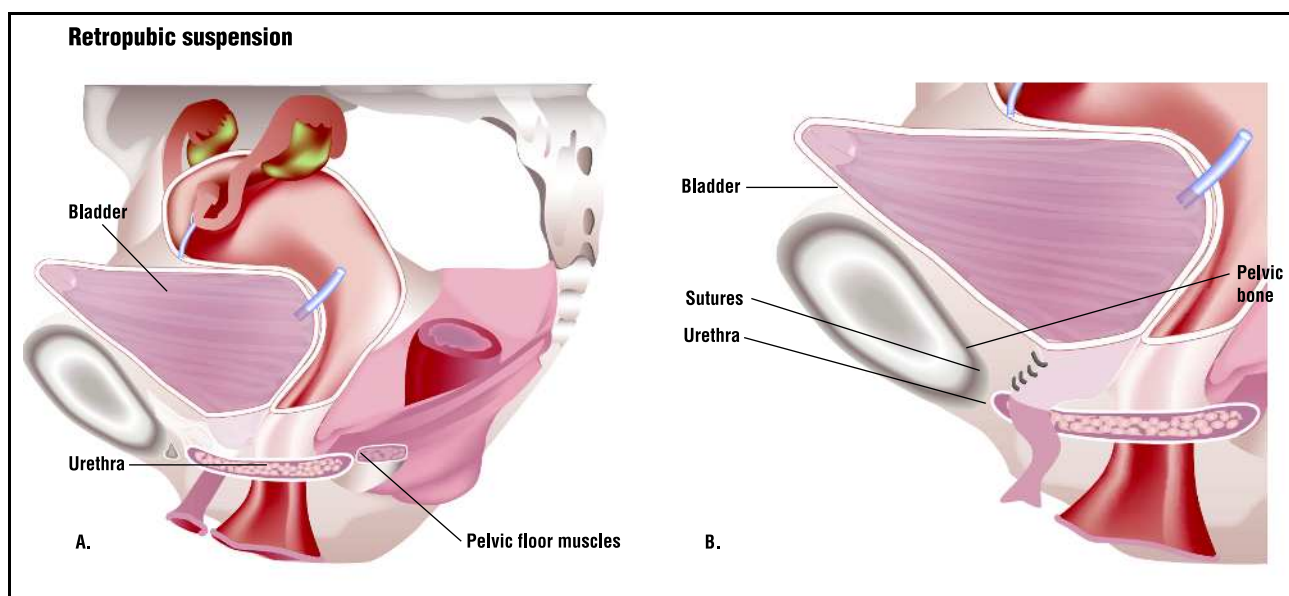
## Retropubic suspension

### Definition

Retropubic suspension refers to the surgical procedures used to correct incontinence by supporting and stabilizing the bladder and urethra. The Burch procedure, also known as retropubic urethropexy procedure or Burch colosuspension, and Marshall-Marchetti-Krantz procedure (MMK) are the two primary surgeries for treating stress incontinence. The major difference between these procedures is the method for supporting the bladder. The Burch procedure uses sutures to attach the urethra and bladder to muscle tissue in the pelvic area. MMK uses sutures to attach these organs to the pelvic cartilage. Laparoscopic retropubic surgery can be performed with a video laparoscope through small incisions in the belly button and above the pubic hairline.

### Purpose

The urinary system expels a quart and a half of urine per day. The amount of urine produced depends upon diet and medications taken, as well as **exercise** and loss of water due to sweating. The ureters, two tubes connecting the kidneys and the bladder, pass urine almost continually and when the bladder is full the brain sends a signal to the bladder to relax and let urine pass from the bladder to the urethra. People who are continent control the release of urine from the urethra via the sphincter muscles. These two sets of muscles act like rubber bands to keep the bladder closed until a conscious decision is made to urinate. The intrinsic sphincter or urethral sphincter muscles



**Weak pelvic floor muscles (A) can cause stress incontinence. In a retropubic suspension, the neck of the bladder is elevated and stitched to the pubic bone to hold it in place (B).** (Illustration by GGS Information Services. Cengage Learning, Gale.)

keep the bladder closed and the extrinsic sphincter muscles surround the urethra and prevent leakage. Incontinence is common when either the urethra lacks tautness and stability (genuine stress urine incontinence, SUI) and/or the sphincter muscles are unable to keep the bladder closed (intrinsic sphincter deficiency, ISD).

Incontinence occurs in many forms with four primary types related to anatomic, neurological, and dietary causes; or disease and injury.

### *Stress incontinence*

The most frequent form of incontinence is stress incontinence. This relates to leakage of the urethra with activity that puts stress on the abdominal muscles. The primary sign of stress incontinence is this leakage at sneezing, coughing, exercise, or other straining activities, which indicates a lack of support for the urethra due to weakened muscles, fascia, or ligaments. Pressure from the abdomen with movement, like exercising, uncompensated by tautness or stability in the urethra, causes the urethra to be displaced or mobile leading to leakage. Essentially, this hypermobility of the urethra is an indication that it is moving down or herniating through weakened pelvic structures.

To diagnose incontinence and determine treatment, three grades of severity for stress incontinence are used.

- Type I: Moderate movement of the urethra, with no hernia or cystocele.

- Type II: Severe or hypermobility in the urethra of more than 0.8 in (2 cm), with or without decent of the urethra into pelvic structures.
- Type III: Hypermobility of the urethra where the primary source of incontinence is the inability of the sphincter muscles to keep the bladder closed. This is due to weakness or deficiency in the intrinsic sphincter muscles.

### *Urge incontinence*

Urge incontinence relates to the frequent need to urinate and may involve going to the bathroom every two hours. Accidents are common when not reaching a bathroom in time. Urge incontinence is not due to general changes in the urethra or supporting muscles. It is often linked to other disorders that produce muscle spasms in the bladder, such as infections. Urge incontinence can also be due to underlying illnesses like stroke, spinal cord injury, multiple sclerosis and Alzheimer's disease, which cause detrusor hyperflexia—the contracting of the bladder muscle responsible for sending urine from the bladder to the urethra. Urge incontinence is very common in the elderly, especially those in long term care facilities.

### *Mixed incontinence*

Mixed incontinence is a combination of stress incontinence and urge incontinence, especially in older women. Since each form of incontinence pertains to different

## KEY TERMS

**Genuine urinary stress incontinence (USI)**—Stress incontinence due to hypermobility of the urethra.

**Intrinsic sphincter deficiency (ISD)**—A factor in severe stress incontinence due to the inadequacy of the sphincter muscles to keep the bladder closed.

**Retropubic urethropexy**—A generic term for the Burch procedure and its variants that treat mild stress incontinence by stabilizing the urethra with retropubic surgery.

**Stress incontinence**—Leakage of urine upon movements that put pressure on the abdominal muscles such as coughing, sneezing, laughing, or exercise. One of four types of incontinence.

**Urethra hypermobility**—Main factor in stress urinary incontinence, with severity based upon how far the urethra has descended into the pelvic floor through herniation or cystocele.

functions or anatomy, it is very important to distinguish which part of the incontinence is to be treated by surgery.

### *Overflow incontinence*

Overflow incontinence results in leakage from a bladder that never completely empties due to weakened bladder muscles. Overflow incontinence is involuntary and not accompanied by the urge to urinate. Many causes exist for overflow incontinence, including weak bladder muscles due to diabetes, nerve damage, or a blocked urethra. Men are more frequently affected than women.

### Demographics

Over 15 million Americans have urinary incontinence and women comprise 85% of all cases. It affects 25% of women of reproductive age and 50% of women past menopause. Due to the female anatomy, women have twice the risk for stress incontinence compared to men. In addition, childbirth places pressure and burden on the pelvic muscles that often weaken with age, thereby weakening urethra stability. Women are more prone to surgeries for urological changes than men and severe urinary incontinence is often associated with these surgeries as well as hysterectomies. The majority of women with incontinence have stress incontinence or mixed incontinence. Male incontinence occurs primarily in response to blockage in the prostate or after prostate

surgery. It is usually treated with implants and/or an artificial sphincter insert.

### Description

There are a variety of retropubic suspension surgeries available to treat stress incontinence. The variations differ by the types of structures used to support the urethra and bladder. In all procedures, parts of the pelvic anatomy (pubic bone, ligaments) serve as an anchor or wall upon which the urethra is tacked for stability. The surgery is called a suspension surgery because it stabilizes the urethra from tilting by suspending it against a part of the pelvic anatomy. The Burch procedure is often performed when other surgery is needed such as repair of the urethra for cystoceles and urethral reconstruction. However, this procedure is the most difficult of the anti-incontinent surgeries and is more common in mild forms of stress incontinence where intrinsic sphincter deficiency is not present.

The Burch procedure can be done through open abdominal surgery, which requires a long incision at the bikini line, or surgery performed through the vagina. The patient, in stirrups, receives **general anesthesia**. Within the retropubic area, the anterior vaginal wall is separated from the bladder manually. The bladder neck is identified and old adhesions or fatty tissues are removed. The neck of the bladder is sutured to pubic ligaments where it will form adhesions and thereby gain stability. The surgeon examines for bladder injury and the surgery is completed. Urethral position is tested by placing a cotton-tipped swab in the urethra and measuring the angle. With abdominal surgery or vaginal surgery a catheter may be put in place by the surgeon for postoperative voiding and to decrease the risks of infection. A suction drain may be placed in the retropubic space for bleeding. The drain is removed one to three days after surgery.

Recently, laparoscopic surgery has been used to perform retropubic suspensions. Laparoscopic surgery requires only three or four 0.25-inch (0.6-cm) incisions in the belly button, pubic hairline, or groin area and uses small instruments without opening the abdominal cavity. A shorter healing time is seen with this procedure. the hospital stay is usually not more than 24 hours and recovery to normal activities takes about seven to 14 days. However, the Burch procedure performed using laparoscopic techniques requires great skill on the part of the surgeon and research indicates that the results may not be as long lasting as those developed with abdominal or vaginal surgery.

## Diagnosis/Preparation

A patient with incontinence may have multiple factors that induce transient or chronic incontinence. It is crucial that the physician obtain a complete history, physical, clinical, neurological and medication evaluation of the patient, as well as a radiographic assessment before continuing urological tests aimed at a surgical solution. The specific indications for the Burch colosuspension procedure or its variants is the correction of stress urinary incontinence. This can be a patient who also requires abdominal surgery that cannot be performed vaginally, like **hysterectomy** or sigmoid surgery, as well as patients who have SUI without ISD.

A urodynamic study with a point pressure leak test will allow a diagnosis to be made that can distinguish the patient who has a hypermobile urethra from the patient who also has ISD. The point pressure leak test, also known as the Valsalva leak test, measures the amount of abdominal pressure required to induce leakage. The patient is asked to cough or strain in order to encourage leakage. The point at which the patient leaks helps determine if stress incontinence with ISD contribution is present. Obese patients and patients that engage in high impact exercise regimens are not considered good candidates for retropubic suspension.

## Aftercare

Patients with open retropubic procedures are given pain medication postoperatively that is tapered down over the next two days. A suprapubic catheter stays in place for approximately five days with voiding difficulties encountered initially in many patients. Patients with laparoscopic suspensions are reported to have less blood loss during surgery, less postoperative narcotic requirements, and shorter hospital stays. Patients are expected to refrain from strenuous activity for three months and to have a follow-up visit within three weeks after surgery.

## Risks

As with any major abdominal or pelvic surgical procedures, complications that may occur after a retropubic suspension include bleeding; injury to the bladder, urethra, and ureters; wound infection; and blood clots. Specific to the Burch procedure are complications that involve urethral obstruction because of urethral kinking due to elevation of the vagina or bladder base. Postoperative voiding difficulties are common and depend upon the suture tension of the urethral axis. Corrective surgery and the release of the

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Retropubic suspension procedures are performed by a urological surgeon specially trained in incontinence surgeries. Surgery is performed in a general hospital.

urethra to a more anatomic position resolves voiding issues with a very high rate of success. Vaginal prolapse is also a risk of this procedure.

## Normal results

The patient can expect more than 80–90% cure or great improvement in their incontinence. There is a large body of literature documenting the success of the Burch procedure. Published research shows a cure rate ranging from 63% to 93%, according to the actual version of colosuspension used. Laparoscopic surgery has not produced the long term results that open surgery has and there is the possibility that the fibrosis (adhesion) necessary for a successful outcome does not occur as easily with the laparoscopic procedure. Patients not carefully screened out for ISD will not have a high level of success with the Burch procedure since the source of the incontinence will not have been treated. Sling procedures are recommended for patients with ISD instead of colosuspension surgery.

## Morbidity and mortality rates

The Burch procedure may aggravate vaginal wall weakness or vaginal prolapse. This incident varies between 3% and 17%. Research on the Marshall-Marchetti-Krantz procedure pertaining to 2,712 patients found a complication rate of 21%, with wound complications and infections making up the majority, 5.5% and 3.9% respectively. Direct wound injury occurred in 1.6% and obstructions in 0.3% overall.

## Alternatives

General or simple severe stress incontinence related primarily to weakening of the urethral support can be remedied with changes in diet, weight loss, and certain behavioral and rehabilitative measures. These include:

- Regular, daily exercising of the pelvic muscles called Kegel exercises, requiring 30–200 contractions a day for eight weeks.



## QUESTIONS TO ASK THE DOCTOR

Which retropubic suspension procedure is recommended?

What is your cure rate with this procedure?

What is your injury rate for this procedure?

Could my incontinence be treated just as well with the sling procedure?

Do you perform laparoscopic surgeries to treat incontinence?

- Biofeedback to gain awareness and control of pelvic muscles.
- Vaginal weight training in which small weights are inserted in the vagina to tighten vaginal muscles.
- Mild electrical stimulation to increase contractions in pelvic muscles.
- Bladder retraining in which the patient is taught how to resist the urge to urinate and expand the intervals between urinations.

There are also medications that can facilitate continence for those experiencing stress or urge incontinence. These include some kinds of antidepressants, although the mechanism of action is not quite understood, as well as antispasmodic medication and estrogen therapy. Finally, should behavioral, rehabilitative, and surgical procedures fail, there remain alternatives through the use of vaginal cones and urethral plugs that can be inserted and removed by the patient.

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American Foundation for Urologic Diseases. The Bladder Health Council, 1128 North Charles Street, Baltimore, MD 21201. (410) 468 1800. <http://www.afud.org/education/bladder.html>.

National Kidney and Urologic Diseases Information Clearinghouse. 3 Information Way, Bethesda, MD 20892 3580. (800) 891 5390 or (301) 654 4415. <http://www.niddk.nih.gov>.

The Simon Foundation for Continence, P.O. Box 835, Wilmette, IL 60091. (800) 23 SIMON or (847) 864 3913. <http://www.simonfoundation.org>.

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Nancy McKenzie, PhD

## Rh blood typing

### Definition

Rh blood typing is performed in order to determine the Rh factor of an individual's blood. The term "Rh factor" refers to an antigen on the surface of the red blood cells. All red blood cells have certain substances on their surfaces. These substances are called "antigens," and may be molecules of protein, carbohydrate, glycolipid, or glycoprotein. Blood typing categorizes blood by identifying the presence or absence of these antigens on the surface of the red blood cell.

The Rh system identifies the presence (denoted as positive) or absence (denoted as negative) of a particular antigen termed the Rhesus antigen. Its names stems from the fact that the Rh factor was first

identified on the red blood cell surfaces of Rhesus monkeys. When the Rh factor is present on the surface of the red blood cell, the blood is said to be Rh-positive; when the Rh factor is absent from the surface of the red blood cell, the blood is said to be Rh-negative.

The Rh factor status is reported in conjunction with identification of the major ABO blood group of the individual. The ABO blood group system identifies a type of protein antigen on the red blood cell surface as Type A, Type B, Type AB, or Type O. An individual's blood type, then is reported as a combination of information obtained about the ABO and RH blood group systems; for example, A-positive, or A-negative, etc.

Blood typing is particularly important when an individual needs to receive a blood **transfusion**. If the wrong blood type is given, there is a high risk of an adverse transfusion reaction. For example, the first time an Rh-negative individual is given blood from an Rh-positive donor, there will probably not be any problem. However, if the Rh-negative individual receives future transfusions of Rh-positive blood, the recipient's immune system will recognize the Rh antigen on the donor blood as foreign, and will begin to produce antibodies directed against that antigen. The antibodies will attack the donor blood, damaging and bursting the donor red blood cells. This results in high serum levels of hemoglobin spilling from the burst red blood cells (called hemoglobinemia), disseminated intravascular coagulation or DIC (a condition in which clotting factors are used up very rapidly, resulting in the potential for severe, uncontrollable bleeding), kidney failure, and eventually complete cardiovascular collapse (a combination of heart attack, shock, and lack of blood flow to all major organs and tissues).

Knowing a pregnant woman's Rh-factor is crucial because there is always a chance during pregnancy, labor, and delivery, that some of the baby's blood will get into the mother's bloodstream. If this happens in an Rh-negative mother with an Rh-positive baby, the mother's body will identify the baby's Rh-negative blood as foreign and begin producing antibodies against the Rh-factor. This is called Rh-sensitization. The first time this sensitization occurs between a mother and her baby, the baby usually doesn't suffer any ill-effects. But in subsequent pregnancies, if the mother is again carrying an Rh-positive baby, having already been exposed to the Rh-antigen previously, her body will begin to produce Rh-antibodies more quickly and in greater numbers. If these cross over into the baby's bloodstream, they can begin destroying the

baby's red blood cells, resulting in severe illness. This problem is referred to as Rh disease, hemolytic disease of the newborn, or erythroblastosis fetalis. In order to avoid this problem, Rh testing is done prior to pregnancy or early in pregnancy. Rh-negative women can be given a special shot called Rh-immune globulin which can prevent Rh-sensitization.

### Purpose

Blood typing is ordered prior to a blood transfusion, to make sure that the donor blood type is appropriately compatible with the recipient's blood type. It is also done on donor blood, on a donor who is giving an organ to be used for transplantation, as well as prior to surgery (so that the patient's blood type is known, should the individual needs an unexpected, emergency blood transfusion). Rh-typing is also important in pregnant women. When the mother and the baby have different Rh-types, there is a risk to the baby of illness caused by the mother's antibodies; if the mother is identified as having Rh-negative blood, a shot called Rh-immune globulin can prevent the problem from developing.

### Precautions

Some situations may confuse the results of blood typing, including recent x-ray test using contrast, use of medications such as methyl dopa, levodopa, and certain **antibiotics** (including cephalixin). Other factors that may confuse test results include having received a blood transfusion in the previous three months, having had a bone marrow transplant in the past, or having a history of cancer or leukemia.

### Description

This test requires blood to be drawn from a vein (usually one in the forearm), generally by a nurse or phlebotomist (an individual who has been trained to draw blood). A tourniquet is applied to the arm above the area where the needle stick will be performed. The site of the needle stick is cleaned with antiseptic, and the needle is inserted. The blood is collected in vacuum tubes. After collection, the needle is withdrawn, and pressure is kept on the blood draw site to stop any bleeding and decrease bruising. A bandage is then applied.

### Preparation

There are no restrictions on diet or physical activity, either before or after the blood test.

## KEY TERMS

**Disseminated intravascular dissemination**—A condition in which the clotting factors in the blood are rapidly used up, resulting in a severe deficit in clotting factors and a very high risk of severe, uncontrollable bleeding.

**Erythroblastosis fetalis**—A condition in which the incompatibility between a mother's Rh-negative blood type and a baby's Rh-positive blood type results in destruction of the baby's red blood cells by maternal antibodies.

## Aftercare

As with any blood tests, discomfort, bruising, and/or a very small amount of bleeding is common at the puncture site. Immediately after the needle is withdrawn, it is helpful to put pressure on the puncture site until the bleeding has stopped. This decreases the chance of significant bruising. Warm packs may relieve minor discomfort. Some individuals may feel briefly woozy after a blood test, and they should be encouraged to lie down and rest until they feel better.

## Risks

Basic blood tests, such as Rh blood typing, do not carry any significant risks, other than slight bruising and the chance of brief dizziness.

## Results

Rh blood typing reports back whether the individual's red blood cells have the Rh antigen present on their surface (Rh-positive) or absent from their surface (Rh-negative). About 84% of all people are Rh-positive; about 16% are Rh-negative.

## Resources

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- American Association of Clinical Chemistry. 1850 K St., N.W. Suite 625, Washington, DC 20006. <http://www.aacc.org>.

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Rosalyn Carson-DeWitt, MD

Rh typing see **Type and screen**

## Rheumatoid factor testing

### Definition

Rheumatoid factor is a type of antibody. Antibodies, also called immunoglobulins, are proteins produced by the body. Antibodies work to clear the body of potentially threatening infections or substances, fighting off various invaders, such as viruses, bacteria, toxins, mold spores, etc.

The body's immune system is made up of lymphoid organs, including lymph nodes, the bone marrow (located within the center of long bones) and the thymus (located in the chest). These lymphoid organs produce lymphocytes, including T cells and B cells. These lymphocytes circulate within the bloodstream, within the lymph system, and are also positioned in clumps within organs and on mucosal surfaces of the body. When a B cell encounters a foreign invader, it recognizes it as foreign by virtue of a chemical identifier on its surface (called an antigen). Once the B cell recognizes an antigen, the B cell gives rise to a large number of plasma cells. These plasma cells are capable of producing antibodies.

Antibodies are made up of units called "chains." All antibodies are composed of two larger chains (called heavy chains) and two smaller chains (called light chains). The tip of the antibody is referred to as the hypervariable region. This hypervariable region is responsible for unique chemical properties possessed by each antibody that allow a specific antibody to "recognize" and match up to a particular antigen. The combination of an antibody with a specific antigen, creates an antibody-antigen complex, marking the invader as foreign and in need of inactivation or destruction by other immune cells in the body.

The first time an antigen is encountered by the immune system, the body's response is slow. Time is required in order to activate the machinery necessary to produce the very specific type of antibody necessary to combat that antigen. However, if that particular antigen is encountered in the future, the needed machinery is already available, and antibody production in response to a "familiar" antigen is quite rapid.

One of the important attributes of a healthy, well-functioning immune system rests on its ability to distinguish between “self” and “other.” This means that it’s crucial that the antibodies don’t mistakenly identify parts of the body itself as foreign invaders. When this does happen, the body’s immune system attacks the body, damaging and destroying it. Conditions in which this occurs are referred to as autoimmune disorders. One example of an autoimmune disorder is the condition called rheumatoid arthritis or RA. In RA, the lining of the joints (synovium) is mis-recognized by the immune system as foreign, resulting in the immune system creating specific antibodies that repeatedly attack, damage, and destroy the joints’ lining, resulting in the cluster of symptoms that accompany this disease.

Rheumatoid factor belongs to the class of antibodies known as IgM antibodies. IgM antibodies are primarily found in the blood, and comprise about 13% of all antibodies. IgM functions to kill bacteria, and is found in the earlier phases of immune response to bacterial invasion of the bloodstream (bacteremia).

In rheumatoid arthritis, rheumatoid factor is directed against IgG antibodies. IgG antibodies are very common circulating antibodies; in fact, about 80% of all circulating antibodies are IgG. IgG is found in blood and tissue fluids. IgG functions to coat invading particles, marking them so that they can more easily and rapidly be taken up by other types of immune cells. IgG is the predominant antibody cell in the later or secondary phase of the immune response.

When rheumatoid factor encounters IgG, it attaches itself to the IgG, forming an immune complex. This immune complex kicks off a complicated immune cascade, prompting the production and release of a variety of chemicals that ultimately mis-identify the synovium as “non-self,” attack the lining, and over time cause tremendous destruction.

### Purpose

Rheumatoid factor testing is usually done when an individual is having symptoms compatible with an autoimmune disorder, particularly rheumatoid arthritis or Sjogren’s syndrome. Suspicious symptoms include joint stiffness, pain and swelling (especially in the morning), bumps (nodules) under the skin, and/or dry eyes, mouth, and skin.

### Precautions

Rheumatoid factor testing is not diagnostic. This means that getting a specific result does not definitively confirm the presence of any particular disease. Instead, the test is used to correlate with the clinical

## KEY TERMS

**Antibody**—A protein that the body produces in response to exposure to a foreign invader such as a virus, bacteria, fungus, or allergen.

**Antigen**—The protein marker that prompts the body’s immune system to produce antibodies.

**Autoimmune disorder**—A condition in which the body produces antibodies that serve to attack organs or tissues of the body itself.

**Immune system**—The collection of organs, tissues, and cells that serve to protect the body against foreign invaders, such as bacteria, viruses, and fungi.

**Lymphocyte**—A white blood cell; part of the immune system responsible for the production of antibodies.

**Plasma cell**—The specific type of white blood cell that produces antibodies.

**Rheumatoid arthritis**—A condition in which the immune system damages and destroys the synovial lining of the joints. Red, warm, swollen, stiff joints are a common symptom. Over time, other organ systems may also be affected, including the heart, eyes, lungs, and kidneys.

**Sjögren’s syndrome**—A disease in which the immune system damages and destroys exocrine glands, such as those that produce tears and saliva. Dry eyes and mouth are the usual initial symptoms of this disorder, but other organ systems can also be severely affected over time, including the skin, pancreas, liver, lungs, brain, and kidneys.

picture, meaning the history and the symptoms that an individual is experiencing.

Some situations may confuse the results of testing for rheumatoid factor, including very high blood levels of triglycerides or other fats, or advanced age (people over 65 years of age have a higher chance of having a higher-than-normal rheumatoid factor that is not associated with disease).

### Description

This test requires blood to be drawn from a vein (usually one in the forearm), generally by a nurse or phlebotomist (an individual who has been trained to draw blood). A tourniquet is applied to the arm above the area where the needle stick will be performed. The site of the needle stick is cleaned with antiseptic, and the needle is inserted. The blood is collected in vacuum



tubes. After collection, the needle is withdrawn, and pressure is kept on the blood draw site to stop any bleeding and decrease bruising. A bandage is then applied.

### Preparation

There are no restrictions on diet or physical activity, either before or after the blood test.

### Aftercare

As with any blood tests, discomfort, bruising, and/or a very small amount of bleeding is common at the puncture site. Immediately after the needle is withdrawn, it is helpful to put pressure on the puncture site until the bleeding has stopped. This decreases the chance of significant bruising. Warm packs may relieve minor discomfort. Some individuals may feel briefly woozy after a blood test, and they should be encouraged to lie down and rest until they feel better.

### Risks

Basic blood tests, such as rheumatoid factor testing, do not carry any significant risks, other than slight bruising and the chance of brief dizziness.

### Results

Normal rheumatoid factor results would demonstrate a rheumatoid factor titer less than 1:20-1:40, or a rheumatoid factor of less than 43 nephelometry units.

The patient's, history, symptoms, and rheumatoid factor results are used together in order to arrive at a diagnosis. An elevated rheumatoid factor may indicate the possibility of rheumatoid arthritis or Sjogren's syndrome. However, some patients (about 20%) with these diseases do not have an elevated rheumatoid factor, or have the condition for several years before their rheumatoid factor becomes abnormally elevated.

Rheumatoid factor may also be elevated in a number of other autoimmune conditions, such as systemic lupus erythematosus, vasculitis, or scleroderma; in severe infections such as syphilis or tuberculosis, mononucleosis, malaria, hepatitis, or endocarditis; in certain types of cancer, including leukemia; and in a number of other conditions, such as cirrhosis of the liver, and lung or kidney disease.

### Resources

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## Rhinoplasty

### Definition

The term rhinoplasty means “nose molding” or “nose forming.” It refers to a procedure in **plastic surgery** in which the structure of the nose is changed. The change can be made by adding or removing bone or cartilage, grafting tissue from another part of the body, or implanting synthetic material to alter the shape of the nose.

### Purpose

Rhinoplasty is most often performed for cosmetic reasons. A nose that is too large, crooked, misshapen, malformed at birth, or deformed by an injury can be given a more pleasing appearance. If breathing is impaired due to the form of the nose or to an injury, it can often be improved with rhinoplasty.

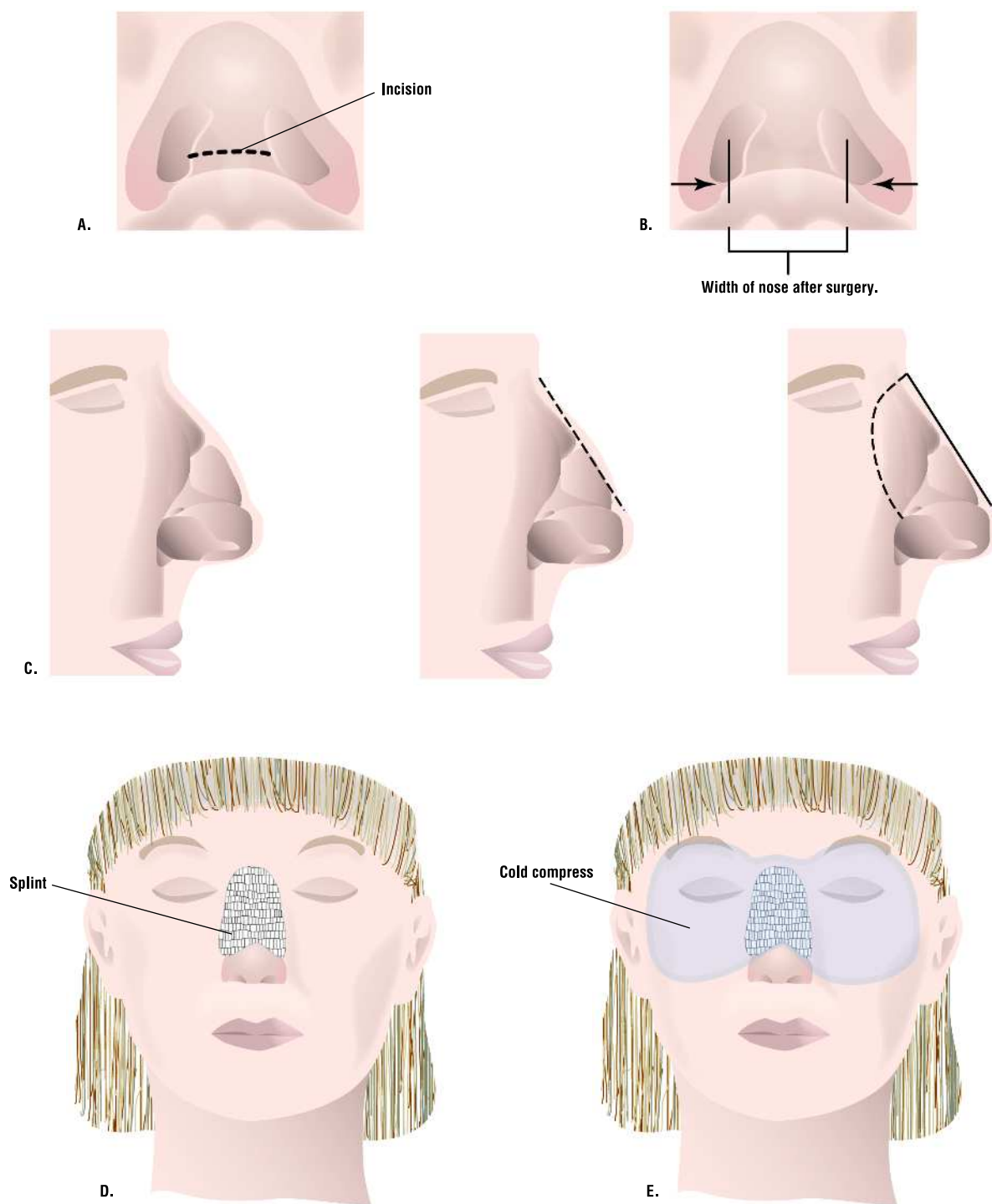
### Demographics

Rhinoplasty is the third most common cosmetic procedure among both men and women. Total number of rhinoplasty procedures in the United States in 1999 was 133,058. More than 13,100 of those procedures were performed on men.

### Description

The external nose is composed of a series of inter-related parts that include the skin, the bony pyramid, cartilage, and the tip of the nose, which is composed of cartilage and skin. The strip of skin separating the nostrils is called the columella.

## Rhinoplasty



During an open rhinoplasty, an incision is made in the skin between the nostrils (A). Closed rhinoplasty involves only incisions inside the nose. Rhinoplasty may involve a change in nostril width (B) or removal of a hump on the nose (C) using bone sculpting. After surgery, a splint supports the nose (D), and a cold compress reduces swelling (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Cartilage**—Firm supporting tissue that does not contain blood vessels.

**Columella**—The strip of skin running from the tip of the nose to the upper lip, which separates the nostrils.

**Septum**—The dividing barrier in the center of the nose.

Surgical approaches to nasal reconstruction are varied. Internal rhinoplasty involves making all incisions from inside the nasal cavity. The external, or “open,” technique involves a skin incision across the base of the nasal columella. An external incision allows the surgeon to expose the bone and cartilage more fully and is most often used for complicated procedures. During surgery, the surgeon will separate the skin from the bone and cartilage support. The framework of the nose is then reshaped in the desired form. Shape can be altered by removing or adding bone, cartilage, or skin. The remaining skin is then replaced over the new framework. If the procedure requires adding to the structure of the nose, the donated bone, cartilage, or skin can come from another location on the patient’s body or from a synthetic source.

When the operation is completed, the surgeon will apply a splint to help the bones maintain their new shape. The nose may also be packed, or stuffed with a dressing, to help stabilize the septum.

When a local anesthetic is used, light sedation is usually given first, after which the operative area is numbed. It will remain insensitive to pain for the length of the surgery. A general anesthetic is used for lengthy or complex procedures, or if the doctor and patient agree that it is the best option.

## Diagnosis/Preparation

The quality of the skin plays a major role in the outcome of rhinoplasty. Persons with extremely thick skin may not see a significant change in the underlying bone structure after surgery. On the other hand, thin skin provides almost no cushion to hide many minor bone irregularities or imperfections.

Rhinoplasty should not be performed until the pubertal growth spurt is complete, age 14–15 for girls and older for boys.

During the initial consultation, the candidate and surgeon will determine what changes can be made in

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Simple rhinoplasty is usually performed in an outpatient surgery center or in the surgeon’s office. Most procedures take only an hour or two, and patients go home right away. Complex procedures may be performed in a hospital and require a short stay.

Rhinoplasty is usually performed by a surgeon with advanced training in plastic and reconstructive surgery.

the shape of the nose. Most doctors take photographs during that consult. The surgeon will also explain the techniques and anesthesia options available to the candidate.

The candidate and surgeon should also discuss guidelines for eating, drinking, smoking, taking or avoiding certain medications, and washing the face for the weeks immediately following surgery.

## Aftercare

Patients usually feel fine immediately after surgery. As a precaution, most surgery centers do not allow patients to drive themselves home after an operation.

The first day after surgery, there will be some swelling of the face. Persons should stay in bed with their heads elevated for at least a day. The nose may hurt and a headache is common. The surgeon will prescribe medication to relieve these conditions. Swelling and bruising around the eyes will increase for a few days, but will begin to diminish after about the third day. Slight bleeding and stuffiness are normal, and vary according to the extent of the surgery performed. Most people are walking in two days, and back to work or school in a week. No strenuous activities are allowed for two to three weeks.

Patients are given a list of postoperative instructions, which include requirements for hygiene, **exercise**, eating, and follow-up visits to the doctor. Patients should not blow their noses for the first week to avoid disruption of healing. It is extremely important to keep the surgical dressing dry. **Dressings**, splints, and **stitches** are removed in one to two weeks. Patients should avoid excessive sun or sunburn.

## QUESTIONS TO ASK THE DOCTOR

Candidates for a rhinoplasty procedure should consider asking the following questions:

- What will be the resulting appearance? (Often, computer programs are available to assist in visualizing the final result.)
- Is the surgeon board certified in plastic and reconstructive surgery?
- How many rhinoplasty procedures has the surgeon performed?
- What is the surgeon's complication rate?
- Will this surgery really make a huge difference to my life or am I trying to live up to an impossible media stereotype of beauty?

### Risks

Any type of surgery carries a degree of risk. There is always the possibility of unexpected events such as an infection or a reaction to the anesthesia.

When the nose is reshaped or repaired from inside, the scars are not visible. If the surgeon needs to make the incision on the outside of the nose, there will be some slight scarring. In addition, tiny blood vessels may burst, leaving small red spots on the skin. These spots are barely visible, but may be permanent.

### Normal results

The best candidates for rhinoplasty are those persons with relatively minor deformities. Nasal anatomy and proportions are quite varied and the final look of any rhinoplasty operation depends on a person's anatomy, as well as the surgeon's skill.

A cosmetic change of the nose will change a person's appearance, but it will not change self-image. A person who expects a different lifestyle after rhinoplasty is likely to be disappointed.

The cost of rhinoplasty depends on the difficulty of the work required and on the specialist chosen. If the problem was caused by an injury, insurance will usually cover the cost. A rhinoplasty done only to change a person's appearance is not usually covered by insurance.

### Morbidity and mortality rates

**Death** from a rhinoplasty procedure is exceedingly rare. When it occurs, the cause is often due to

an adverse reaction to anesthesia or postoperative medications or to an infection. About 10% of persons receiving rhinoplasty require a second procedure.

### Alternatives

The alternative to cosmetic rhinoplasty is to accept oneself, literally, at face value. Persons contemplating rhinoplasty may want to question some of the conventional standards of beauty and work on their body image issues to improve their self-confidence.

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American Board of Plastic Surgery. Seven Penn Center, Suite 400, 1635 Market Street, Philadelphia, PA 19103 2204. (215) 587-9322. <http://www.abplsurg.org/>.

American College of Plastic and Reconstructive Surgery. <http://www.breastimplant.org>.

American College of Surgeons. 633 North Saint Claire Street, Chicago, IL 60611. (312) 202-5000. <http://www.facs.org/>.

American Society for Aesthetic Plastic Surgery. 11081 Winners Circle, Los Alamitos, CA 90720. (800) 364-2147 or (562) 799-2356. <http://www.surgery.org/>.

American Society for Dermatologic Surgery. 930 N. Meacham Road, P.O. Box 4014, Schaumburg, IL 60168 4014. (847) 330-9830. <http://www.asds.net.org>.

American Society of Plastic Surgeons. 444 E. Algonquin Rd., Arlington Heights, IL 60005. (847) 228-9900. <http://www.plasticsurgery.org/>.

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L. Fleming Fallon, Jr., MD, DrPH

## Rhizotomy

### Definition

Rhizotomy is the cutting of nerve roots as they enter the spinal cord.

### Purpose

Rhizotomy (also called dorsal rhizotomy, selective dorsal rhizotomy, and selective posterior rhizotomy) is a treatment for spasticity that is unresponsive to less invasive procedures.

### Demographics

Spasticity (involuntary muscle contractions) affects many thousands of Americans, but very few are affected seriously enough to require surgery for its treatment.

### Description

Rhizotomy is performed under **general anesthesia**. The patient lies face down. An incision is made along the lower spine, exposing the sensory nerve roots at the center the spinal cord. Individual nerve rootlets are electrically stimulated. Since these are sensory nerves, they should not stimulate muscle movement. Those that do (and therefore cause spasticity) are cut. Typically, one-quarter to one-half of nerve rootlets tested are cut.

### Diagnosis/Preparation

Rhizotomy is performed on patients with spasticity that is insufficiently responsive to oral medications or injectable therapies (botulinum toxin, phenol, or alcohol). It is most commonly performed for those patients with lower extremity spasticity that interferes with walking or severe spasticity that prevents hygiene or positioning of the legs. It is most commonly performed on children with cerebral palsy.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Rhizotomy is performed by a neurosurgeon in a hospital. The patient's neurologist and physical therapist may also be in attendance to help with the evaluation during surgery.

Patients undergoing rhizotomy receive a large battery of tests before the procedure, in order to document the functional effects of spasticity, and the patient's medical health and likely response to anesthesia and other operative stresses. Rhizotomy is performed as an in-patient procedure, and the patient is likely to require an overnight hospital stay before the operation.

### Aftercare

After surgery, the patient will spend one to several days in the hospital. Physical therapy and strength training usually begin the next day, in order to maximize the gains expected from surgery, and to keep the limbs mobile. Medication may be given for pain.

### Risks

Rhizotomy carries small but significant risks of nerve damage, permanent loss of sensation or altered sensation, weakness of the lower extremities, bowel and bladder dysfunction, increased likelihood of hip dislocation, and scoliosis progression. Anesthesia carries its own risks.

### Normal results

Rhizotomy reduces spasticity, which should allow more normal gait and improve mobility. Patients may require fewer walking aids, such as walkers or crutches.

### Morbidity and mortality rates

Other than the risks from anesthesia, rhizotomy does not carry a risk of **death** during surgery. Morbidity rates vary among centers performing the surgery. Persistent and significant adverse effects may occur in 1–5% of patients, including bowel or bladder changes and low back pain.

## QUESTIONS TO ASK THE DOCTOR

- How many rhizotomies have you performed?
- What is your complication rate?
- Is orthopedic surgery still likely to be necessary later on?

### Alternatives

Other spasticity treatments include oral medications and an implanted pump delivering baclofen to the space around the spinal cord (intrathecal baclofen). These may be appropriate alternatives for some patients. **Orthopedic surgery** can correct deformities that occur from untreated spasticity. Some controversy exists whether rhizotomy can delay or prevent the need for other spasticity procedures, especially orthopedic surgery such as **tenotomy**, with some evidence suggesting it can, and other evidence suggesting it may not.

### Resources

#### ORGANIZATIONS

United Cerebral Palsy. 1660 L Street, NW, Suite 700,  
Washington, DC 20036. (800) 872 5827 or (202) 776  
0406. TTY: (202) 973 7197. Fax: (202) 776 0414.  
webmaster@ucp.org. <http://www.UCP.org>.  
WE MOVE. <http://www.wemove.org>.

Richard Robinson

Rhytidoplasty see **Face lift**

## Robot-assisted surgery

### Definition

Robot-assisted surgery involves the use of a robot under the direction and guidance of a surgeon.

### Purpose

Robot-assisted surgery provides many benefits in the surgical care of patients. Computer-assisted robots provide exact motion and trajectories to minimize the side effects of surgical intervention. Robot-assisted surgeries can use three-dimensional imaging and smaller surgical tools to operate in a closed environment through smaller incisions. For example, traditional

methods of cardiac surgery usually required a six-to-eight inch incision in the sternum and the use of a heart-lung machine to maintain the functions of the heart and lungs while they are stopped for the surgery. Robot-assisted surgery has furthered the use of the keyhole approach, in which multiple small incisions are made between the ribs. With robot-assisted surgery, the surgeon is also able to make more precise movements using motion scaling. In this practice, an image is enlarged and the movements of the surgeon's hands are translated by the computer into smaller movements. This allows surgeons to perform more precisely, which can be especially important when the surgery is to be performed on particularly small parts of the body.

### Demographics

Patients undergoing surgical procedures classified as **neurosurgery**, **orthopedic surgery**, radio surgery and radiotherapy, prostatectomy, endoscopy, **laparoscopy**, cardiac surgery and craniofacial surgery may experience robot-assisted surgical techniques.

### Description

#### *Neurosurgery*

A high level of accuracy is required when operating on the brain to avoid damage to the sensitive brain tissue. Biopsies and minor interventions are best assisted by the robotic device. Interventions include drilling into the skull and making an incision through the dura mater to gain brain tissue samples, empty cysts, or eliminate hemorrhage.

#### *Orthopedic surgery*

Applications such as cementless hip-replacement, total knee arthroplasties, and pedicle screw placement can benefit from the more accurate cutting and drilling provided by a robot. Femur bone-cutting devices provide improved drilling to carve a cavity in the bone for prosthesis implant. Pins inserted into the bone before surgery are used as landmarks for computerized tomography (CT) imaging. The CT image provides the surgeon with the necessary information for choosing an implant. The surgeon removes the head from the femur bone, eliminating the joint. The leg is secured in position and the robot is brought into position. A high speed cutter is then applied to create the cavity, and then followed by a smoothing tool. The surgeon manually inserts the implant into the femur and completes the cap implant into the pelvic bone.

## KEY TERMS

**Arthoplastic**—Manufactured replacement joint.

**Cardiac surgery**—Surgery performed on the heart.

**Craniofacial surgery**—Surgery of the facial tissue and skull.

**Endoscopy**—Used to visualize internal structures of the body, such as the trachea, esophagus or intestines.

**Laparoscopy**—Surgery on internal structures through small incisions and visualized with the laparoscope.

**Neurosurgery**—Surgery performed on the brain.

**Orthopedic surgery**—Surgery performed on the bones. May include joint replacements and surgery of the vertebrae.

**Prostatectomy**—Performed for the treatment of prostate disease including prostate cancer.

**Radio surgery and radiotherapy**—Used in the treatment of cancerous growths or kidney stones.

### *Radiosurgery and radiotherapy*

Radiation treatment is provided by a robot. The CT image or magnetic resonance image (MRI) is used to determine where the radiation treatment should be delivered. The robot aligns with patient anatomy, delivering specific doses of radiation to the intended location.

### *Prostatectomy*

Removal of all or part of the prostate is another robot-assisted procedure. The robot controls instruments inserted through the urethra to the prostate gland. A diathermic hot wire cutting loop is guided to remove tissue in an appropriate pattern around the urethra. Fastening the guiding frame to the upper legs of the patient secures the device for accurate guidance.

### *Endoscopy*

Endoscopy is used to examine patient cavities for the presence of polyps, tumors, and other diseases. The endoscope can be better passed through cavities such as the colon or trachea. Three-dimensional images of the cavity are obtained and used to dictate the path taken by the endoscope. Sedation and heavy analgesia can be avoided.

## THE DA VINCI SURGICAL SYSTEM

Approved by the U.S. Food and Drug Administration in 2000, the da Vinci surgical system is the most popular surgical robotic system used in hospitals as of 2008. According to the company that manufactures the system, Intuitive Surgical, over 210 are used in hospitals throughout the world. The system has four robotic arms which move the cameras and tools the surgeon controls from a console. While the da Vinci costs over one million dollars, many surgeons who use the system say that it has become an indispensable aid to complicated surgical procedures. Moreover, it has been estimated that hospitals save money overall because the length of post-surgical hospitalization is cut in half.

### *Laparoscopy*

In laparoscopic surgeries, three to four small incisions are made in the abdominal or thoracic cavity to insert the instruments and video equipment. The surgeon performs the operation from a remote console that provides the human-machine interface. The console provides video monitoring images that are three-dimensional. Joysticks are used to manipulate the tools within the chest cavity to complete the surgical procedure.

### *Cardiac surgery*

Robots can be used in the coronary artery bypass grafting surgeries and cardiac valve replacement and repair surgeries. The harvesting of artery and vein grafts can also be accomplished with the aid of laparoscopic techniques.

### *Craniofacial surgery*

Difficult bone cuts and bone tumor removals are accomplished successfully using robotic instruments. Pre-planned trajectories are programmed into the machine. Precision cuts are made in the manner desired to achieve an aesthetically satisfactory result. As the surgeon manipulates the saw, he or she is guided along the path by a predetermined trajectory determined during an initial run on a model of the surgical site.

### *Aftercare*

The patient should expect a faster recovery than that achieved by traditional surgery procedures.

## QUESTIONS TO ASK THE DOCTOR

- Is there an institution in the vicinity which uses robot-assisted surgery?
- How experienced is the surgeon with robot-assisted surgical techniques?
- What benefits would the robot-assisted surgery provide?
- What complications can be avoided and which may be encountered with robot-assisted surgery?

### Risks

With some of these procedures, a longer surgical time is required to achieve the same desired outcome as the traditional surgical approach. There is an increased risk of anesthesia related complications as surgical times increase. Additionally, if the robotic procedure is not completed successfully, the surgeon may need to complete the procedure with a traditional technique.

### Normal results

Results for each procedure are comparable to or better than the standard surgical procedure.

### Morbidity and mortality rates

Complications should be comparable to the standard surgical procedure, and even reduced. Some complications may only be associated with the robot-assisted procedure.

### Alternatives

The alternative to using robot-assisted surgery is for the surgeon to employ a traditional surgical approach.

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Robert Bockstiegel

## Root canal treatment

### Definition

Root canal treatment, also known as endodontic treatment, is a dental procedure in which the diseased or damaged pulp (central core) of a tooth is removed and the inside areas (the pulp chamber and root canals) are filled and sealed.

### Purpose

An inflamed or infected pulp is called pulpitis. It is the most common cause of a toothache. To relieve the pain and prevent further complications, the tooth may be extracted (surgically removed) or saved by root canal treatment.

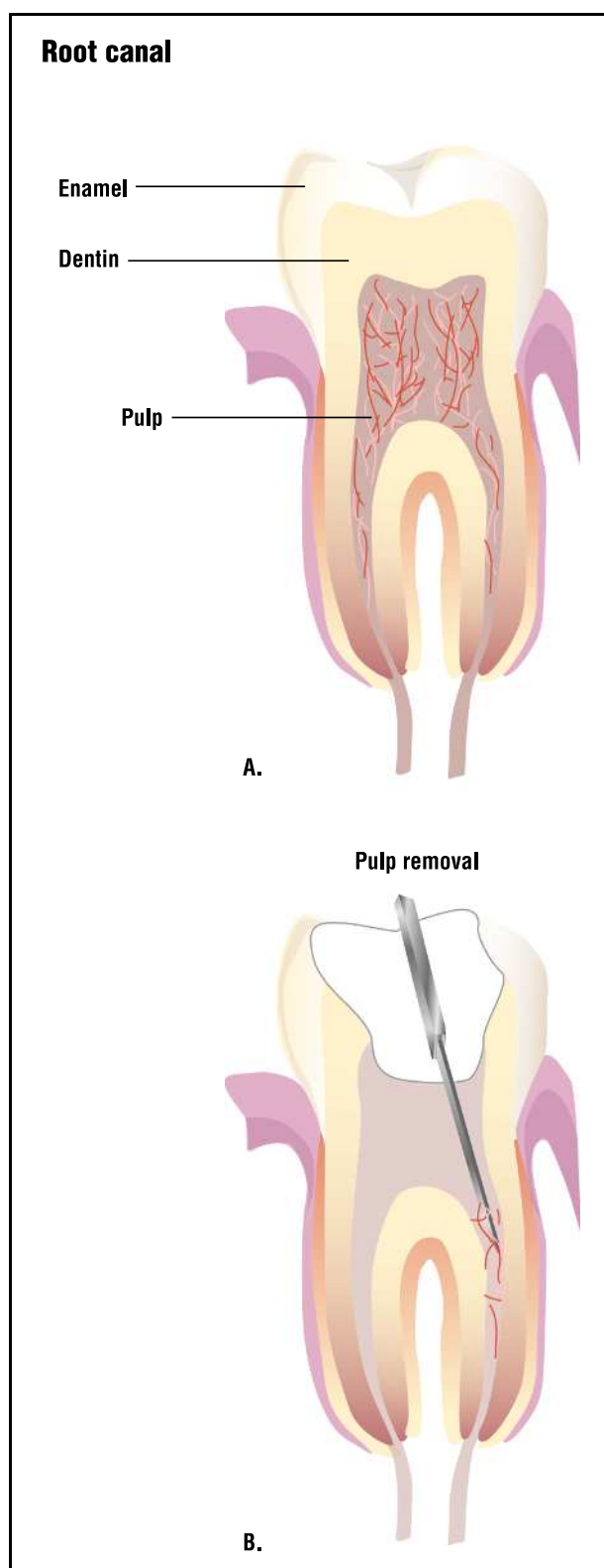
### Demographics

Root canal treatment has become a common dental procedure. According to the American Association of Endodontists, more than 14 million root canal treatments are performed every year, with a 95% success rate.

### Description

Inside the tooth, the pulp of a tooth is comprised of soft tissue that contains the blood supply, by which the tooth receives its nutrients; and the nerve, by which the tooth senses hot and cold. This tissue is vulnerable to damage from deep dental decay, accidental injury, tooth fracture, or trauma from repeated dental procedures such as multiple fillings or restorations over time. If a tooth becomes diseased or injured, bacteria may build up inside the pulp, spreading infection from the natural crown of the tooth to the root tips in the jawbone. Pus accumulating at the ends of the roots can form a painful abscess that can damage the bone supporting the teeth. Such an infection may produce pain that is severe, constant, or throbbing. It can also





During a root canal, the diseased pulp of a tooth (A), is removed (B). The remaining empty tooth is filled and sealed with a filling or crown. (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Abscess**—A cavity or space in tooth or gum tissue filled with pus as the result of infection. Its swelling exerts pressure on the surrounding tissues, causing pain.

**Apicoectomy**—Also called root resectioning. The root tip of a tooth is accessed in the bone and a small amount is shaved away. The diseased tissue is removed and a filling is placed to reseal the canal.

**Crown**—The natural crown of a tooth is that part of the tooth covered by enamel. Also, a restorative crown is a protective shell that fits over a tooth.

**Endodontic**—Pertaining to the inside structures of the tooth, including the dental pulp and tooth root, and the periapical tissue surrounding the root.

**Endodontist**—A dentist who specializes in the diagnosis and treatment of disorders affecting the inside structures of teeth.

**Extraction**—The surgical removal of a tooth from its socket in a bone.

**Gutta percha**—An inert, latex-like substance used for filling root canals.

**Pulp**—The soft innermost layer of a tooth, containing blood vessels and nerves.

**Pulp chamber**—The area within the tooth occupied by dental pulp.

**Pulpitis**—Inflammation of the pulp of a tooth involving the blood vessels and nerves.

**Root canal**—The space within a tooth that runs from the pulp chamber to the tip of the root.

**Root canal treatment**—The process of removing diseased or damaged pulp from a tooth, then filling and sealing the pulp chamber and root canals.

result in prolonged sensitivity to heat or cold, swelling, and tenderness in the surrounding gums, facial swelling, or discoloration of the tooth. In some cases, however, the pulp may die so gradually that there is little noticeable pain.

Root canal treatment is performed under **local anesthesia**. A thin sheet of rubber, called a rubber dam, is placed in the mouth and around the base of the tooth to isolate the tooth and help to keep the operative field dry. The dentist removes any tooth decay and makes an opening through the natural crown of the tooth into the pulp chamber. Creating

this access also relieves the pressure inside the tooth and can dramatically ease pain.

The dentist determines the length of the root canals, usually with a series of x rays. Small wire-like files are then used to clean the entire canal space of diseased pulp tissue and bacteria. The debris is flushed out with large amounts of water (irrigation). The canals are also slightly enlarged and shaped to receive an inert (non-reactive) filling material called gutta percha. However, the tooth is not filled and permanently sealed until it is completely free of active infection. The dentist may place a temporary seal, or leave the tooth open to drain, and prescribe an antibiotic to counter any spread of infection from the tooth. This is why root canal treatment may require several visits to the dentist.

Once the canals are completely clean, they are filled with gutta percha and a sealer cement to prevent bacteria from entering the tooth in the future. A metal post may be placed in the pulp chamber for added structural support and better retention of the crown restoration. The tooth is protected by a temporary filling or crown until a permanent restoration may be made. This restoration is usually a gold or porcelain crown, although it may be a gold inlay, or an amalgam or composite filling (paste fillings that harden).

### Diagnosis/Preparation

Signs that a root canal treatment is necessary include severe pain while chewing, prolonged sensitivity to heat or cold, or a darkening of the tooth. Swelling and tenderness of the gums or pimples appearing on the gums are also common symptoms. However, it is also possible that no symptoms will be noticed. The dentist will take an x ray of the tooth to determine if there is any sign of infection in the surrounding bone.

### Aftercare

Once a root canal treatment is performed, the recipient must have a crown placed over the tooth to protect it. The cost of the treatment and the crown may be expensive. However, replacing an extracted tooth with a fixed bridge, a removable partial denture, or an implant to maintain the space and restore the chewing function is typically even more expensive.

During the time when **antibiotics** are being used, care should be taken to avoid using the tooth to chew food. The tooth has been structurally weakened and may break, or there is a possibility of the interior of the tooth becoming reinfected.

If the tooth feels sensitive following the procedure, a standard over-the-counter pain medication such as

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A root canal treatment may be performed by a general dentist or by an endodontist. An endodontist is a dentist who specializes in endodontic (literally “inside of the tooth”) procedures. The procedure is usually performed in a professional dental office. In rare situations, it may be performed in a hospital outpatient facility.

ibuprofen or naproxen may be taken. This sensitivity will fade after a few days. In most cases the patient can resume regular activity the following day.

### Risks

There is a possibility that a root canal treatment will not be successful the first time. If infection and inflammation recur and an x ray indicates a repeat treatment is feasible, the old filling material is removed and the canals are thoroughly cleaned out. The dentist will try to identify and correct problems with the first root canal treatment before filling and sealing the tooth a second time.

In cases where an x ray indicates that another root canal treatment cannot correct the problem, endodontic surgery may be performed. In a procedure called an apicoectomy, or root resectioning, the root end of the tooth is accessed in the bone, and a small amount is shaved away. The area is cleaned of diseased tissue and a filling is placed to reseal the canal.

### Normal results

With successful root canal treatment, the tooth will no longer cause pain. However, because it does not contain an internal nerve, it no longer has sensitivity to hot, cold, or sweets. Because these are signs of dental decay, the root canal recipient must receive regular dental check-ups with periodic x rays to avoid further disease in the tooth. The restored tooth may last a lifetime. However, with routine wear, the filling or crown may eventually need to be replaced.

### Morbidity and mortality rates

In some cases, despite proper root canal treatment and endodontic surgery, the tooth dies and must be extracted. This is relatively uncommon.

## QUESTIONS TO ASK THE DOCTOR

What will be the resulting functional capacity of the tooth?

Is the oral surgeon board certified in endodontic surgery?

How many root canal procedures has the oral surgeon performed?

What is the oral surgeon's complication rate?

### Alternatives

The only alternative to performing a root canal procedure is to extract the diseased tooth. After restoration or extraction, the two main goals are to allow normal chewing and to maintain proper alignment and spacing between teeth. A fixed bridge, a removable partial denture or an implant will accomplish both goals. However, these are usually more expensive than a root canal treatment.

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#### ORGANIZATIONS

- Academy of General Dentistry, 211 East Chicago Avenue, Chicago, IL 60611. (312) 440 4300. <http://www.agd.org>.
- American Academy of Pediatric Dentistry, 211 East Chicago Avenue, #700, Chicago, IL 60611 2663. (312) 337 2169. Fax: (312) 337 6329. <http://www.aapd.org>.

- American Association of Endodontists, 211 E. Chicago Ave., Suite 1100, Chicago, IL 60611 2691. (800) 872 3636 or (312) 266 7255. Fax: (866) 451 9020 or (312) 266 9867. E mail: [info@aae.org](mailto:info@aae.org). <http://www.aae.org>.
- American Dental Association, 211 E. Chicago Avenue, Chicago, IL 60611. (312) 440 2500. Fax: (312) 440 7494. <http://www.ada.org>.

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## Rotator cuff repair

### Definition

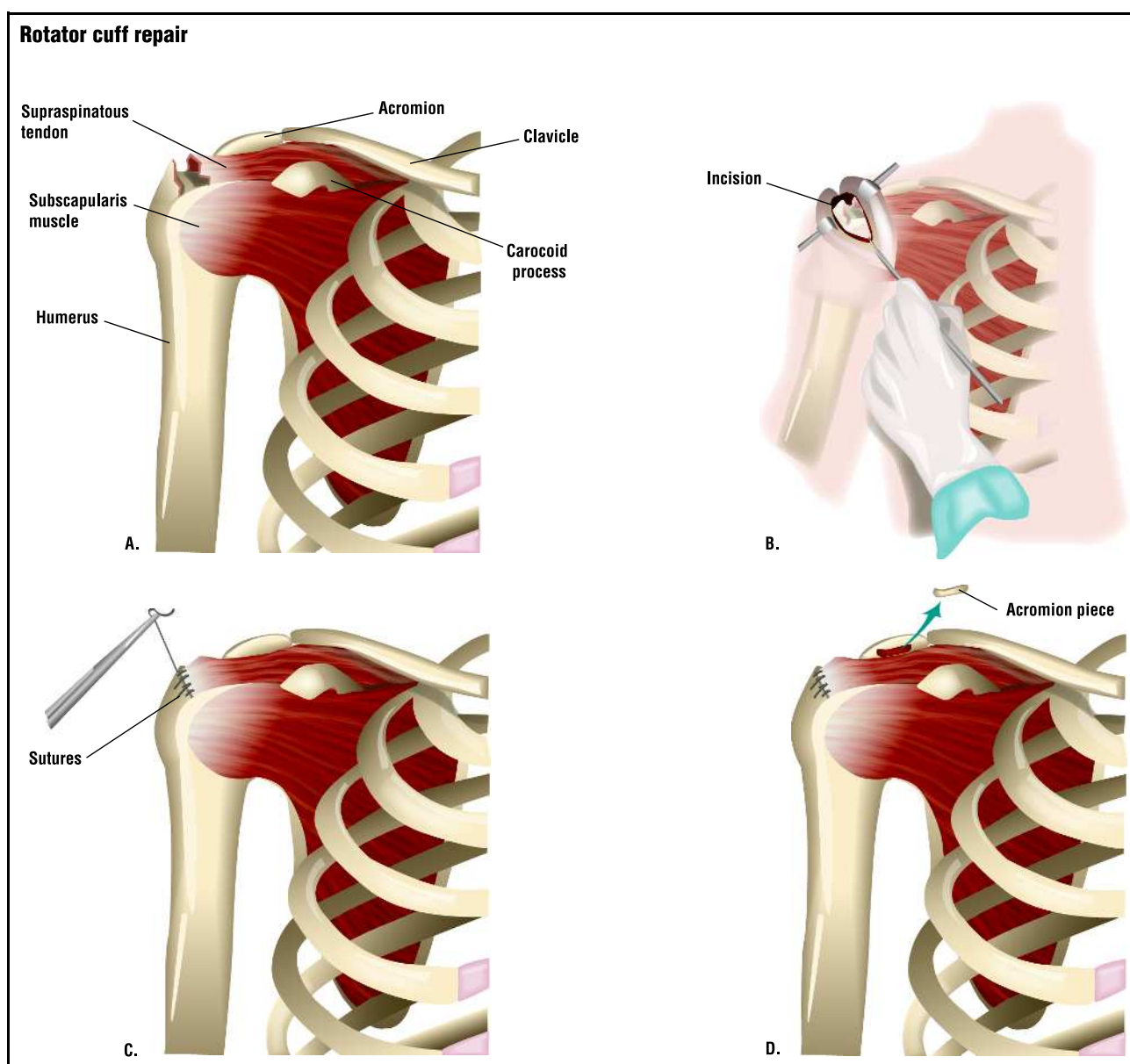
Rotator cuff surgery is the repair of inflammation or tears of the rotator cuff tendons in the shoulder. There are four tendons in the rotator cuff, and these tendons are attached individually to the following muscles: teres minor, subscapularis, infraspinatus, and the supraspinatus. The tears and inflammation associated with rotator cuff injury occur in the region near where these tendon/muscle complexes attach to the humerus (upper arm) bone.

### Purpose

Rotator cuff surgery is necessary when chronic shoulder pain associated with rotator cuff injury does not respond to conservative therapy such as rest, heat/ice application, or the use of non-steroidal anti-inflammatory drugs (NSAIDs). Rotator cuff injuries are often lumped into the category referred to as rotator cuff syndrome. Rotator cuff syndrome describes a range of symptoms from basic sprains and tendon swelling (tendonitis) to total rupture or tearing of the tendon.

### Demographics

Approximately 5–10% of the general population is believed to have rotator cuff syndrome at a given time. It is not commonly found in individuals under the age of 20 years, even though many in this population are athletically active. In general, males are more likely than females to develop rotator cuff syndrome and require surgery. Most rotator cuff injuries are



A rotator cuff injury results in a torn tendon at the top of the shoulder (A). To repair it, an incision is made over the site of the tear (B). The tendon's attachment to the bone is repaired with sutures (C), and a small piece of bone from the acromion may be removed (D) to ensure smoother movement of the tendons. (Illustration by GGS Information Services. Cengage Learning, Gale.)

associated with athletic activities such as baseball, tennis, weight lifting, and swimming, where the arms are repeatedly lifted over the head. Rotator cuff injuries can also occur in accidents involving falling to the ground or when the humerus is pushed into the shoulder socket. Rotator cuff injuries can also occur in older, active individuals because the rotator cuff tendons begin to deteriorate after age 40. Occupations that have been associated with rotator cuff injuries

include nursing, painting, carpentry, tree pruning, fruit picking, and grocery clerking.

### Description

For most patients, if the pain begins to subside, they are encouraged to undergo a period of physical therapy. If the pain does not subside after a few weeks, then the physician may suggest the use of cortisone



## KEY TERMS

**Adhesions**—A fibrous band that holds together tissue that are usually separated and that are associated with wound healing.

**Arthrography**—Visualization of a joint by radiographic means following injection of a contrast dye into the joint space.

**Arthroscope**—An endoscope, or a tube containing an optical system, that is used to examine the interior of a joint.

**Bone spurs**—A sharp or pointed calcified projection.

**Bursa**—A sac found in connective tissue that acts to reduce friction between tendon and bone.

**Deltoid muscle**—Muscle that covers the prominence of the shoulder.

injections into the shoulder region. Rotator cuff repair is then considered if the more conservative methods are not successful.

The primary aim of rotator cuff repair is to repair the connection between the damaged tendon and the bone. Once this bridge is re-established and the connection between the tendon and the bone has thoroughly healed, the corresponding muscles can once again move the arm in a normal fashion. The goal of the surgery is to ensure the smooth movement of the rotator cuff tendons and bursa under the upper part of the shoulder blade. The surgery is also performed to improve the comfort of the patient and to normalize the function of the shoulder and arm. There are a variety of surgical approaches that can be used to accomplish rotator cuff repair. The most common approach is called the anterior acromioplasty approach. This approach allows for excellent access to the most common sites of tears—the biceps groove, anterior cuff, and the undersurface of the joint.

Three types of rotator cuff repair surgeries are performed: open incision, mini-open incision, and arthroscopic. Most rotator cuff repairs are accomplished using incisions that minimize cosmetic changes in the skin following healing. If possible, the surgery is performed with an arthroscope to minimize cosmetic damage to the skin. Typically, the incision made is about the size of a buttonhole. The arthroscope, a pencil-sized instrument, is then inserted into the joint. The surgeon usually accesses the rotator cuff by opening part of the deltoid muscle. If bone spurs, adhesions, and damaged bursa are present in the

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Rotator cuff repair is generally performed by a specialist known as an orthopedic surgeon, who has received specialized training in the diseases and injuries of the musculoskeletal system. Orthopedic surgeons who perform rotator cuff repair receive extensive training in general surgery and in the specific techniques involving the musculoskeletal system. Rotator cuff repairs are often performed in the specialized department of a general hospital, but they are also performed in specialized orthopedic surgery clinics or institutes for orthopedic conditions.

rotator cuff region, then the surgeon will generally remove these damaged structures to improve function in the joint. In cases where the arthroscopic technique is not advised or when it fails to achieve the desired results, a conversion to open surgery is made. This involves a larger incision and usually requires more extensive anesthesia and a longer recovery period.

The success of the rotator cuff repair is dependent on the following factors:

- age of the patient
- type of surgical technique employed
- degree of damage present
- patient's recovery goals
- patient's ability to follow a physical therapy program following surgery
- smoking status
- number of previous cortisone injections

## Diagnosis/Preparation

The diagnosis of rotator cuff injury is based on a combination of clinical signs and symptoms, coupled with diagnostic testing. The most common clinical signs and symptoms include:

- tenderness in the rotator cuff
- pain associated with the movement of the arm above the head
- pain that is fairly constant but more intense at night
- weakness or pain with the forward movement of the arm
- muscle atrophy (wasting) in long-term injuries that involve a complete tendon tear

## QUESTIONS TO ASK THE DOCTOR

- What are my alternatives?
- Is surgery the answer for me?
- Can you recommend a surgeon who performs rotator cuff repairs?
- If surgery is appropriate for me, what are the next steps?

X rays are used to rule out other types of injuries or abnormalities present in the shoulder region. While x rays are often used to help solidify the diagnosis, **arthrography**, ultrasonography, computed tomography (CT), and **magnetic resonance imaging** (MRI) are the definitive tests in the diagnosis of rotator cuff injury. Arthrography and ultrasonography of the shoulder can help determine whether or not there is a full tear in the rotator cuff. A MRI can help determine whether there is a full tear, partial tear, chronic tendonitis, or other cause of the shoulder pain. The final decision to repair the tear ultimately rests on the amount of pain and restriction suffered by the patient.

### Aftercare

Following the procedure, the patient will typically spend several hours in the **recovery room**. Generally, an ice pack will be applied to the affected shoulder joint for a period up to 48 hours. The patient will usually be given either prescription or non-prescription pain medication. The dressing is usually removed the day after surgery and is replaced by adhesive strips. The patient should contact a physician if there are any significant changes in the affected area once the patient goes home. These changes can include increased swelling, pain, bleeding, drainage in the affected area, nausea, vomiting, or signs of infection. Signs of infection include fever, dizziness, headache, and muscle aches.

It often takes several days for the arthroscopic puncture wounds to heal, and the joint usually takes several weeks to recover. Most patients can resume normal daily activities, with the permission of a physician, within a few days following the procedure. Most patients are advised to undergo a rehabilitation program that includes physical therapy. Such a program can facilitate recovery and improve the functioning of the joint in the future.

## QUESTIONS TO ASK THE SURGEON

- How many times have you performed rotator cuff repair?
- Are you a board-certified surgeon?
- What type of outcomes have you had?
- What are the most common side effects or complications?
- What should I do to prepare for surgery?
- What should I expect following the surgery?
- Can you refer me to one of your patients who has had this procedure?
- What type of diagnostic procedures are performed to determine if patients require surgery?
- Will I need to see another specialist for the diagnostic procedures?

### Risks

Complications following arthroscopic rotator cuff surgery are very rare. Such complications occur in less than 1% of cases. These complications include instrument breakage, blood vessel or nerve damage, blood vessel clots, infection, and inflammation. Complications, though still rare, are more common following open surgery. This is due to the larger incisions and more complicated anesthesia that is often necessary.

### Normal results

The prognosis for the long-term relief from rotator cuff syndrome is good, especially when both conservative and surgical therapeutic approaches are used. In those patients who do require surgery, six weeks of physical therapy is typically instituted following surgery. Complete recovery following surgery may take several months. In rare cases, the rotator cuff injury is so severe that the patient may require muscle transfers and tendon grafts. Even more rarely, the injury can be so severe that the tendons are not repairable. This typically occurs when a severe rotator cuff injury is neglected for a long period of time.

### Morbidity and mortality rates

Morbidity is rare in both the arthroscopic and open procedures. Mortality is exceedingly rare in patients undergoing rotator cuff repair.

## Alternatives

Conservative approaches are typically used before surgery is considered in patients with rotator cuff injury. This is true even in cases where there is evidence of a full tendon tear. Some patients with a full or partial tear do not suffer a significant amount of pain and retain normal or nearly normal range of motion in shoulder movement. A majority of those with rotator cuff syndrome respond to conservative non-surgical approaches. Conservative therapies include the following:

- heat or ice to reduce pain and swelling
- cessation or reduction of activities that involve the movement of the arms overhead
- medication such as non-steroidal anti-inflammatory agents to reduce pain and inflammation
- cortisone injections to reduce pain and inflammation
- rest

Once the pain begins to subside, the patient usually is encouraged to begin a program of physical therapy to help re-institute normal motion and function to the shoulder.

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Mark Mitchell

Routine urinalysis see **Urinalysis**

# S

## Sacral nerve stimulation

### Definition

Sacral nerve stimulation, also known as sacral neuromodulation, is a procedure in which the sacral nerve at the base of the spine is stimulated by a mild electrical current from an implanted device. It is done to improve functioning of the urinary tract, to relieve pain related to urination, and to control fecal incontinence.

### Purpose

As a proven treatment for urinary incontinence, sacral nerve stimulation (SNS) has recently been found effective in the treatment of interstitial cystitis, a disorder that involves hyperreflexia of the urinary sphincter. SNS is also used to treat pelvic or urinary pain as well as fecal incontinence.

A person's ability to hold urine or feces depends on three body functions:

- a reservoir function represented by the urethra/bladder or colon
- a gatekeeping function represented by the urethral or anal sphincter and
- the brain's ability to control urination, defecation, and nerve sensitivity

A dysfunction or deficiency in any of these components can result in incontinence. The most common forms of incontinence are stress urinary incontinence and urge incontinence. Stress incontinence is related to an unstable detrusor muscle that controls the urinary sphincter. When the detrusor muscle is weak, urine can leak out of the bladder from pressure on the abdomen caused by sneezing, coughing, and other movements. Urge incontinence is characterized by a sudden strong need to urinate and inability to hold urine until an appropriate time; it is also associated with hyperactivity of the urinary sphincter. Both conditions can be treated by SNS. SNS requires an implanted device

that sends continuous stimulation to the sacral nerve that controls the urinary sphincter. This treatment has been used with over 1500 patients with a high rate of success. It was approved in Europe in 1994. The Food and Drug Administration (FDA) approved SNS for the treatment of urinary urge incontinence in 1997 and for urinary frequency in 1999.

Interstitial cystitis (IC) is a chronic condition of unknown origin that causes pain in the bladder and lower abdomen, urinary urgency, a frequent need to urinate at night, and pain during intercourse. IC has no known cause; it is diagnosed by the level of reported discomfort and by excluding other sources of urinary pain, frequency and urgency. SNS has only recently been used to treat IC. According to three studies presented to the American Urological Association in 2001, SNS significantly reduced urinary urgency and frequency, with some relief of pain, in patients who had not responded to other treatments. The use of SNS in treating IC is still considered experimental, however.

Treatment of fecal incontinence with SNS is very recent; it is also considered experimental. Newer research from Italy, however, indicates that patients with anorectal disturbances that are usually treated by augmentation of the sphincter muscle or implanting an artificial sphincter can benefit from electrical stimulation of the sacral nerve. Although the mechanism of SNS is not completely clear, researchers believe that the patient's control of the pelvic region is restored by the stimulation or activation of afferent fibers in the muscles of the pelvic floor.

### Demographics

Urinary incontinence affects between 15% and 30% of American adults living in the community, and as many as 50% of people confined to **nursing homes**. It is a disorder that affects women far more frequently than men; 85% of people suffering from urinary incontinence are women. According to the chief of geriatrics



## KEY TERMS

**Afferent fibers**—Nerve fibers that conduct nerve impulses from tissues and organs toward the central nervous system.

**Detrusor muscle**—The medical name for the layer of muscle tissue covering the urinary bladder. When the detrusor muscle contracts, the bladder expels urine.

**Fecal incontinence**—Inability to control bowel movements.

**Hyperreflexia**—A condition in which the detrusor muscle of the bladder contracts too frequently, leading to inability to hold one's urine.

**Interstitial cystitis**—A condition of unknown origin that causes urinary urgency, pain in the bladder and abdomen, and pain during sexual intercourse.

**Neuromodulation**—Electrical stimulation of a nerve for relief of pain.

**Sacral nerve**—The nerve in the lower back region of the spine that controls the need to urinate.

**Sphincter**—A ringlike band of muscle that tightens or closes the opening to a body organ.

**Urgency**—A sudden compelling need to urinate.

**Urinary incontinence**—Inability to control urination.

at a Boston hospital, 25 million Americans suffer each year from occasional episodes of urinary or fecal incontinence.

Interstitial cystitis is less common than urinary or fecal incontinence but still affects about 12% of women in the United States each year. The average age of IC patients is 40; 25% of patients are younger than 30. Although 90% of patients diagnosed with IC are women, it is thought that the disorder may be underdiagnosed in men.

## Description

Sacral nerve stimulation (SNS) is conducted through an implanted device that includes a thin insulated wire called a lead and a neurostimulator much like a cardiac pacemaker. The device is inserted in a pocket in the patient's lower abdomen. SNS is first tried on an outpatient basis in the doctor's office with the implantation of a test lead. If the trial treatment is successful, the patient is scheduled for inpatient surgery.

Permanent surgical implantation is done under **general anesthesia** and requires a one-night stay in the hospital. After the patient has been anesthetized, the surgeon implants the neurostimulator, which is about the size of a pocket stopwatch, under the skin of the patient's abdomen. Thin wires, or leads, running from the stimulator carry electrical pulses from the stimulator to the sacral nerves located in the lower back. After the stimulator and leads have been implanted, the surgeon closes the incision in the abdomen.

## Diagnosis/Preparation

Incontinence significantly affects a patient's quality of life; thus patients usually consult a doctor when their urinary problems begin to cause difficulties in the workplace or on social occasions. A family care practitioner will usually refer the patient to a urologist for diagnosis of the cause(s) of the incontinence. Patients with urinary and fecal incontinence are evaluated carefully through the taking of a complete patient history and a **physical examination**. The doctor will use special techniques to assess the capacity of the bladder or rectum as well as the functioning of the urethral or anal sphincter in order to determine the cause or location of the incontinence. **Cystoscopy**, which is the examination of the full bladder with a scope attached to a small tube, allows the physician to rule out certain disorders as well as plan the most effective treatment. These extensive tests are especially important in diagnosing interstitial cystitis because all other causes of urinary urgency, frequency, and pain must be ruled out before surgery can be suggested. Cystoscopy is done under anesthesia and often works as a treatment for IC. Once the doctor has made the diagnosis of urinary incontinence due to sphincter insufficiency, he or she will explain and discuss the surgical implant with the patient. SNS may be tried out on a temporary basis. The same pattern of diagnosis and treatment is used for patients with IC and fecal incontinence. Temporary implants can help eliminate those patients who will not benefit from a permanent implant.

## Aftercare

Following surgery, the patient remains overnight in the hospital. **Antibiotics** may be given to reduce the risk of infection and pain medications to relieve discomfort. The patient will be given instructions on **incision care** and follow-up appointments before he or she leaves the hospital.

Aftercare includes fine-tuning of the SNS stimulator. The doctor can adjust the strength of the electrical

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

SNS devices are implanted under general anesthesia by urologists, who are physicians specializing in treating disorders of the urinary tract. The procedure is usually performed in a hospital.

impulses in his or her office with a handheld programmer. The stimulator runs for about five to 10 years and can be replaced during an outpatient procedure. About a third of patients require a second operation to adjust or replace various elements of the stimulator device.

### Risks

In addition to the risks of bleeding and infection that are common to surgical procedures, implanting an SNS device carries the risks of pain at the insertion site, discomfort when urinating, mild electrical shocks, and displacement or dislocation of the leads.

### Normal results

Patients report improvement in the number of urinations, the volume of urine produced, lessened urgency, and higher overall quality of life after treatment with SNS. Twenty-two patients undergoing a three- to seven-day test of sacral nerve stimulation on an outpatient basis reported significant reduction in urgency and frequency, according to the American Urological Association. Studies have indicated complete success in about 50% of patients. Sacral nerve stimulation is being used to treat fecal incontinence in the United States and Europe, with promising early reports. As of 2003, SNS is the least invasive of the recognized surgical treatments for fecal incontinence.

### Morbidity and mortality rates

Sacral nerve stimulation has been shown to be a safe and effective procedure for the treatment of both urinary and fecal incontinence. Two groups of researchers, in Spain and the United Kingdom respectively, have reported that “The effects of neuromodulation are long-lasting and associated morbidity is low.” The most commonly reported complications of SNS are pain at the site of the implant (15.3% of patients); pain on urination (9%); and displacement of the leads (8.4%).

## QUESTIONS TO ASK THE DOCTOR

- Am I likely to benefit from SNS?
- How many stimulators have you implanted?
- How many of your patients consider SNS a successful treatment?
- What side effects have your patients reported?

### Alternatives

There are three types of nonsurgical treatments that benefit some patients with IC:

- Behavioral approaches. These include biofeedback, diet modifications, bladder retraining, and pelvic muscle exercises.
- Medications. These include antispasmodic drugs, tricyclic antidepressants, and pentosan polysulfate sodium, which is sold under the trade name Elmiron. Elmiron appears to work by protecting the lining of the bladder from bacteria and other irritating substances in urine.
- Intravesical medications. These are medications that affect the muscular tissues of the bladder. Oxybutynin is a drug that is prescribed for patients who are incontinent because their bladders fail to store urine properly. Capsaicin and resiniferatoxin are used to treat hyperreflexia of the detrusor muscle.

Surgical alternatives to SNS are considered treatments of last resort for IC because they are invasive, irreversible, and benefit only 30–40% of patients. In addition, some studies indicate that these surgeries can lead to long-term kidney damage. They include the following procedures:

- Augmentation cystoplasty. In this procedure, the surgeon removes the patient’s bladder and replaces it with a section of the bowel—in effect creating a new bladder. The patient passes urine through the urethra in the normal fashion.
- Urinary diversion. The surgeon creates a tube from a section of the patient’s bowel and places the ureters (tubes that carry urine from the kidneys to the bladder) in this tube. The tube is then attached to a stoma, or opening in the abdomen. Urine is carried into an external collection bag that the patient must empty several times daily.
- Internal pouch. The surgeon creates a new bladder from a section of the bowel and attaches it inside the abdomen. The patient empties the pouch by self-catheterization four to six times daily.

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- American Urological Association (AUA). 1120 North Charles Street, Baltimore, MD 21201. (410) 727-1100. [www.auanet.org](http://www.auanet.org).
- National Association for Continence (NAFC). P. O. Box 1019, Charleston, SC 29402-1019. (843) 377-0900. [www.nafc.org](http://www.nafc.org).
- National Kidney Foundation. 30 East 33rd Street, Suite 1100, New York, NY 10016. (800) 622-9010 or (212) 889-2210. [www.kidney.org](http://www.kidney.org).
- National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC). 3 Information Way, Bethesda, MD 20892-3580.

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Nancy McKenzie, PhD

## Salpingo-oophorectomy

### Definition

Unilateral salpingo-oophorectomy is the surgical removal of a fallopian tube and an ovary. If both sets of fallopian tubes and ovaries are removed, the procedure is called a bilateral salpingo-oophorectomy.

### Purpose

This surgery is performed to treat ovarian or other gynecological cancers, or infections caused by pelvic inflammatory disease. Occasionally, removal of one or both ovaries may be done to treat endometriosis, a

condition in which the lining of the uterus (the endometrium) grows outside of the uterus (usually on and around the pelvic organs). The procedure may also be performed if a woman has been diagnosed with an ectopic pregnancy in a fallopian tube and a **salpingostomy** (an incision into the fallopian tube to remove the pregnancy) cannot be done. If only one fallopian tube and ovary are removed, the woman may still be able to conceive and carry a pregnancy to term. If both are removed, however, the woman is rendered permanently infertile. This procedure is commonly combined with a **hysterectomy** (surgical removal of the uterus); the ovaries and fallopian tubes are removed in about one-third of hysterectomies.

Until the 1980s, women over age 40 having hysterectomies routinely had healthy ovaries and fallopian tubes removed at the same time. Many physicians reasoned that a woman over 40 was approaching menopause and soon her ovaries would stop secreting estrogen and releasing eggs. Removing the ovaries would eliminate the risk of ovarian cancer and only accelerate menopause by a few years.

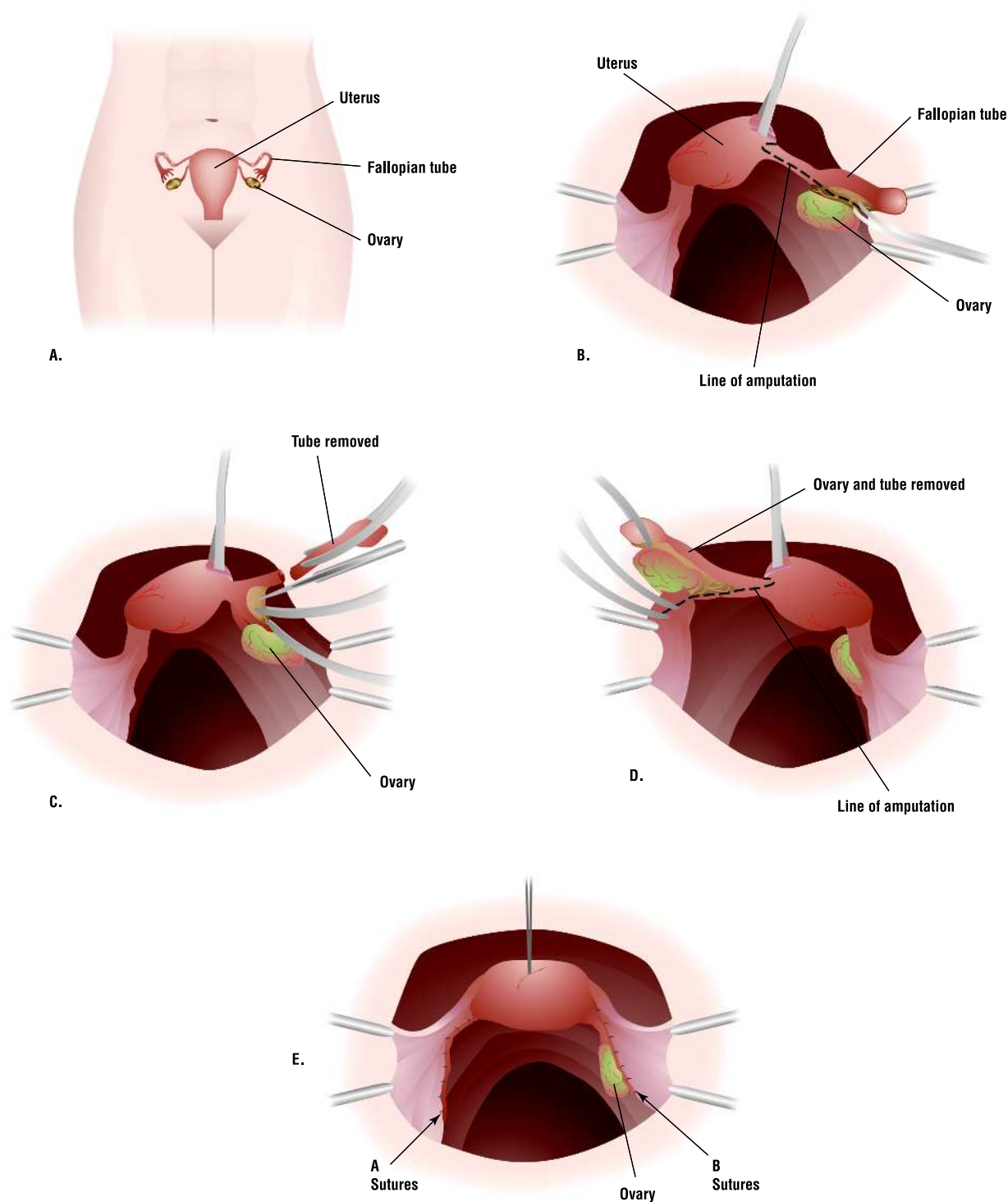
In the 1990s, the thinking about routine salpingo-oophorectomy began to change. The risk of ovarian cancer in women who have no family history of the disease is less than 1%. Moreover, removing the ovaries increases the risk of cardiovascular disease and accelerates osteoporosis unless a woman takes prescribed hormone replacements.

### Demographics

Overall, ovarian cancer accounts for only 4% of all cancers in women. For women at increased risk, **oophorectomy** may be considered after the age of 35 if childbearing is complete. Factors that increase a woman's risk of developing ovarian cancer include age (most ovarian cancers occur after menopause), the presence of a mutation in the BRCA1 or BRCA2 gene, the number of menstrual periods a woman has had (affected by age of onset, pregnancy, breastfeeding, and oral contraceptive use), history of breast cancer, diet, and family history. The incidence of ovarian cancer is highest among Native American (17.5 cases per 100,000 population), Caucasian (15.8 per 100,000), Vietnamese (13.8 per 100,000), Hispanic (12.1 per 100,000), and Hawaiian (11.8 per 100,000) women; it is lowest among Korean (7.0 per 100,000) and Chinese (9.3 per 100,000) women. African American women have an ovarian cancer incidence of 10.2 per 100,000 population.

Endometriosis, another reason why salpingo-oophorectomy may be performed, has been estimated

## Salpingo-oophorectomy



In a salpingo-oophorectomy, a woman's reproductive organs are accessed through an incision in the lower abdomen, or laparoscopically (A). Once the area is visualized, a diseased fallopian tube can be severed from the uterus and removed (B and C). The ovary can also be removed with the tube (D). The remaining structures are stitched (E), and the wound is closed. (Illustration by GGS Information Services. Cengage Learning, Gale.)



## KEY TERMS

**BRCA1 or BRCA2 genetic mutation**—A genetic mutation that predisposes otherwise healthy women to breast cancer.

**Endometriosis**—A painful disease in which cells from the lining of the uterus (endometrium) become attached to other organs in the pelvic cavity. The condition is hard to diagnose and often causes severe pain as well as infertility.

**Fallopian tubes**—Tubes that extend from either end of the uterus that convey the egg from the ovary to the uterus during each monthly cycle.

**Hysterectomy**—The surgical removal of the uterus.

**Ureter**—The tube that carries urine from the bladder to the kidneys.

to affect up to 10% of women. Approximately four out of every 1,000 women are hospitalized as a result of endometriosis each year. Women 25–35 years of age are affected most, with 27 being the average age of diagnosis.

## Description

General or regional anesthesia will be given to the patient before the procedure begins. If the procedure is performed through a laparoscope, the surgeon can avoid a large abdominal incision and can shorten recovery. With this technique, the surgeon makes a small cut through the abdominal wall just below the navel. A tube containing a tiny lens and light source (a laparoscope) is then inserted through the incision. A camera can be attached that allows the surgeon to see the abdominal cavity on a video monitor. When the ovaries and fallopian tubes are detached, they are removed through a small incision at the top of the vagina. The organs can also be cut into smaller sections and removed. When the laparoscope is used, the patient can be given either regional or **general anesthesia**; if there are no complications, the patient can leave the hospital in a day or two.

If a laparoscope is not used, the surgery involves an incision 4–6 in (10–15 cm) long into the abdomen extending either vertically up from the pubic bone toward the navel, or horizontally (the “bikini incision”) across the pubic hairline. The scar from a bikini incision is less noticeable, but some surgeons prefer the vertical incision because it provides greater visibility while operating. A disadvantage to abdominal salpingo-oophorectomy is that bleeding is more likely

to be a complication of this type of operation. The procedure is more painful than a laparoscopic operation and the recovery period is longer. A woman can expect to be in the hospital two to five days and will need three to six weeks to return to normal activities.

## Diagnosis/Preparation

Before surgery, the doctor will order blood and urine tests, and any additional tests such as **ultrasound** or x rays to help the surgeon visualize the woman’s condition. The woman may also meet with the anesthesiologist to evaluate any special conditions that might affect the administration of anesthesia. A colon preparation may be done, if extensive surgery is anticipated.

On the evening before the operation, the woman should eat a light dinner, then take nothing by mouth, including water or other liquids, after midnight.

## Aftercare

If performed through an abdominal incision, salpingo-oophorectomy is major surgery that requires three to six weeks for full recovery. However, if performed laparoscopically, the recovery time can be much shorter. There may be some discomfort around the incision for the first few days after surgery, but most women are walking around by the third day. Within a month or so, patients can gradually resume normal activities such as driving, exercising, and working.

Immediately following the operation, the patient should avoid sharply flexing the thighs or the knees. Persistent back pain or bloody or scanty urine indicates that a ureter may have been injured during surgery.

If both ovaries are removed in a premenopausal woman as part of the operation, the sudden loss of estrogen will trigger an abrupt premature menopause that may involve severe symptoms of hot flashes, vaginal dryness, painful intercourse, and loss of sex drive. (This is also called “surgical menopause.”) In addition to these symptoms, women who lose both ovaries also lose the protection these hormones provide against heart disease and osteoporosis many years earlier than if they had experienced natural menopause. Women who have had their ovaries removed are seven times more likely to develop coronary heart disease and much more likely to develop bone problems at an early age than are premenopausal women whose ovaries are intact. For these reasons, some form of hormone replacement therapy (HRT) may be prescribed to relieve the symptoms of surgical menopause and to help prevent heart and bone disease.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Salpingo-oophorectomies are usually performed in a hospital operating room by a gynecologist, a medical doctor who has completed specialized training in the areas of women's general health, pregnancy, labor and childbirth, prenatal testing, and genetics.

Reaction to the removal of fallopian tubes and ovaries depends on a wide variety of factors, including the woman's age, the condition that required the surgery, her reproductive history, how much social support she has, and any previous history of depression. Women who have had many gynecological surgeries or chronic pelvic pain seem to have a higher tendency to develop psychological problems after the surgery.

### Risks

Major surgery always involves some risk, including infection, reactions to the anesthesia, hemorrhage, and scars at the incision site. Almost all pelvic surgery causes some internal scars, which in some cases can cause discomfort years after surgery.

Potential complications after a salpingo-oophorectomy include changes in sex drive, hot flashes, and other symptoms of menopause if both ovaries are removed. Women who have both ovaries removed and who do not take estrogen replacement therapy run an increased risk for cardiovascular disease and osteoporosis. Women with a history of psychological and emotional problems before an oophorectomy are more likely to experience psychological difficulties after the operation.

### Normal results

If the surgery is successful, the fallopian tubes and ovaries will be removed without complication, and the underlying problem resolved. In the case of cancer, all the cancer will be removed. A woman will become infertile following a bilateral salpingo-oophorectomy.

### Morbidity and mortality rates

Studies have shown that the complication rate following salpingo-oophorectomy is essentially the same as

## QUESTIONS TO ASK THE DOCTOR

- Why is a salpingo-oophorectomy being recommended?
- How will the procedure be performed?
- Will one or both sets of ovaries/fallopian tubes be removed?
- What alternatives to salpingo-oophorectomy are available to me?

that following hysterectomy. The rate of complications differs by the type of hysterectomy performed. Abdominal hysterectomy is associated with a higher rate of complications (9.3%), while the overall complication rate for vaginal hysterectomy is 5.3%, and 3.6% for laparoscopic vaginal hysterectomy. The risk of **death** is about one in every 1,000 (1/1,000) women having a hysterectomy. The rates of some of the more commonly reported complications are:

- excessive bleeding (hemorrhaging): 1.8–3.4%
- fever or infection: 0.8–4.0%
- accidental injury to another organ or structure: 1.5–1.8%

Because of the cessation of hormone production that occurs with a bilateral oophorectomy, women who lose both ovaries also prematurely lose the protection these hormones provide against heart disease and osteoporosis. Women who have undergone bilateral oophorectomy are seven times more likely to develop coronary heart disease and much more likely to develop bone problems at an early age than are premenopausal women whose ovaries are intact.

### Alternatives

Depending on the specific condition that warrants an oophorectomy, it may be possible to modify the surgery so at least a portion of one ovary remains, allowing the woman to avoid early menopause. In the case of endometriosis, there are a number of alternative treatments that are usually pursued before a salpingo-oophorectomy (with or without hysterectomy) is performed. These include excising the growths without removing any organs, blocking or destroying the nerves that provide sensation to some of the pelvic structures, or prescribing drugs that decrease estrogen levels.

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American Cancer Society. 1599 Clifton Road NE, Atlanta, GA 30329. (800) ACS 2345. <http://www.cancer.org>.

American College of Obstetricians and Gynecologists. 409 12th St., SW, PO Box 96920, Washington, DC 20090 6920. <http://www.acog.org>.

Midlife Women's Network. 5129 Logan Ave. S., Minneapolis, MN 55419. (800) 886 4354.

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## Salpingostomy

### Definition

A salpingostomy is a surgical incision into a fallopian tube. This procedure may be done to repair a damaged tube or to remove an ectopic pregnancy (one that occurs outside of the uterus).

### Purpose

The fallopian tubes are the structures that carry a mature egg from the ovaries to the uterus. These tubes, which are about 4 inches (10 cm) long and 0.2 inches (0.5 cm) in diameter, are found on the upper outer sides of the uterus, and open into the uterus through

small channels. It is within the fallopian tubes that fertilization, the joining of an egg and a sperm, takes place.

During a normal pregnancy, the fertilized egg passes from the fallopian tubes into the uterus and then implants into the lining of the uterus. If the fertilized egg implants anywhere outside of the uterus, it is called an ectopic (or tubal) pregnancy. The majority of ectopic pregnancies occur in the fallopian tubes (95%); they may also occur in the uterine muscle (1–2%), the abdomen (1–2%), the ovaries (less than 1%), and the cervix (less than 1%).

As an ectopic pregnancy progresses, the fallopian tubes are unable to contain the growing embryo and may rupture. A ruptured ectopic pregnancy is considered a medical emergency as it can cause significant hemorrhaging (excessive bleeding). If an ectopic pregnancy is diagnosed early (i.e., before rupture has occurred), it may be possible to manage medically; the drug methotrexate targets rapidly dividing fetal cells, preventing the fetus from developing further. If medicinal management is not possible or has failed, surgical intervention may be necessary. A salpingostomy may then be performed to remove the pregnancy.

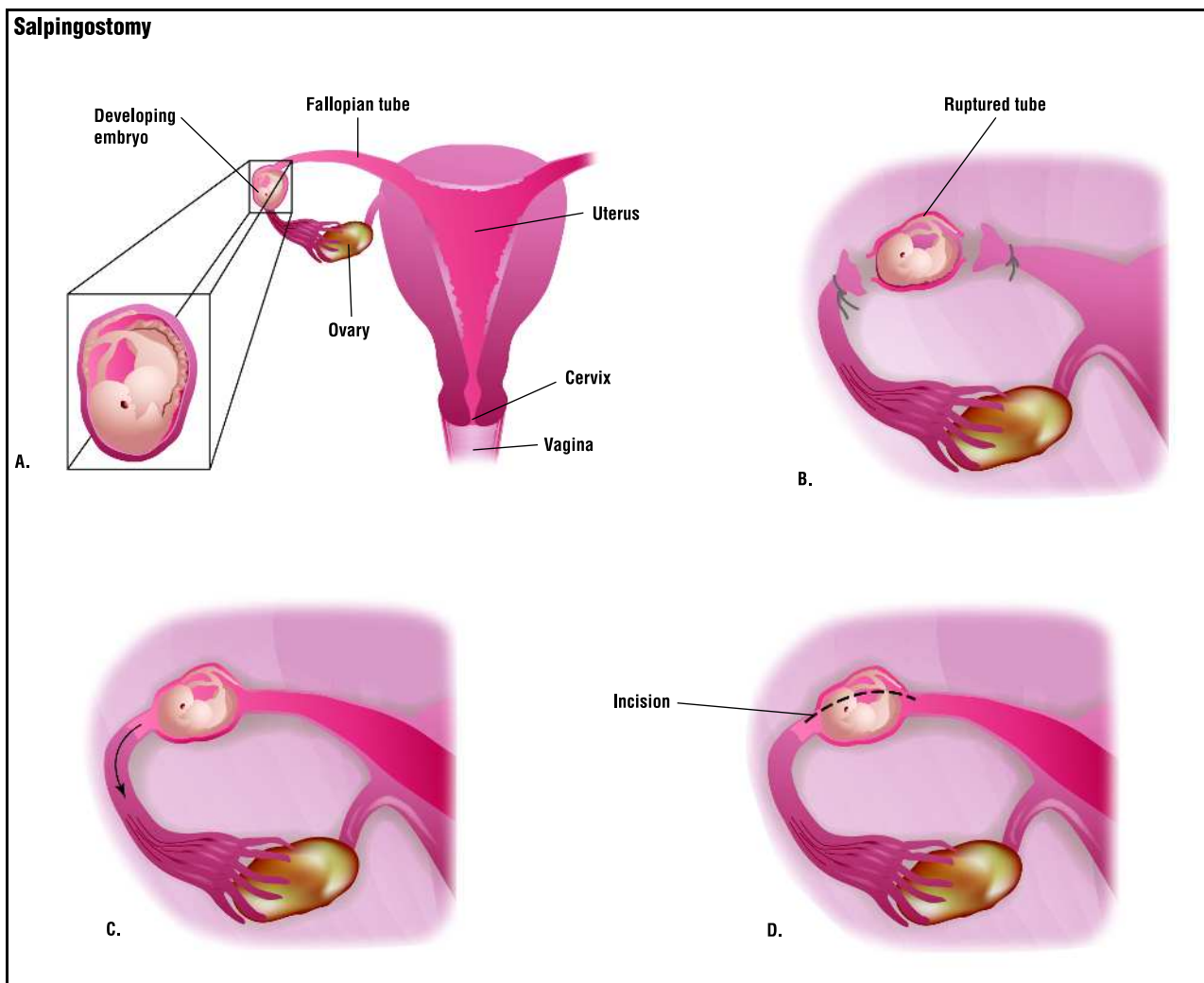
Salpingostomy may also be performed in an effort to restore fertility to a woman whose fallopian tubes have been damaged, such as by adhesions (bands of scar tissue that may form after surgery or trauma). In the case of hydrosalpinx, a condition in which a tube becomes blocked and filled with fluid, a salpingostomy may be performed to create a new tubal ostium (opening).

### Demographics

Ectopic pregnancy occurs in approximately 2% of all pregnancies. Once a woman has an ectopic pregnancy, she has an increased chance (10–25%) of having another. Women between the ages of 25 and 34 have a higher incidence of ectopic pregnancy, although the mortality rate among women over the age of 35 is 2.5–5.9 times higher. Minority women are also at an increased risk of ectopic pregnancy-related death.

### Description

Salpingostomy may be performed via laparotomy or **laparoscopy**, under general or regional anesthesia. A laparotomy is an incision made in the abdominal wall through which the fallopian tubes are visualized. If the tube has already ruptured as a result of an ectopic pregnancy, a salpingectomy will be performed



**A tubal or ectopic pregnancy can be removed in several ways. If the Fallopian tube is ruptured (A), the tube is tied off on both sides, and the embryo removed. If the tube is intact, the embryo can be pulled out the end of the tube (C), or tube can be cut open and the contents removed (D).** (Illustration by GGS Information Services. Cengage Learning, Gale.)

to remove the damaged fallopian tube. If rupture has not occurred, a drug called vasopressin is injected into the fallopian tube to minimize the amount of bleeding. An incision (called a linear salpingostomy) is made through the wall of the tube in the area of the ectopic pregnancy. The products of conception are then flushed out of the tube with an instrument called a suction-irrigator. Any bleeding sites are treated by suturing or by applying pressure with forceps. The incision is not sutured but instead left to heal on its own (called closure by secondary intent). The abdominal wall is then closed.

A neosalpingostomy is similar to a linear salpingostomy but is performed to treat a tubal blockage (e.g., hydrosalpinx). An incision is made to create a new opening in the fallopian tube; the tissue is folded over and

stitched into place. The new hole, or ostium, replaces the normal opening of the fallopian tube through which the egg released by an ovary each menstrual cycle is collected.

Salpingostomy may also be performed laparoscopically. With this surgery, a tube (called a laparoscope) containing a tiny lens and light source is inserted through a small incision in the navel. A camera can be attached that allows the surgeon to see the abdominal cavity on a video monitor. The salpingostomy is then performed with instruments inserted through **trocars**, small incisions of 0.2–0.8 in (0.5–2 cm) made through the abdominal wall.

An advantage of laparoscopic salpingostomy is that the operation is less invasive, thus recovery time is quicker and less painful as compared to a



## KEY TERMS

**Adhesions**—Bands of scar tissue that may form after surgery or trauma.

**Hydrosalpinx**—A condition in which a fallopian tube becomes blocked and filled with fluid.

**Methotrexate**—A drug that targets rapidly dividing fetal cells, preventing a fetus from developing further.

**Salpingectomy**—The surgical removal of a fallopian tube.

laparotomy; the average duration of recovery following laparoscopy is 2.4 weeks, compared to 4.6 weeks for laparotomy. An abdominal incision, on the other hand, allows the surgeon a better view of and easier access to the pelvic organs. Several studies have indicated a reduced rate of normal pregnancy after salpingostomy by laparoscopy versus laparotomy.

## Diagnosis/Preparation

It has been estimated that 40–50% of ectopic pregnancies are incorrectly diagnosed when first presenting to emergency room medical personnel. Often the symptoms of ectopic pregnancy are confused with other conditions such as miscarriage or pelvic inflammatory disease. Diagnosis is usually based on presentation of symptoms, a positive pregnancy test, and detection of a pregnancy outside of the uterus by means of ultrasonography (using a machine that transmits high frequency sound waves to visualize structures in the body).

Diagnosis of hydrosalpinx or other defects of the fallopian tubes may be done surgically, using a laparoscope to visualize the fallopian tubes. Alternatively, a hysterosalpingogram may be performed, in which the uterus is filled with a dye and an x ray is taken to see if the dye flows through the fallopian tubes.

## Aftercare

If performed through an abdominal incision, a salpingostomy requires three to six weeks for full recovery. If salpingostomy is performed laparoscopically, the recovery time can be much shorter (an average of 2.4 weeks). There may be some discomfort around the incision for the first few days after surgery, but most women are walking by the third day. Within a month or so, patients can gradually resume normal activities such as driving, exercising, and working.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Salpingostomies are usually performed in a hospital operating room by a surgeon or gynecologist, a medical doctor who has completed specialized training in the areas of women's general health, pregnancy, labor and childbirth, prenatal testing, and genetics.

## Risks

Complications associated with the surgical procedure include reaction to anesthesia, excessive bleeding, injury to other organs, and infection. With an ectopic pregnancy, there is a chance that not all of the products of conception will be removed and that the persistent tissue will continue growing. If this is the case, further treatment will be necessary.

## Normal results

In the case of ectopic pregnancy, the products of conception will be removed without significantly impairing fertility. If salpingostomy is being performed to restore fertility, the procedure will increase a woman's chance of conceiving without resorting to artificial reproductive techniques.

## Morbidity and mortality rates

Abdominal pain occurs in 97% of women with an ectopic pregnancy, vaginal bleeding in 79%, abdominal tenderness in 91%, and infertility in 15%. Persistent ectopic pregnancy after surgical treatment occurs in 5–10% of cases. Ectopic pregnancy accounts for 10–15% of all maternal deaths; the mortality rate for ectopic pregnancy is approximately one in 2,500 cases.

## Alternatives

Some ectopic pregnancies may be managed expectantly (allowing the pregnancy to progress to see if it will resolve on its own). This may occur in up to 25% of ectopic pregnancies. There is, of course, a chance that the fallopian tube will rupture during the period of observation. Treatment with methotrexate is gaining popularity and has been shown to have success rates similar to laparoscopic salpingostomy if multiple doses are given and the patient is in stable condition. Salpingectomy is another surgical option and is indicated if a tube has ruptured or is seriously damaged.

## QUESTIONS TO ASK THE DOCTOR

- Why is a salpingostomy being recommended?
- How will the procedure be performed?
- If an ectopic pregnancy is suspected, how will the diagnosis be confirmed?
- What alternatives to salpingostomy are available to me?

### Resources

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Stephanie Dionne Sherk

Saphenous vein bypass see **Peripheral vascular bypass surgery**

## Scar revision surgery

### Definition

Scar revision surgery refers to a group of procedures that are done to partially remove scar tissue following surgery or injury, or to make the scar(s) less noticeable. The specific procedure that is performed depends on the type of scar; its cause, location, and size; and the characteristics of the patient's skin.

### Purpose

Scar revision surgery is performed to improve the appearance of the patient's face or other body part, but it is also done to restore or improve functioning when the formation of a scar interferes with the movement of muscles and joints. The shortening or tightening of the skin and underlying muscles that may accompany scar formation is known as contracture. Contractures may interfere with range of motion and other aspects of joint functioning, as well as deform the shape of the hand or other body part. Contractures in the face often affect the muscles that control facial expressions.

Scar revision surgery may be considered as either a cosmetic procedure or a **reconstructive surgery**, depending on whether the patient's concern is primarily related to appearance or whether contractures have also affected functioning. Some insurance companies will cover the cost of scar revision surgery if the scarring resulted from injury. Patients who are considering scar revision surgery should consult their insurance carriers to learn whether their condition may be covered. According to the American Academy of Facial Plastic and Reconstructive Surgery (AAFPRS), the average cost for scar revision surgery on the face is \$1,135, compared to \$1,376 for **dermabrasion**, \$149 for microdermabrasion and \$2,484 for **laser skin resurfacing**.

### Demographics

The demographics of scar revision are difficult to establish precisely because of the number of different procedures that are grouped under this heading and the different types of scars that they are intended to treat. In addition, although dermabrasion and laser resurfacing of the skin are often described as surgical methods of scar treatment to distinguish them from medical modalities, they are usually listed separately in statistical tables. According to the American Society of Plastic Surgeons (ASPS), in 2006 the number of procedures, by type, were as follows: 164,684 for scar

## KEY TERMS

**Collagen**—A type of protein found in connective tissue that gives it strength and flexibility.

**Contracture**—A condition in which the skin and underlying muscles shorten and tighten as the result of the formation of scar tissue or a disorder of the muscle fibers.

**Dermabrasion**—Planing of the skin done by a mechanical device, most commonly fine sandpaper or a wire brush.

**Epidermis**—The outermost layer of the skin.

**Flap**—A piece of tissue used for grafting that has kept its own blood supply.

**Hypertrophic**—A type of thick scar that is raised above the surface of the skin, usually caused by increasing or prolonging the inflammation stage of wound healing.

**Keloid**—A raised, irregularly shaped scar that gradually increases in size due to the overproduction of collagen during the healing process. The name comes from a Greek word that means “crablike.”

**Microdermabrasion**—A technique for skin resurfacing that uses abrasive crystals passed through a hand piece to even out skin irregularities.

**Nonablative**—Not requiring removal or destruction of the epidermis. Some techniques for minimizing scars are nonablative.

revision; 69,300 for dermabrasion; 262,926 for laser resurfacing; and 816,774 for microdermabrasion.

The female to male ratio for scar revision surgery is about four to three, whereas women are almost five times as likely as men to have laser skin resurfacing and almost 13 times as likely to have a microdermabrasion procedure. Most patients who have scar revision surgery are between 15 and 39, although a significant number choose to undergo this type of surgery in their 40s and 50s.

It is difficult to compare scar revision surgery with other treatments across ethnic and racial groups because skin color is a factor in the effectiveness of some forms of therapy. In addition, some types of scars—particularly keloids—are more likely to form in darker skin. On the whole, it is estimated that between 4.5% and 16% of the United States population is affected by keloids and hypertrophic scars. These are the most difficult scars to treat, and are discussed in further detail below.

## Description

### *Scar formation*

A description of the process of scar formation may be helpful in understanding scar revision surgery and other procedures intended to improve the appearance of scarred skin. There are three phases in the formation of a scar:

- **Inflammation.** This phase begins right after the injury and lasts until the wound is closed. It is the body’s way of preventing infection, because a wound is not sterile until it is covered by a new outer layer of skin.
- **Transitional repair.** Scar tissue is formed during this phase to hold the wound together. The length of this phase depends on the severity of the injury.
- **Maturation.** This phase usually begins about seven to 12 weeks after the injury occurs. It is also the phase in which problem scars appear. Under normal conditions, a repair process takes place in which the development of new skin is combined with breaking down the scar tissue that was formed in the second phase of healing. A problem scar is likely to develop when the repair process is interrupted or disturbed.

### *Causes and types of problem scars*

Problem scars may result from inflammatory diseases—particularly acne; trauma, including cuts and burns; previous surgery; and a genetic predisposition for the skin to overreact to injury. Tension on the skin around the wound, foreign material in the wound, infection, or anything that delays closure of the wound may also contribute to scar formation.

The most difficult types of scars to treat are characterized by overproduction of collagen, which is the extracellular protein found in connective tissue that gives it strength and flexibility. The two types of scars that are most often considered for treatment are keloids and hypertrophic scars. Keloids are shiny, smooth benign tumors that arise in areas of damaged skin and look like irregular growths in the wound area. Hypertrophic scars, on the other hand, are thick, ropy-textured scars that are often associated with contractures.

Keloids can be distinguished from hypertrophic scars by the following characteristics:

- **Timing.** Hypertrophic scars usually begin to form within weeks of the injury, whereas keloids may not appear until a year later.
- **Growth pattern.** Hypertrophic scars do not continue to grow after they form, and remain within the original area of injury. Keloids continue to grow and spread outward into normal tissue.

- Role of genetic factors. Keloids tend to run in families, whereas hypertrophic scars do not.
- Racial and age distribution. Keloids occur more frequently in persons with darker skin than in fair-skinned persons. They are also more likely to develop during adolescence and pregnancy, which are periods of high hormone production.
- Recurrence. Hypertrophic scars may fade with time and do not recur. Keloids, on the other hand, may recur even after surgical removal.
- Collagen structure. The collagen fibers in a hypertrophic scar are shorter and generally arranged in a wavelike pattern, whereas the collagen fibers in keloids tend to be randomly arranged.

### *Surgical approaches to scar revision*

The treatment of scars is highly individualized. Most plastic surgeons use a variety of nonsurgical and surgical approaches to improve the appearance of scars. In addition, patients might need several different surgical procedures if their scar revisions require a series of operations at different stages of the healing process.

**SURGICAL EXCISION.** Surgical excision is a procedure in which the surgeon shaves down and cuts out scar tissue to reduce the size of the scar. This technique is most commonly used on large scars that cannot be treated adequately with medications or other nonsurgical means. When excision is done in stages, it is referred to as “serial excision.” This is performed if the area of the scar is too large to remove at one time without distorting nearby skin.

**FLAPS, GRAFTS, AND ARTIFICIAL SKIN.** Flaps, grafts, and artificial skin are used to treat contractures and large areas of scarring resulting from burns and other traumatic injuries. When there is not enough skin at the site of the injury to cover an incision made to remove scar tissue, the surgeon implants a skin graft or flap after cutting out the scar tissue itself. Skin grafts are thin layers of skin that are removed from another part of the patient’s body and carefully matched to the color and texture of the face or other area where the graft is to be placed. A skin flap is a full-thickness piece of tissue with its own blood supply that is taken from a site as close as possible to the scarred area.

Dermal regeneration templates, often called “artificial skin,” are used to treat people with contracture scars or severe burns. These devices were approved by the Food and Drug Administration (FDA) in April 2002. The templates are made of two layers of material, a bottom layer composed of collagen derived

from cows and a top layer made of silicone. To use the artificial skin, the surgeon first removes all the burned skin or scar tissue from the patient’s wound. The collagen layer, which is eventually absorbed, allows the patient’s body to start growing new skin while the silicone layer closes and protects the wound. After 14–21 days, the silicone layer can be removed and a very thin graft of the patient’s own skin is applied to the surface of the wound. The advantages of using a dermal regeneration template are that it lowers the risk of infection and minimizes the amount of tissue that must be removed from the patient’s other body sites.

**Z-PLASTY AND W-PLASTY.** Z-plasty and W-plasty are surgical techniques used to treat contractures and to minimize the visibility of scars by repositioning them along the natural lines and creases in the patient’s skin. They are not usually used to treat keloids or hypertrophic scars. In Z-plasty, the surgeon makes a Z-shaped incision with the middle line of the Z running along the scar tissue. The flaps of skin formed by the other lines of the Z are rotated and sewn into a new position that reorients the scar about 90 degrees. In effect, the Z-plasty minimizes the appearance of the scar by breaking up the straight line of the scar into smaller units.

A W-plasty is similar to a Z-plasty in that the goal of the procedure is to minimize the visibility of a scar by turning a straight line into an irregular one. The surgeon makes a series of short incisions to form a zigzag pattern to replace the straight line of the scar. The primary difference between a Z-plasty and a W-plasty is that a W-plasty does not involve the formation and repositioning of skin flaps. A variation on the W-plasty is known as the geometric broken line closure, or GBLC.

**LASER SKIN RESURFACING AND DERMABRASION.** Skin resurfacing and dermabrasion are techniques used to treat acne scars or to smooth down scars with raised or uneven surfaces. They are known as ablative skin treatments because they remove the top layer of skin, or the epidermis. In dermabrasion, the surgeon moves an instrument with a high-speed rotating wheel over the scar tissue and surrounding skin several times in order to smooth the skin surface down to the lowest level of scarring. Laser skin resurfacing involves the use of a carbon dioxide or Er:YAG laser to evaporate the top layer of skin and tighten the underlying layer. Keloid or hypertrophic scars are treated with a pulsed dye laser. Dermabrasion or laser resurfacing can be used about five weeks after a scar excision to make the remaining scar less noticeable.



Laser skin resurfacing, however, is less popular than it was in the late 1990s because of increasing awareness of its potential complications. The skin of patients who have undergone laser skin resurfacing takes several months to heal, often with considerable discomfort as well as swelling and reddish discoloration of the skin. In addition, there is a 33–85% chance that changes in the color of the skin will be permanent; the risk of permanent discoloration is higher for patients with darker skin. As of 2003, some plastic surgeons are recommending laser resurfacing only for patients with deep wrinkles or extensive sun damage who are willing to accept the pain and permanent change in skin color.

### Diagnosis/Preparation

Preparation for scar revision surgery includes the surgeon's assessment of the patient's psychological stability as well as the type and extent of potential scar tissue. Many patients respond to scarring following trauma with intense anger, particularly if the face is disfigured or their livelihood is related to their appearance. Some people are impatient to have the scars treated as quickly as possible, and may have the idea that revision surgery will restore their skin to its original condition. During the initial interview, the surgeon must explain that scar revision may take months or years to complete; that some techniques essentially replace one scar with another, rather than remove all scar tissue; and that it is difficult to predict the final results in advance. Most plastic surgeons recommend waiting at least six months, preferably a full year, for a new scar to complete the maturation phase of development. Many scars will begin to fade during this period of time, and others may respond to more conservative forms of treatment.

Good candidates for scar revision surgery are people who have a realistic understanding of its risks as well as its benefits, and equally realistic expectations of its potential outcomes. On the other hand, the following are considered psychological warning signs:

- The patient is considering scar revision surgery to please someone else—most often a spouse or partner.
- The patient has a history of multiple cosmetic procedures and/or complaints about previous surgeons.
- The patient has an unrealistic notion of what scar revision surgery will accomplish.
- The patient seems otherwise emotionally unstable.

In addition to discussing the timing and nature of treatments, the surgeon will take a careful medical history, noting whether the patient is a heavy smoker or has a family history of keloids, as well as other

disorders that may influence the healing of scar tissue. These disorders include diabetes, lupus, scleroderma, and other disorders that compromise body's immune system.

### Aftercare

Aftercare following Z-plasty or surgical removal of a scar is relatively uncomplicated. The patient is given pain medication, told to rest for a day or two at home, and advised to avoid any activities that might put tension or pressure on the new incision(s). Most patients can return to work on the third day after surgery. The most important aspect of long-term aftercare is protecting the affected area from the sun because the surgical scar will take about a year to mature and is only about 80% as strong as undamaged skin. Sunlight can cause burns, permanent redness, loss of pigment in the skin, and breakdown of the collagen that maintains the elasticity of the skin.

Aftercare following the use of skin grafts, flaps, or dermal regeneration templates begins in the hospital with standard postoperative patients care. If sutures have been used, they are usually removed three to four days after surgery on the face and five to seven days after surgery for incisions elsewhere on the body. Patients are usually asked to return to the hospital at regular intervals so that the graft sites can be monitored. If artificial skin has been used, the patients must keep the site absolutely dry, which may require special precautions or restrictions on bathing or showering.

Aftercare for some patients includes going for psychotherapy or joining a support group to deal with emotions related to disfigurement and scar treatment.

### Risks

Scar revision surgery carries the same risks as other surgical procedures under anesthesia, such as bleeding, infection at the incision site, and an adverse reaction to the anesthetic. The chief risk specific to this type of surgery is that the scar may grow, change color, or otherwise become more noticeable. Some plastic surgeons use the "90–10 rule," which means that there is a 90% chance that the scar will look better after surgery; a 9% chance that it will look about the same; and a 1% chance that it will look significantly worse.

### Normal results

Normal results of scar revision surgery and associated nonsurgical treatments are a less noticeable scar.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Scar revision surgery is a specialized procedure performed only by a qualified plastic surgeon. Plastic surgeons are physicians (with M.D. or D.O. [doctors of osteopathy]) who have completed three years of general surgical training, followed by two to three years of specialized training in plastic surgery.

Scar revision may be conducted either in a hospital or in an outpatient clinic that specializes in plastic surgery. Scar revision surgery that involves skin grafts and flaps, however, is usually done in a hospital as an inpatient procedure. Microdermabrasion, chemical peels, steroid injections, pressure wraps, and silicone treatments may be performed in the surgeon's office.

### Morbidity and mortality rates

Mortality rates for scar revision surgery are very low. Rates of complications depend on the specific technique that was used, the condition of the patient's general health, and genetic factors affecting the condition of the patient's skin.

### Alternatives

There are a number of nonsurgical treatments that can be used before, after, or in place of scar revision surgery.

#### Drugs

Medications may be used during the initial inflammatory phase of scar formation, as well as therapy for such specific skin disorders as acne. Keloids are often treated by direct injections of **corticosteroids** to reduce itching, redness, and burning; steroid treatment may also cause the keloid to shrink. Corticosteroid injections, gels, or tapes impregnated with medication are also used after scar excisions and Z-plasty to prevent recurrence or formation of hypertrophic scars. Acne scars are treated with oral **antibiotics** or isotretinoin.

#### *Massage, wraps, radiation, and nonablative treatments*

The most conservative treatments of scar tissue include several techniques that help to minimize scar formation and improve the appearance of scars that

## QUESTIONS TO ASK THE DOCTOR

- Am I a candidate for treatment by a nonsurgical method of scar revision?
- What treatment technique(s) would be best for my scar?
- How long should I wait before scar revision surgery?
- What are the risks of the specific procedures you are recommending in my case?

existing already. The simplest approach is repeated massage of the scarred area with cocoa butter or vitamin E preparations. Burn scars are treated typically with the application of pressure **dressings**, which restrict movement of the affected area and provide insulation. Another technique that is often used is silicone gel sheeting. The sheeting is applied to the scarred area, and remains for a minimum of 12 hours a day over a period of three to six months. It is effective in improving the appearance of keloids in about 85% of cases.

Keloids that do not respond to any other form of treatment may be treated with low-dose radiation therapy.

Nonablative treatments, which do not remove the epidermal layer of skin, include microdermabrasion and superficial chemical peels. Microdermabrasion, the use of which has increased widely since 2000, is a technique for smoothing the skin. During this procedure, the physician uses a handheld instrument that buffs the skin with aluminum oxide crystals; skin flakes are removed through a vacuum tube. Microdermabrasion does not remove deep wrinkles or extensive scar tissue, but can make scars somewhat less noticeable without the risk of serious side effects. Mild chemical peels, such as those made with alpha-hydroxy acid (AHA), are used sometimes to treat acne scars or uneven skin pigmentation resulting from other types of scar revision treatment.

#### *Camouflage*

Scars on the face and legs can often be covered with specially formulated cosmetics that even out the color of the surrounding skin and help to make the scar less noticeable. Some of these preparations are available in waterproof formulations for use during swimming and other athletic activities during which one perspires.

## Resources

### BOOKS

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- Cummings, CW, et al. *Otolaryngology: Head and Neck Surgery*. 4th ed. St. Louis: Mosby, 2005.
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### PERIODICALS

- Lee KK. "Surgical Revision." *Dermatologic Clinics* 23 (January 2005): 141-50.

### ORGANIZATIONS

- American Academy of Facial Plastic and Reconstructive Surgery (AAFPRS). 310 South Henry Street, Alexandria, VA 22314. (703) 299-9291. [www.facemd.org](http://www.facemd.org).
- American Burn Association. 625 North Michigan Avenue, Suite 1530, Chicago, IL 60611. (312) 642-9260. [www.ameriburn.org](http://www.ameriburn.org).
- American Society of Plastic Surgeons (ASPS). 444 East Algonquin Road, Arlington Heights, IL 60005. (847) 228-9900. [www.plasticsurgery.org](http://www.plasticsurgery.org).
- FACES: The National Craniofacial Association. P. O. Box 11082, Chattanooga, TN 37401. (800) 332-2373. [www.facescranio.org](http://www.facescranio.org).

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Rebecca Frey, Ph. D.

## Scleral buckling

### Definition

Scleral buckling is a surgical procedure in which a piece of silicone plastic or sponge is sewn onto the sclera at the site of a retinal tear to push the sclera toward the retinal tear. The buckle holds the retina against the sclera until scarring seals the tear. It also prevents fluid leakage which could cause further retinal detachment.

### Purpose

Scleral buckling is used to reattach the retina if the break is very large or if the tear is in one location. It is also used to seal breaks in the retina.

### Demographics

Retinal detachment occurs in 25,000 Americans each year. Patients suffering from retinal detachments are commonly nearsighted, have had eye surgery, experienced ocular trauma, or have a family history of retinal detachments. Retinal detachments also are common after cataract removal. White males are at a higher risk, as are people who are middle-aged or older. Patients who already have had a retinal detachment also have a greater chance for another detachment.

Some conditions, such as diabetes or Coats's disease in children, make people more susceptible to retinal detachments.

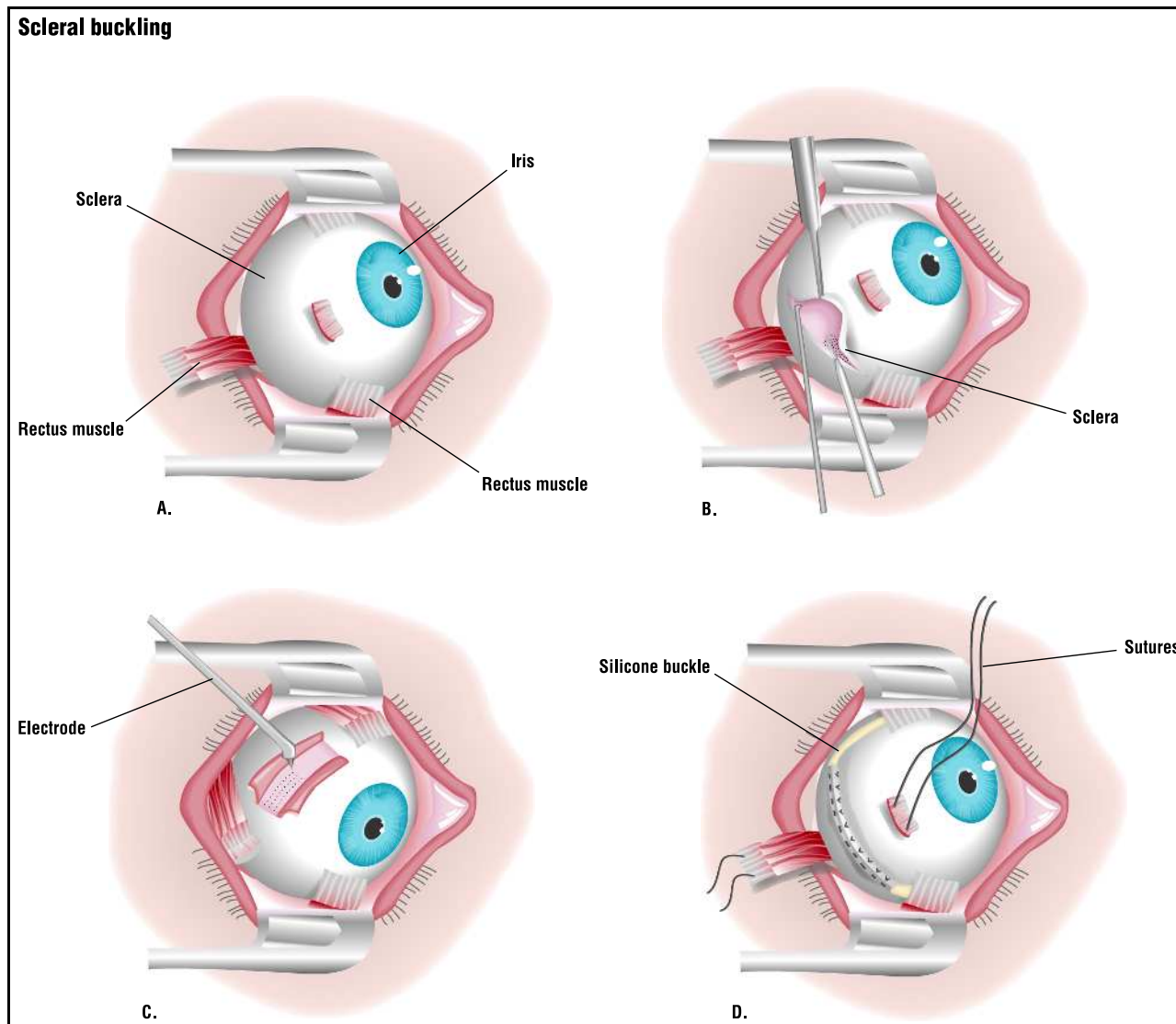
### Description

Scleral buckling is performed in an **operating room** under general or local anesthetic. Immediately before the procedure, patients are given eye drops to dilate the pupil to allow better access to the eye. The patient is given a local anesthetic. After the eye is numbed, the surgeon cuts the eye membrane, exposing the sclera. If bleeding or inflammation blocks the surgeon's view of the retinal detachment or hole, he or she may perform a vitrectomy before scleral buckling.

Vitrectomy is necessary only in cases in which the surgeon's view of the damage is hindered. The surgeon makes two incisions into the sclera, one for a light probe and the other for instruments to cut and aspirate. The surgeon uses a tiny, guillotine-like device to remove the vitreous, which he or she then replaces with saline. After the removal, the surgeon may inject air or gas to hold the retina in place.

After the surgeon is able to see the retina, he or she will perform one of two companion procedures.

- **Laser photocoagulation.** The laser is used when the retinal tear is small or the detachment is slight. The surgeon points the laser beam through a contact lens to burn the area around the retinal tear. The laser creates scar tissue that will seal the hole and prevent leakage. It requires no incision.
- **Cryopexy.** Using a freezing probe, the surgeon freezes the outer surface of the eye over the tear or detachment. The inflammation caused by the freezing leads to scar formation that seals the hole and prevents leakage. Cryopexy is used for larger holes or detachments, and for areas that may be hard to reach with a laser.



In a scleral buckling procedure, one of the eye's rectus muscles are severed to gain access to the sclera (A). The sclera is cut open (B), and an electrode is applied to the area of retinal detachment (C). A silicone buckle is threaded into place beneath the rectus muscles (D), and the severed muscle is repaired. (Illustration by GGS Information Services. Cengage Learning, Gale.)

After the surgeon has performed laser photocoagulation or cryopexy, he or she indents the affected area of the sclera with silicone. The silicone, either in the form of a sponge or buckle, closes the tear and reduces the eyeball's circumference. This reduction prevents further pulling and separation of the vitreous. Depending on the severity of the detachment or hole, a buckle may be placed around the entire eyeball.

When the buckle is in place, the surgeon may drain subretinal fluid that might interfere with the retina's reattachment. After the fluid is drained, the surgeon will suture the buckle into place and then cover it with

the conjunctiva. The surgeon then inserts an antibiotic (drops or ointment) into the affected eye and patches it.

For less severe detachments, the surgeon may choose a temporary buckle that will be removed later. Usually, however, the buckle remains in place for the patient's lifetime. It does not interfere with vision. Scleral buckles in infants, however, will need to be removed as the eyeball grows.

### Diagnosis/Preparation

Retinal detachment is considered an emergency situation. In the case of acute onset detachment, the



## KEY TERMS

**Conjunctiva**—The mucous membrane that lines the visible part of the eye and the inner eyelid.

**Glaucoma**—Disease of the eye characterized by increased pressure of the fluid inside the eye. Untreated, glaucoma can lead to blindness.

**Sclera**—The outer part of the eyeball that creates the visible white of the eye and surrounds the optic nerve at the back of the eyeball.

**Vitreous**—Between the lens and the retina, this area contains a clear jelly called the vitreous humor.

longer it takes to repair the detachment, the less chance of successful reattachment. Usually the patient sees floating spots and experiences peripheral visual field loss. Patients commonly describe the vision loss as having someone pull a shade over their eyes. In extreme cases, patients may lose vision completely.

An ophthalmologist or optometrist will take a complete medical history, including family history of retinal detachment and any recent ocular trauma. In addition to performing a general eye exam, which includes a slit lamp examination, examination of the macula and lens evaluation, physicians may perform the following tests to determine the extent of retinal detachment:

- echography
- 3-mirror contact lens/panfunduscopy
- scleral indentation

Small breaks in the retina will not require surgery, but patients with acute onset detachment require reattachment in 24–48 hours. Chronic retinal detachments should be repaired within one week.

Because this is usually an emergency procedure, there is no long-term preparation. Patients are required to fast for at least six hours before surgery.

### Aftercare

Immediately following the surgery, patients will need help with meals and walking. Some patients must remain hospitalized for several days. However, many scleral buckling procedures are performed on an outpatient basis.

After release from the hospital, patients should avoid heavy lifting or strenuous **exercise** that could increase intraocular pressure. Rapid eye movements should also be avoided; reading may be prohibited

until the surgeon gives permission. Sunglasses should be worn during the day and an eye patch at night. Pain, redness, and a scratchy sensation in the eyes also may occur after surgery. Ice packs may be applied if the conjunctiva swells. Patients may take pain medication, but should check with their physician before taking any over-the-counter medication.

Excessive pain, swelling, bleeding, discharge from the eye or decreased vision is not normal, and should immediately be reported to the physician.

If a vitrectomy was performed in conjunction with the scleral buckling, patients must sleep with their heads elevated. They also must avoid air travel until the air bubble is absorbed.

After scleral buckling, patients will use dilating, antibiotic, or corticosteroid eye drops for up to six weeks to decrease inflammation and the chance of infection. Best visual acuity cannot be determined for at least six to eight weeks after surgery. Driving may be prohibited or restricted while vision stabilizes. At the six-to-eight week postoperative visit, physicians determine if the patient needs corrective lenses or stronger prescription lenses. Full vision restoration depends on the location and severity of the detachment.

### Risks

Complications are rare but may be severe. In some instances, patients lose sight in the affected eye or lose the entire eye.

Scar tissue, even pre-existing scar tissue, may interfere with the retina's reattachment and the scleral buckling procedure may have to be repeated. Scarring, along with infection, is the most common complication.

Other possible but infrequent complications include:

- bleeding under the retina
- cataract formation
- double vision
- glaucoma
- vitreous hemorrhage

Patients may also become more nearsighted after the procedure. In some instances, although the retina reattaches, vision is not restored.

### Normal results

The National Institutes of Health reports that scleral buckling has a success rate of 85–90%. Restored vision depends largely on the location and extent of the detachment, and the length of time before the detachment was repaired. Patients with a

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Scleral buckling can be performed by a general ophthalmologist, an M.D. who specializes in treatment of the eye. Even more specialized ophthalmologists, vitreo-retinal surgeons who specialize in diseases of the retina, may be called upon for serious cases.

The surgery is usually performed in hospital settings. Because of the delicacy of the procedure, sometimes an overnight hospital stay is required. Less severe retinal detachments can be treated on an outpatient basis at surgery centers.

peripheral detachment have a quicker recovery than those patients whose detachment was located in the macula. The longer the patient waits to have the detachment repaired, the worse the prognosis.

### Morbidity and mortality rates

The danger of mortality and loss of vision depends on the cause of the retinal detachment. Patients with Marfan syndrome, pre-eclampsia, and diabetes, for example, are more at risk during the scleral buckling procedure than a patient in relatively good health. The risk of surgery also rises with the use of **general anesthesia**. Scleral buckling, however, is considered a safe, successful procedure.

Severe infections that are left untreated can cause vision loss, but following the prescribed regimen of eye drops and follow-up treatment by the physician greatly minimizes this risk.

### Alternatives

Vitrectomy is sometimes performed alone to treat retinal detachments. Laser photocoagulation and cryopexy also may be used to treat less serious tears. The more common alternative, however, is pneumatic retinopexy, which is used when the tear is located in the upper portion of the eye. The surgeon uses cryopexy to freeze the area around the tear, then removes a small amount of fluid. When the fluid is drained and the eye softened, the surgeon injects a gas bubble into the vitreous cavity. As the gas bubble expands, it seals the retinal tear by pushing the retina against the choroid. Eventually, the bubble will be absorbed.

## QUESTIONS TO ASK THE DOCTOR

How many scleral buckling procedures have you performed?

Could other treatments be an option?

Will I have to stay in the hospital?

Will my sight be completely restored?

What is the probability of having another retinal detachment in the same eye?

Am I likely to have a retinal detachment in my unaffected eye?

The patient is required to remain in a certain position for at least a few days after surgery while the bubble helps seal the hole. Pneumatic retinopexy also is not as successful as scleral buckling. Complications include recurrent retinal detachments and the chance of gas getting under the retina.

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American Academy of Ophthalmology. PO Box 7424, San Francisco, CA 94120 7424. (415) 561 8500. <http://www.aaao.org>.

American Board of Ophthalmology. 111 Presidential Boulevard, Suite 241, Bala Cynwyd, PA 19004 1075. (610) 664 1175. [info@abop.org](mailto:info@abop.org). <http://www.abop.org>.

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Mary Bekker

## Sclerostomy

### Definition

A sclerostomy is a procedure in which the surgeon makes a small opening in the outer covering of the eyeball to reduce intraocular pressure (IOP) in patients with open-angle glaucoma. It is classified as a type of glaucoma filtering surgery. The name of the surgery comes from the Greek word for “hard,” which describes the tough white outer coat of the eyeball, and the Greek word for “cutting” or “incision.”

### Purpose

Sclerostomies are usually performed to reduce IOP in open-angle glaucoma patients who have not been helped by less invasive forms of treatment, specifically medications and **laser surgery**. In some cases—most commonly patients who are rapidly losing their vision or who cannot tolerate glaucoma medications—an ophthalmologist (eye specialist) may recommend a sclerostomy without trying other forms of treatment first.

As of 2003, glaucoma is not considered a single disease but rather a group of diseases characterized by three major characteristics: elevated intraocular pressure (IOP) caused by an overproduction of aqueous humor in the eye or by resistance to the normal outflow of fluid; atrophy of the optic nerve; and a resultant loss of visual field. A sclerostomy works to reduce the IOP by improving the outflow of aqueous humor. Between 80% and 90% of aqueous humor leaves the eye through the trabecular meshwork while the remaining 10–20% passes through the ciliary muscle bundles. A sclerostomy allows the fluid to collect under the conjunctiva, which is the thin membrane lining the eyelids, to form a filtration bleb.

### Demographics

In 1995, the World Health Organization (WHO) reported that over five million people around the world have lost their sight due to complications of glaucoma; about 120,000 Americans are blind as a result of glaucoma. According to the National Eye Institute (NEI), nearly three million people in the United States have the disorder; however, nearly half are unaware that they have it. Primary open-angle glaucoma (POAG) accounts for 60–70% of cases. “Primary” means that the glaucoma is not associated with a tumor, injury to the eye, or other eye disorder.

Although glaucoma can occur at any age, it is most common in adults over 35. One major study reported that less than 1% of the United States population between 60 and 64 suffer from POAG. The rate rises to 1.3% for persons between 70 and 74, however, and rises again to 3% for persons between 80 and 84.

With regard to race, African-Americans are four times as likely to develop glaucoma as Caucasians, and six to eight times more likely to lose their sight to the disease. African Americans also develop glaucoma at earlier ages; while everyone over age 60 is at increased risk for POAG, the risk for African Americans rises sharply after age 40. A 2001 study reported that the rate for Mexican Americans lies between the rate of POAG in African Americans and that in Caucasians. Mexican Americans, however, are more likely to suffer from undiagnosed glaucoma—62% as compared to 50% for other races and ethnic groups in the United States. In addition, the rate of POAG in Mexican Americans was found to rise rapidly after age 65; in the older age groups, it approaches the rates reported for African Americans. Among Caucasians, people of Scandinavian, Irish, or Russian ancestry are at higher risk of glaucoma than people from other ethnic groups.

The question of a sex ratio in open-angle glaucoma is debated. Three studies done in the United States between 1991 and 1996 reported that the male to female ratio for open-angle glaucoma is about one to one. Three other studies carried out in the United States, Barbados, and the Netherlands, however, found that the male to female ratio was almost two to one. A 2002 study from western Africa reported a male to female ratio of 2.26 to one. It appears that further research is needed in this area.

### Description

Most sclerostomies are performed as outpatient procedures under **local anesthesia**. In some cases the

## KEY TERMS

**Angle**—The open point in the anterior chamber of the eye at which the iris meets the cornea.

**Aqueous humor**—The watery fluid produced in the eye that ordinarily leaves the eye through the angle of the anterior chamber and Schlemm's canal.

**Atrophy**—Wasting away or degeneration. Atrophy of the optic nerve is one of the defining characteristics of glaucoma.

**Bleb**—A thin-walled auxiliary drain created on the outside of the eyeball during filtering surgery for glaucoma. It is sometimes called a filtering bleb.

**Conjunctiva**—The thin membrane that lines the eyelids and covers the visible surface of the sclera.

**Cornea**—The transparent front portion of the exterior cover of the eye.

**Endophthalmitis**—An infection on the inside of the eye, which may result from an infected bleb. Endophthalmitis can result in vision loss.

**Glaucoma**—A group of eye disorders characterized by increased fluid pressure inside the eye that eventually damages the optic nerve. As the cells in the optic nerve die, the patient gradually loses vision.

**Gonioscopy**—A technique for examining the angle between the iris and the cornea with the use of a special mirrored lens applied to the cornea.

**Hyphema**—Blood inside the anterior chamber of the eye. Hyphema is one of the risks associated with sclerostomies.

**Hypotony**—Intraocular fluid pressure that is too low.

**Insidious**—Developing in a stealthy and inconspicuous way. Open-angle glaucoma is an insidious disorder.

**Ocular hypertension**—A condition in which fluid pressure inside the eye is higher than normal but the optic nerve and visual fields are normal.

**Open-angle glaucoma**—A form of glaucoma in which fluid pressure builds up inside the eye even though the angle of the anterior chamber is open and looks normal when the eye is examined with a gonioscope. Most cases of glaucoma are open-angle.

**Ophthalmology**—The branch of medicine that deals with the diagnosis and treatment of eye disorders.

**Peripheral vision**—The outer portion of the visual field.

**Schlemm's canal**—A circular channel located at the point where the sclera of the eye meets the cornea. Schlemm's canal is the primary pathway for aqueous humor to leave the eye.

**Sclera**—The tough white fibrous membrane that forms the outermost covering of the eyeball.

**Tonometry**—Measurement of the fluid pressure inside the eye.

**Trabecular meshwork**—The main drainage passageway for fluid to leave the anterior chamber of the eye.

**Visual field**—The total area in which one can see objects in one's peripheral vision while the eyes are focused on a central point.

patient may be given an intravenous sedative to help him or her relax before the procedure.

### *Conventional sclerostomy*

After the patient has been sedated, the surgeon injects a local anesthetic into the area around the eye as well as a medication to prevent eye movement. Using very small instruments with the help of a microscope, the surgeon makes a tiny hole in the sclera as a passageway for aqueous humor. Some surgeons use an erbium YAG laser to create the hole. Most surgeons apply an antimetabolite drug during the procedure to minimize the risk that the new drainage channel will be closed by tissue regrowth. The most common antimetabolites that are used are mitomycin and 5-fluorouracil.

After the surgery, the aqueous humor begins to flow through the sclerostomy hole and forms a small blister-like structure on the upper surface of the eye. This structure is known as a bleb or filtration bleb, and is covered by the eyelid. The bleb allows the aqueous humor to leave the eye in a controlled fashion.

### *Enzymatic sclerostomy*

A newer technique that was first described in 2002 is enzymatic sclerostomy, which was developed at the Weizmann Institute of Science in Israel. In enzymatic sclerostomy, the surgeon applies an enzyme called collagenase to the eye to increase the release of aqueous humor. The collagenase is applied through an applicator that is attached to the eye with tissue **glue** for 22–24 hours and then removed.



According to the researchers, the procedure reduced the intraocular pressure in all patients immediately following the procedure and in 80% of the subjects at one-year follow-up. None of the patients developed systemic complications. Enzymatic sclerostomy is considered experimental as of mid-2003.

## Diagnosis/Preparation

### Diagnosis

Open-angle glaucoma is not always diagnosed promptly because it is insidious in onset, which means that it develops slowly and gradually. Unlike closed-angle glaucoma, open-angle glaucoma rarely has early symptoms. It is usually diagnosed either in the course of an eye examination or because the patient has noticed that they are having problems with their peripheral vision—that is, they are having trouble seeing objects at the side or out of the corner of the eye. In some cases the patient notices that he or she is missing words while reading; having trouble seeing stairs or other objects at the bottom of the visual field; or having trouble seeing clearly when driving. Other symptoms of open-angle glaucoma may include headaches, seeing haloes around lights, or difficulty adjusting to darkness. It is important to diagnose open-angle glaucoma as soon as possible because the vision that has been already lost cannot be recovered. Although open-angle glaucoma cannot be cured, it can be stabilized and controlled in almost all patients. Because of the importance of catching open-angle glaucoma as early as possible, adults should have their eyes examined every two years at least.

**HIGH-RISK GROUPS.** Not everyone is at equal risk for glaucoma. People with any of the risk factors listed below should consult their doctor for advice about the frequency of eye checkups:

- Age over 40 (African Americans) or over 60 (other races and ethnic groups).
- Ocular hypertension. The normal level of IOP is between 11 mm Hg and 21 mm Hg. It is possible for people to have an IOP above 21 mm Hg without signs of damage to the optic nerve or loss of visual field; this condition is referred to as ocular hypertension. Conversely, about one out of six of patients diagnosed with open-angle glaucoma have so-called normal-tension glaucoma, which means that their optic nerve is being damaged even though their IOP is within the “normal” range. Ocular hypertension does, however, increase a person’s risk of developing glaucoma in the future.
- Family history of glaucoma in a first-degree relative. As of 2003, at least six different genes related to glaucoma have been identified.

- An unusually thin cornea (the clear front portion of the outer cover of the eye). A recent National Eye Institute (NEI) study found that patients whose corneas are thinner than 555 microns are three times as likely to develop glaucoma as those whose corneas are thicker than 588 microns.
- Extreme nearsightedness. People who are very nearsighted are two to three times more likely to develop glaucoma than those who are not nearsighted.
- Diabetes.
- History of traumatic injury to the eye or surgery for other eye disorders.
- Use of steroid medications.
- Migraine headaches or sleep-related breathing disorder.
- Male sex.

Some patients should not be treated with filtration surgery. Contraindications for a sclerostomy include cardiovascular disorders and other severe systemic medical problems; eyes that are already blind; or the presence of an intraocular tumor or bleeding in the eye.

**DIAGNOSTIC TESTS.** Ophthalmologists use the following tests to screen patients for open-angle glaucoma:

- Tonometry. Tonometry is a painless procedure for measuring IOP. One type of tonometer blows a puff of pressurized air toward the patient’s eye as the patient sits near a lamp; it measures the changes in the light reflections on the patient’s corneas. Another method of tonometry involves the application of a local anesthetic to the outside of the eye and touching the cornea briefly with an instrument that measures the fluid pressure directly.
- Visual field test. This test measures loss of peripheral vision. In the simplest version of this test, the patient sits directly in front of the examiner with one eye covered. The patient looks at the examiner’s eye and indicates when he or she can see the examiner’s hand. In the automated version, the patient sits in front of a hollow dome and looks at a central target inside the dome. A computer program flashes lights at intervals at different locations inside the dome, and the patient presses a button whenever he or she sees a light. At the end of the test, the computer prints an assessment of the patient’s responses.
- Gonioscopy. Gonioscopy measures the size of the angle in the anterior chamber of the eye with the use of a special mirrored contact lens. The examiner numbs the outside of the eye with a local anesthetic and touches the outside of the cornea with the gonioscopic lens. He or she can use a slit lamp to magnify

what appears on the lens. Gonioscopy is necessary in order to distinguish between open- and closed-angle glaucoma; it can also distinguish between primary and many secondary glaucomas.

- **Ophthalmoscopic examination of the optic nerve.** An ophthalmoscope is an instrument that contains a perforated mirror as well as magnifying lenses. It allows the examiner to view the interior of the eye. If the patient has open-angle glaucoma, the examiner can see a cup-shaped depression in the optic disk.

Newer diagnostic devices include a laser-scanning microscope known as the Heidelberg retinal tomograph (HRT) and **ultrasound** biomicroscopy (UBM). UBM has proved to be a useful method of long-term follow-up of sclerostomies.

### **Preparation**

Preparation for a sclerostomy begins with the patient's decision to undergo incisional surgery rather than continuing to take medications or having repeated laser procedures. Three factors commonly influence the decision: the present extent of the patient's visual loss; the speed of visual deterioration; and the patient's life expectancy.

With regard to the procedure itself, patients may be asked to take oral antibiotic and anti-inflammatory medications for several days prior to surgery.

### **Aftercare**

Patients can use their eyes after filtering surgery, although they should have a friend or relative to drive them home after the procedure. They can go to work the next day, although they will probably notice some blurring of vision in the operated eye for about a month. Patients can carry out their normal activities with the exception of heavy lifting, although they should not drive until their vision has completely cleared. Most ophthalmologists recommend that patients wear their eyeglasses during the day and tape an eye shield over the operated eye at night. They should apply eye drops prescribed by the ophthalmologist to prevent infection, manage pain, and reduce swelling. They should also avoid rubbing, bumping, or getting water into the operated eye. Complete recovery after filtering surgery usually takes about six weeks. Long-term aftercare includes avoiding damage to or infection of the bleb.

It is important for patients recovering from filtering surgery to see their doctor for frequent checkups in the first few weeks following surgery. In most cases the ophthalmologist will check the patient's eye the day after surgery and about once a week for the next several weeks.

### **Risks**

The risks of a sclerostomy include the following:

- **Infection.** Infections may develop in the bleb (blebitis), but may spread to the interior of the eye (endophthalmitis). The symptoms of an infection include pain and redness in the eye, blurred vision, teariness, and a discharge. Infections must be treated promptly, as they can lead to loss of vision.
- **Hyphema.** Hyphema refers to the presence of blood inside the anterior chamber of the eye. Hyphemas are most common within the first two to three days after surgery and are usually treated with corticosteroid medications to reduce inflammation.
- **Suprachoroidal hemorrhage.** A suprachoroidal hemorrhage, or massive bleeding behind the retina, is a serious complication that can occur during as well as after eye surgery.
- **Cataract formation.**
- **Hypotony (low IOP).** If hypotony is not corrected, it can lead to failure of the bleb and eventual cataract formation.
- **Loss of central vision.** This is a very rare complication.
- **Bleb leak or failure.** Blebs can develop leaks at any time from several days after surgery to years later. Bleb failure usually results from inadequate control of the intraocular pressure and a new obstruction of aqueous humor outflow.
- **Closing of the opening in the sclera by new tissue growth.** A sclerostomy can be repeated if necessary.

### **Normal results**

According to the National Eye Institute, sclerostomy is 80–90% effective in lowering intraocular pressure. The success rate is highest in patients who have not had previous eye surgery.

### **Morbidity and mortality rates**

Mortality following a sclerostomy is very low because the majority of procedures are performed under local anesthesia. The most common complications of filtering surgery are cataract formation (30% of patients develop cataracts within five years of a sclerostomy) and closure of the drainage opening requiring additional surgery (10–15% of patients). Bleeding or infection occur in less than 1% of patients.

### **Alternatives**

#### ***Nonpenetrating deep sclerectomy***

There are two surgical alternatives to sclerostomy that are called nonpenetrating deep sclerectomies

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Sclerostomies are performed by ophthalmologists, who are physicians who have completed four to five years of specialized training following medical school in the medical and surgical treatment of eye disorders. Ophthalmology is one of 24 specialties recognized by the American Board of Medical Specialties.

Sclerostomies are usually done as outpatient procedures, either in the ophthalmologist's office or in an ambulatory surgery center; however, they may also be performed in a hospital with sedation as well as local anesthesia.

because they do not involve entering the anterior chamber of the eye. The first alternative, viscocanalostomy, is a procedure that involves creating a window in Descemet's membrane (a layer of tissue in the cornea) to allow aqueous humor to leave the anterior chamber; and injecting a viscoelastic substance into Schlemm's canal, which is the main pathway for aqueous humor to leave the eye. The viscoelastic helps to keep the canal from scarring shut following surgery.

The second type of nonpenetrating surgery involves implanting a device called the Aquaflow® collagen wick about 0.8 in (2 cm) long under the sclera. The wick keeps open a space created by the surgeon to allow drainage of the aqueous humor. The wick is made of a material that is absorbed by the body within six to nine months, but the drainage pathway remains open after the wick is absorbed. The Aquaflow wick was approved by the Food and Drug Administration (FDA) in July 2001.

Both types of nonpenetrating deep sclerectomies allow patients to recover faster, with fewer complications than traditional sclerostomies. Their drawbacks include a lower success rate and the need for additional procedures to control the patient's IOP. Visco-canalostomy in particular is not as effective in reducing IOP levels as traditional filtering surgery.

### ***Complementary and alternative (CAM) approaches***

Bilberry (European blueberry) extract has been recommended as improving night vision; it was given to pilots during World War II for this reason. There is evidence that 80–160 mg of bilberry extract taken

## QUESTIONS TO ASK THE DOCTOR

- How many sclerostomies have you performed?
- Do you prefer using miniature instruments or a laser, and why?
- What are my chances of developing a cataract if I have this procedure?
- Would you recommend nonpenetrating surgery? Why or why not?

three times a day does improve night vision temporarily. The plant does not have any serious side effects, but it should not be used in place of regular eye examinations or other treatments for glaucoma.

People who support the medicinal use of marijuana have argued that cannabinoids, the active chemical compounds found in the plant, lower intraocular pressure in patients with glaucoma. According to the Glaucoma Research Foundation, however, very high doses of marijuana are required to produce any significant effect on IOP. A Canadian researcher has concluded that the effects of cannabinoids on IOP "...are not sufficiently strong, long lasting or reliable to provide a valid basis for therapeutic use [of marijuana]."

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- American Academy of Ophthalmology. P.O. Box 7424, San Francisco, CA 94120 7424. (415) 561 8500. <http://www.aao.org>.
- American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991 4100.
- Canadian Ophthalmological Society (COS). 610 1525 Carling Avenue, Ottawa ON K1Z 8R9. <http://www.eyesite.ca>.
- (The) Glaucoma Foundation. 116 John Street, Suite 1605, New York, NY 10038. (212) 285 0080 or (800) 452 8266. <http://www.glaucoma-foundation.org>.
- Glaucoma Research Foundation. 490 Post Street, Suite 1427, San Francisco, CA 94102. (415) 986 3162 or (800) 826 6693. <http://www.glaucoma.org>.
- National Eye Institute. 2020 Vision Place, Bethesda, MD 20892 3655. (301) 496 5248. <http://www.nei.nih.gov>.
- Prevent Blindness America. 500 East Remington Road, Schaumburg, IL 60173. (800) 331 2020. <http://www.prevent-blindness.org>.
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## Sclerotherapy for esophageal varices

### Definition

Sclerotherapy for esophageal varices, also called endoscopic sclerotherapy, is a treatment for esophageal bleeding that involves the use of an endoscope and the injection of a sclerosing solution into veins.

### Purpose

Esophageal varices are enlarged or swollen veins on the lining of the esophagus which are prone to bleeding. They are life-threatening; each episode of bleeding carries a 20-30% risk of **death**. 70% of patients who do not receive treatment for their varices die of bleeding within a year of their first episode of bleeding. Esophageal varices are a complication of portal hypertension, a condition characterized by increased blood pressure in the portal vein resulting from liver disease, such as cirrhosis. Increased pressure causes the veins to balloon outward. The vessels may rupture, causing vomiting of blood and bloody stools.

In most hospitals, sclerotherapy for esophageal varices is the treatment of choice to stop esophageal bleeding during acute episodes, and to prevent further incidences of bleeding. Emergency sclerotherapy is often followed by preventive treatments to eradicate distended esophageal veins.

### Demographics

Bleeding esophageal varices are a serious complication of liver disease. In the United States, at least 50% of people who survive bleeding esophageal varices are at risk of recurrent bleeding during the next one to two years.



## KEY TERMS

**Cirrhosis**—A chronic degenerative liver disease causing irreversible scarring of the liver.

**Endoscope**—An instrument used to examine the inside of a canal or hollow organ. Endoscopic surgery is less invasive than traditional surgery.

**Esophagus**—The part of the digestive canal located between the pharynx (part of the digestive tube) and the stomach. Also called the food pipe.

**Portal hypertension**—Abnormally high pressure within the veins draining into the liver.

**Sclerosant**—An irritating solution that stops bleeding by hardening the blood or vein it is injected into.

**Varices**—Swollen or enlarged veins, in this case on the lining of the esophagus.

## Description

Sclerotherapy for esophageal varices involves injecting a strong and irritating solution (a sclerosant) into the veins and/or the area beside the distended vein. Sclerosant injected directly into the vein causes blood clots to form and stops the bleeding, while sclerosant injected into the area beside the distended vein stops the bleeding by thickening and swelling the vein to compress the blood vessel. Most physicians inject the sclerosant directly into the vein, although injections into the vein and the surrounding area are both effective. Once bleeding has been stopped, the treatment can be used to significantly reduce or destroy the varices.

Sclerotherapy for esophageal varices is performed with the patient awake but sedated. Hyoscine butylbromide (Buscopan) may be administered to freeze the esophagus, making injection of the sclerosant easier. During the procedure, an endoscope is passed through the patient's mouth to the esophagus to allow the surgeon to view the inside. The branches of the blood vessels at or just above where the stomach and esophagus come together, the usual site of variceal bleeding, are located. After the bleeding vein is identified, a long, flexible sclerotherapy needle is passed through the endoscope. When the tip of the needle's sheath is in place, the needle is advanced, and the sclerosant is injected into the vein or the surrounding area. The most commonly used sclerosants are ethanolamine and sodium tetradecyl sulfate. The needle is withdrawn. The procedure is repeated as many times as necessary to eradicate all distended veins.

## Diagnosis/Preparation

A radiologist assesses patients for sclerotherapy based on blood work and liver imaging studies performed using **CT scans**, **ultrasound**, or MRI scans, and in consultation with the treating gastroenterologist, hepatologist, or surgeon. Tests to localize bleeding and detect active bleeding are also performed.

Before a sclerotherapy procedure, the patient's **vital signs** and other pertinent data are recorded, an intravenous line is inserted to administer fluid or blood, and a sedative is prescribed.

## Aftercare

After sclerotherapy for esophageal varices, the patient will be observed for signs of blood loss, lung complications, fever, a perforated esophagus, or other complications. Vital signs are monitored, and the intravenous line maintained. Pain medication is usually prescribed. After leaving the hospital, the patient follows a diet prescribed by the physician, and, if appropriate, can take mild pain relievers.

## Risks

Risks associated with sclerotherapy include complications that can arise from use of the sclerosant or from the endoscopic procedure. Minor complications, which cause discomfort but do not require active treatment or prolonged hospitalization, include transient chest pain, difficulty swallowing, and fever, which usually go away after a few days. Some patients may have allergic reactions to the sclerosant solution. Infection occurs in up to 50% of cases. In 2-10% of patients, the esophagus tightens, but this can usually be treated with dilatation. More serious complications may occur in 10-15% of patients. These include perforation or bleeding of the esophagus and lung problems, such as aspiration pneumonia. Long-term sclerotherapy can also damage the esophagus, and increase the patient's risk of developing cancer.

Patients with advanced liver disease complicated by bleeding are very poor risks for this procedure. The surgery, premedications, and anesthesia may be sufficient to tip the patient into protein intoxication and hepatic coma. The blood in the bowels acts like a high-protein meal and may induce protein intoxication.

## Normal results

Normal sclerotherapy results include the control of acute bleeding if present and the shrinking of the esophageal varices.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Sclerotherapy for esophageal varices is performed by a surgeon specialized in gastroenterology or hepatology in a hospital setting, very often as an emergency procedure.

### Morbidity and mortality rates

Sclerotherapy for esophageal varices has a 20–40% incidence of complications and a 1–2% mortality rate. The procedure controls acute bleeding in about 90% of patients, but it may have to be repeated within the first 48 hours to achieve this success rate. During the initial hospitalization, sclerotherapy is usually performed two or three times. Preventive treatments are scheduled every few weeks or so, depending on the patient's risk level and healing rate. Several studies have shown that the risk of recurrent bleeding is much lower in patients treated with sclerotherapy: 30–50% as opposed to 70–80% for patients not treated with sclerotherapy.

### Alternatives

Pharmacological agents are also used in the treatment of esophageal varices. Drugs such as vasopressin and somatostatin are administered to actively bleeding patients on admission, while propranolol, nadolol or subcutaneous octreotide are used to prevent subsequent bleeding after successful endoscopic variceal eradication. Vasopressin or vasopressin with nitroglycerin has been proven effective in the acute control of variceal hemorrhage. Somatostatin is more effective in the control of active bleeding when compared to vasopressin, glypressin, endoscopic sclerotherapy or balloon tamponade. Octreotide has comparable outcomes to vasopressin, terlipressin or endoscopic sclerotherapy. **Liver transplantation** should be considered as an alternative for patients with bleeding varices from liver disease.

Another alternative treatment is provided by Transjugular intrahepatic portal-systemic shunting (TIPS). In TIPS, a catheter fitted with a stent, a wire mesh tube used to prop open a vein or artery, is inserted through a vein in the neck into the liver. Under x ray guidance, the stent is placed in an optimal position within the liver so as to allow blood to flow more easily through the portal vein. This treatment reduces the excess pressure in the

## QUESTIONS TO ASK THE DOCTOR

- What are esophageal varices?
- Are there alternatives to sclerotherapy?
- How do I prepare for surgery?
- What type of anesthesia will be used?
- How is the surgery performed?
- How long will I be in the hospital?
- How many sclerotherapy procedures do you perform in a year?

esophageal varices, and thus decreases the risk of recurrent bleeding.

### Resources

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Society of American Gastrointestinal Endoscopic Surgeons (SAGES). 2716 Ocean Park Boulevard, Suite 3000, Santa Monica, CA 90405. (310) 314 2404. <http://www.sages.org>.

#### OTHER

SAGES: The Role of Endoscopic Sclerotherapy. [http://www.sages.org/sg\\_asgepub1019.html](http://www.sages.org/sg_asgepub1019.html).

Lori De Milto  
Monique Laberge, Ph.D.

## Sclerotherapy for varicose veins

### Definition

Sclerotherapy, which takes its name from a Greek word meaning “hardening,” is a method of treating enlarged veins by injecting an irritating chemical called a sclerosing agent into the vein. The chemical causes the vein to become inflamed, which leads to the formation of fibrous tissue and closing of the lumen, or central channel of the vein.

### Purpose

Sclerotherapy in the legs is performed for several reasons. It is most often done to improve the appearance of the legs, and is accomplished by closing down spider veins—small veins in the legs that have dilated under increased venous blood pressure. A spider vein is one type of telangiectasia, which is the medical term for a reddish-colored lesion produced by the permanent enlargement of the capillaries and other small blood vessels. The word telangiectasia comes from three Greek words that mean “end,” “blood vessel,” and “stretch out.” In a spider vein, also called a “sunburst varicosity,” there is a central reddish area that is visible to the eye because it lies close to the surface of the skin; smaller veins spread outward from it in the shape of a spider’s legs. Spider veins may also appear in two other common patterns—they may look like tiny tree branches or like extra-fine separate lines.

In addition to the cosmetic purposes sclerotherapy serves, it is also performed to treat the soreness, aching, muscle fatigue, and leg cramps that often accompany small- or middle-sized varicose veins in the legs. It is not, however, used by itself to treat large varicose veins.

Because sclerotherapy is usually considered a cosmetic procedure, it is usually not covered by health insurance. People who are being treated for cramps and discomfort in their legs, however, should ask their insurance companies whether they are covered for sclerotherapy. Sclerotherapy costs usually reflect the number of syringes of sclerosant required; the average cost of each syringe is \$225. Many procedures will require the use of two syringes of sclerosant. The average cost is \$326.

Sclerotherapy as a general treatment modality is also performed to treat hemorrhoids (swollen veins) in the esophagus.

### Demographics

The American College of Phlebology (ACP), a group of dermatologists, plastic surgeons, gynecologists, and general surgeons with special training in the treatment of venous disorders, comments that about 60% of all people in the United States suffer from spider veins or varicose veins. Women are more commonly affected than men, with about half of all women experiencing some type of vein disorder. The American Society of Plastic Surgeons (ASPS) estimates that more than 40% of women over 50 in the United States have spider veins.

Women are more likely to develop spider veins than men, but the incidence among both sexes increases with age. The results of a recent survey of middle-aged and elderly people in San Diego, California, show that 80% of the women and 50% of the men had spider veins. Men are less likely to seek treatment for spider veins for cosmetic reasons, however, because the discoloration caused by spider veins is often covered by leg hair. On the other hand, men who are bothered by aching, burning sensations or leg cramps can benefit from sclerotherapy.

According to the ASPS, there were 559,285 sclerotherapy procedures performed in the United States in 2006. Most people who are treated with sclerotherapy are between the ages of 30 and 60.

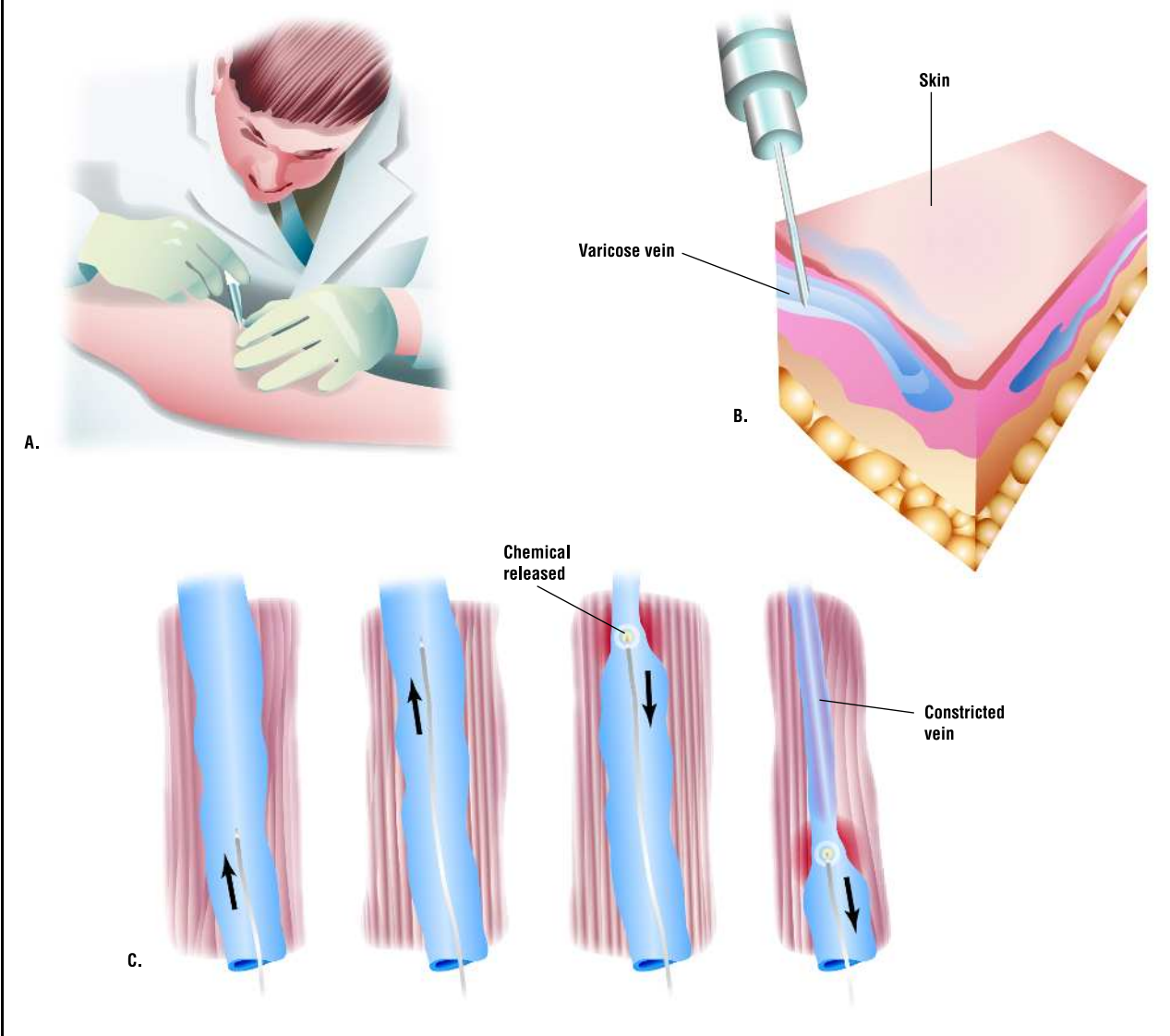
Spider veins are most noticeable and common in Caucasians. Hispanics are less likely than Caucasians but more likely than either African or Asian Americans to develop spider veins.

### Description

#### *Causes of spider veins*

To understand how sclerotherapy works, it is helpful to begin with a brief description of the venous system in the human body. The venous part of the circulatory system returns blood to the heart to be pumped to the lungs for oxygenation. This is in contrast to the arterial system, which carries oxygenated blood away from the heart to be distributed throughout the body. The smallest parts of the venous system are the capillaries, which feed into larger superficial veins. All superficial veins lie between the skin and a layer of fibrous connective tissue called fascia, which covers and supports the muscles and the internal organs. The deeper veins of the body lie within the muscle fascia. This distinction helps to explain why superficial veins can be treated by sclerotherapy without damage to the larger veins.

## Sclerotherapy for varicose veins



During sclerotherapy for the treatment of varicose veins, the doctor injects a chemical solution directly into the vein (A and B). The needle travels up the vein, and as it is pulled back, the chemical is released, causing the vein to form fibrous tissue that collapses the inside of it (C). (Illustration by GGS Information Services. Cengage Learning, Gale.)

Veins contain one-way valves that push blood inward and upward toward the heart when they are functioning normally. The blood pressure in the superficial veins is usually low, but if it rises and remains at a higher level over a period of time, the valves in the veins begin to fail and the veins dilate, or expand. Veins that are not functioning properly are said to be “incompetent.” As the veins expand, they become more noticeable because they lie closer to the

surface of the skin, forming the typical patterns seen in spider veins.

Some people are at greater risk for developing spider veins. These risk factors include:

- Sex. Females in any age group are more likely than males to develop spider veins.
- Genetic factors. Some people have veins with abnormally weak walls or valves. They may develop spider



## KEY TERMS

**Arteriole**—A very small branch of an artery, usually close to a capillary network.

**Edema**—The presence of abnormally large amounts of fluid in the soft tissues of the body.

**Electrodesiccation**—A method of treating spider veins or drying up tissue by passing a small electric current through a fine needle into the affected area.

**Hemosiderin**—A form of iron that is stored inside tissue cells. The brownish discoloration of skin that sometimes occurs after sclerotherapy is caused by hemosiderin.

**Hirsutism**—Abnormal hair growth on the part of the body treated by sclerotherapy. It is also called hypertrichosis.

**Incompetent**—In a medical context, insufficient. An incompetent vein is one that is not performing its function of carrying blood back to the heart.

**Lumen**—The channel or cavity inside a tube or hollow organ of the body.

**Palpation**—Examining by touch as part of the process of physical diagnosis.

**Percussion**—Thumping or tapping a part of the body with the fingers for diagnostic purposes.

**Phlebology**—The study of veins, their disorders, and their treatments. A phlebologist is a doctor who specializes in treating spider veins, varicose veins, and associated disorders.

**Sclerose**—To harden or undergo hardening. Sclerosing agents are chemicals that are used in sclerotherapy to cause swollen veins to fill with fibrous tissue and close down.

**Spider nevus (plural, nevi)**—A reddish lesion that consists of a central arteriole with smaller branches radiating outward from it. Spider nevi are also called spider angiomas; they are most common in small children and pregnant women.

**Spider veins**—Telangiectasias that appear on the surface of the legs, characterized by a reddish central point with smaller veins branching out from it like the legs of a spider.

**Telangiectasia**—The medical term for the visible discolorations produced by permanently swollen capillaries and smaller veins.

**Varicose**—Abnormally enlarged and distended.

veins even without a rise in blood pressure in the superficial veins.

- **Pregnancy.** A woman's total blood volume increases during pregnancy, which increases the blood pressure in the venous system. In addition, the hormonal changes of pregnancy cause the walls and valves in the veins to soften.
- **Using birth control pills.**
- **Obesity.** Excess body weight increases pressure on the veins.
- **Occupational factors.** People whose jobs require standing or sitting for long periods of time without the opportunity to walk or move around are more likely to develop spider veins than people whose jobs allow more movement.
- **Trauma.** Falls, deep bruises, cuts, or surgical incisions may lead to the formation of spider veins in or near the affected area.

As of 2008, there is no known method to prevent the formation of spider veins.

### *Sclerotherapy procedures*

In typical outpatient sclerotherapy treatment, the patient changes into a pair of shorts at the doctor's office and lies on an examination table. After cleansing the skin surface with an antiseptic, the doctor injects a sclerosing agent into the veins. This agent is eliminated when the skin is stretched tightly over the area with the other hand. The doctor first injects the larger veins in each area of the leg, then the smaller ones. In most cases, one injection is needed for every inch of spider vein; a typical treatment session will require five to 40 separate injections. No anesthetic is needed for sclerotherapy, although the patient may feel a mild stinging or burning sensation at the injection site.

The liquid sclerosing agents that are used most often to treat spider veins are polidocanol (aethoxysklerol), sodium tetradecyl sulfate, and saline solution at 11.7% concentration. Some practitioners prefer to use saline because it does not cause allergic reactions. The usual practice is to use the lowest concentration of the chemical that is still effective in closing the veins.

A newer type of sclerosing agent is a foam instead of a liquid chemical that is injected into the veins. The foam has several advantages: It makes better contact with the wall of the vein than a liquid sclerosing agent; it allows the use of smaller amounts of chemical; and its movement in the vein can be monitored on an **ultrasound** screen. Sclerosing foam has been shown to have a high success rate with a lower cost, and causes fewer major complications.

After all the veins in a specific area of the leg have been injected, the doctor covers the area with a cotton ball or pad and compression tape. The patient may be asked to wait in the office for 20–30 minutes after the first treatment session to ensure that there is no hypersensitivity to the sclerosing chemicals. Most sclerotherapy treatment sessions are short, lasting from 15 to 45 minutes.

It is not unusual for patients to need a second treatment to completely eliminate the spider veins; however, it is necessary to wait four to six weeks between procedures.

## Diagnosis/Preparation

### *Diagnosis*

The most important aspect of diagnosis prior to undergoing sclerotherapy is distinguishing between telangiectasias and large varicose veins, and telangiectasias and spider nevi. Because sclerotherapy is intended to treat only small superficial veins, the doctor must confirm that the patient does not have a more serious venous disorder.

Spider nevi, which are also called “spider angiomas,” are small, benign reddish lesions that consist of a central arteriole, which is a very small branch of an artery with smaller vessels radiating from it. Although the names are similar, spider nevi occur in the part of the circulatory system that carries blood (away) from the heart, whereas spider veins occur in the venous system that returns blood to the heart. To distinguish between the two, the doctor will press gently on the spot in the center of the network. A spider nevus will blanch, or lose its reddish color, when the central arteriole is compressed. When the doctor releases the pressure, the color will return. Spider veins are not affected by compression in this way. In addition, spider nevi occur most frequently in children and pregnant women, rather than in older adults. They are treated by laser therapy or electrodesiccation, rather than by sclerotherapy.

After taking the patient’s medical history, the doctor examines the patient from the waist down,

both to note the location of spider veins and to palpate (touch with gentle pressure) them for signs of other venous disorders. Ideally, the examiner will have a small, raised platform for the patient to stand on during the examination. The doctor will ask the patient to turn slowly while standing, and will be looking for scars or other signs of trauma, bulges in the skin, areas of discolored skin, or other indications of chronic venous insufficiency. While palpating the legs, the doctor will note areas of unusual warmth or soreness, cysts, and edema (swelling of the soft tissues due to fluid retention). Next, the doctor will percuss certain parts of the legs where the larger veins lie closer to the surface. By gently tapping or thumping on the skin over these areas, the doctor can feel fluid waves in the veins and determine whether further testing for venous insufficiency is required. If the patient has problems related to large varicose veins, these must be treated before sclerotherapy can be performed to eliminate spider veins.

Some conditions and disorders are considered contraindications for sclerotherapy:

- Pregnancy and lactation. Pregnant women are advised to postpone sclerotherapy until at least three months after the baby is born, because some spider veins will fade by themselves after delivery. Nursing mothers should postpone sclerotherapy until the baby is weaned because it is not yet known whether the chemicals used in sclerotherapy may affect the mother’s milk.
- Diabetes.
- A history of AIDS, hepatitis, syphilis, or other diseases that are carried in the blood.
- Heart conditions.
- High blood pressure, blood clotting disorders, and other disorders of the circulatory system.

### *Preparation*

Patients are asked to discontinue **aspirin** or aspirin-related products for a week before sclerotherapy. Further, they are told not to apply any moisturizers, creams, tanning lotions, or sunblock to the legs on the day of the procedure. Patients should bring a pair of shorts to wear during the procedure, as well as compression stockings and a pair of slacks or a long skirt to cover the legs afterwards.

Most practitioners will take photographs of the patient’s legs before sclerotherapy to evaluate the effectiveness of treatment. In addition, some insurance companies request pretreatment photographs for documentation purposes.

## Aftercare

Aftercare following sclerotherapy includes wearing medical compression stockings that apply either 20–30 mmHg or 30–40 mmHg of pressure for at least seven to 10 days (preferably four to six weeks) after the procedure. Wearing compression stockings minimizes the risk of edema, discoloration, and pain. Fashion support stockings are a less acceptable alternative because they do not apply enough pressure to the legs.

The surgical tape and cotton balls used during the procedure should be left in place for 48 hours after the patient returns home.

Patients are encouraged to walk, ride a bicycle, or participate in other low-impact forms of **exercise** (examples: yoga and tai chi) to prevent the formation of blood clots in the deep veins of the legs. They should, however, avoid prolonged periods of standing or sitting, and high-impact activities, such as jogging.

## Risks

Cosmetically, the chief risk of sclerotherapy is that new spider veins may develop after the procedure. New spider veins are dilated blood vessels that can form when some of the venous blood forms new pathways back to the larger veins; they are not the original blood vessels that were sclerosed. Some patients may develop telangiectatic matting, which is a network of new spider veins that surface around the treated area. Telangiectatic matting usually clears up by itself within three to 12 months after sclerotherapy, but it can also be treated with further sclerosing injections.

Other risks of sclerotherapy include:

- Venous thrombosis. A potentially serious complication, thrombosis refers to the formation of blood clots in the veins.
- Severe inflammation.
- Pain after the procedure lasting several hours or days. This discomfort can be eased by wearing medical compression stockings and by walking briskly.
- Allergic reactions to the sclerosing solution or foam.
- Permanent scarring.
- Loss of feeling resulting from damage to the nerves in the treated area.
- Edema (swelling) of the foot or ankle. This problem is most likely to occur when the foot or ankle is treated for spider veins. The edema usually resolves within a few days or weeks.
- Brownish spots or discoloration in the skin around the treated area. These changes in skin color are caused by deposits of hemosiderin, which is a form

of iron that is stored within tissue cells. The spots usually fade after several months.

- Ulceration of the skin. This complication may result from reactive spasms of the blood vessels, the use of overly strong sclerosing solutions, or poor technique in administering sclerotherapy. It can be treated by diluting the sclerosing chemical with normal saline solution.
- Hirsutism. Hirsutism is the abnormal growth of hair on the area treated by sclerotherapy. It usually develops several months after treatment and goes away on its own. It is also known as hypertrichosis.

## Normal results

Normal results of sclerotherapy include improvement in the external appearance of the legs and relief of aching or cramping sensations associated with spider veins. It is common for complete elimination of spider veins to require three to four sclerotherapy treatments.

## Morbidity and mortality rates

Mortality associated with sclerotherapy for spider veins is almost 0% when the procedure is performed by a competent doctor. The rates of other complications vary somewhat, but have been reported as falling within the following ranges:

- Hemosiderin discoloration: 10%–80% of patients, with fewer than 1% of cases lasting longer than a year.
- Telangiectatic matting: 5%–75% of patients.
- Deep venous thrombosis: Fewer than 1%.
- Mild aching or pain: 35%–55%.
- Skin ulceration: About 4%.

## Alternatives

### Conservative treatments

Patients who are experiencing some discomfort from spider veins may be helped by any or several of the following approaches:

- Exercise. Walking or other forms of exercise that activate the muscles in the lower legs can relieve aching and cramping because these muscles keep the blood moving through the leg veins. One exercise that is often recommended is repeated flexing of the ankle joint. By flexing the ankles five to 10 times every few minutes and walking around for one to two minutes every half hour throughout the day, the patient can prevent the venous congestion that results from sitting or standing in one position for hours at a time.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Sclerotherapy is usually performed by general surgeons, dermatologists, or plastic surgeons, but it can also be done by family physicians or naturopaths who have been trained to do it. The American College of Phlebology holds workshops and intensive practical courses for interested practitioners. The ACP can be contacted for a list of members in each state.

Sclerotherapy is done as an outpatient procedure, most often in the doctor's office or in a plastic surgery clinic.

- Avoiding high-heeled shoes. Shoes with high heels do not allow the ankle to flex fully when the patient is walking. This limitation of the range of motion of the ankle joint makes it more difficult for the leg muscles to contract and force venous blood upwards toward the heart.
- Elevating the legs for 15–30 minutes once or twice a day. This change of position is frequently recommended for reducing edema of the feet and ankles.
- Wearing compression hosiery. Compression benefits the leg veins by reducing inflammation as well as improving venous outflow. Most manufacturers of medical compression stockings now offer some relatively sheer hosiery that is both attractive and that offers support.
- Medications. Drugs that have been used to treat the discomfort associated with spider veins include non-steroidal anti-inflammatory drugs (NSAIDs) and preparations of vitamins C and E. One prescription medication that is sometimes given to treat circulatory problems in the legs and feet is pentoxifylline, which improves blood flow in the smaller capillaries. Pentoxifylline is sold under the brand name Trendar.

If appearance is the patient's primary concern, spider veins on the legs can often be covered with specially formulated cosmetics that come in a wide variety of skin tones. Some of these preparations are available in waterproof formulations for use during swimming and other athletic activities.

### *Electrodesiccation, laser therapy, and pulsed light therapy*

Electrodesiccation is a treatment modality whereby the doctor seals off the small blood vessels that cause

## QUESTIONS TO ASK THE DOCTOR

- How likely am I to develop new spider veins in the treated areas?
- Do you use the newer sclerosing foams when you administer sclerotherapy?
- What technique(s) do you prefer to use for sclerotherapy and why?

spider veins by passing a weak electric current through a fine needle to the walls of the veins. Electrodesiccation seems to be more effective in treating spider veins in the face than in treating those in the legs; it tends to leave pitted white scars when used to treat spider veins in the legs or feet.

Laser therapy, like electrodesiccation, works better in treating facial spider veins. The sharply focused beam of intense light emitted by the laser heats the blood vessel, causing the blood in it to coagulate and close the vein. Various lasers have been used to treat spider veins, including argon, KTP 532nm, and alexandrite lasers. The choice of light wavelength and pulse duration are based on the size of the vein to be treated. Argon lasers, however, have been found to increase the patient's risk of developing hemosiderin discoloration when used on the legs. The KTP 532nm laser gives better results in treating leg spider veins, but is still not as effective as sclerotherapy.

Intense pulsed light (IPL) systems differ from lasers because the light emitted is noncoherent and not monochromatic. The IPL systems enable doctors to use a wider range of light wavelengths and pulse frequencies when treating spider veins and other skin problems, such as pigmented birthmarks. This flexibility, however, requires considerable skill and experience on the part of the doctor to remove spider veins without damaging the surrounding skin.

### *Complementary and alternative (CAM) treatments*

According to Dr. Kenneth Pelletier, the former director of the program in complementary and alternative treatments at Stanford University School of Medicine, California, horse chestnut extract is as safe and effective as compression stockings when used as a conservative treatment for spider veins. Horse chestnut (*Aesculus hippocastanum*) has been used in Europe for some years to treat circulatory problems in the legs; most recent research has been conducted in



Great Britain and Germany. The usual dosage is 75 mg twice a day, at meals. The most common side effect of oral preparations of horse chestnut is occasional indigestion in some patients.

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- American Academy of Dermatology. 930 East Woodfield Rd., PO Box 4014, Schaumburg, IL 60168. (847) 330-0230. [www.aad.org](http://www.aad.org).
- American Association for Vascular Surgery (AAVS). 900 Cummings Center, #221 U, Beverly, MA 01915. [www.aavs.vascularweb.org](http://www.aavs.vascularweb.org).
- American College of Phlebology. 100 Webster Street, Suite 101, Oakland, CA 94607-3724. (510) 834-6500. [www.phlebology.org](http://www.phlebology.org).
- American Society of Plastic Surgeons (ASPS). 444 East Algonquin Road, Arlington Heights, IL 60005. (847) 228-9900. [www.plasticsurgery.org](http://www.plasticsurgery.org).
- Peripheral Vascular Surgery Society (PVSS). 824 Munras Avenue, Suite C, Monterey, CA 93940. (831) 373-0508. [www.pvss.org](http://www.pvss.org).

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Scoliosis surgery, Arthrodesis see **Spinal fusion**

## Scopolamine patch

### Definition

A scopolamine patch (Transdermal Scop or Transderm-V) is an adhesive medication patch that is applied to the skin behind the ear the night before surgery or a caesarean section. The patch is treated with the belladonna alkaloid scopolamine, an anticholinergic drug that is a central nervous system depressant and an antiemetic.

### Purpose

Scopolamine patches are prescribed to reduce post-operative nausea and vomiting (PONV) associated with anesthesia and surgery. Scopolamine also has a mild analgesic and sedative effect, which adds to its therapeutic value for some surgical patients. In addition to PONV, scopolamine patches are also used for the treatment of motion sickness.

### Demographics

Elderly patients may be more sensitive to scopolamine treatment and its use should be prescribed with caution in this group. The safety of scopolamine patches has not been determined in children; according to the Food and Drug Administration (FDA), the patch should not be used in children.

## KEY TERMS

**Anticholinergic**—Drugs that block the action of acetylcholine, a neurotransmitter, consequently impairing the parasympathetic (involuntary) nervous system. Anticholinergic drugs inhibit secretion of bodily fluids (i.e., saliva, perspiration, stomach acid).

**Antiemetic**—A drug that prevents emesis, or vomiting.

## Description

A potent drug derived from an alkaloid of belladonna (*Atropa belladonna*; common name deadly nightshade), scopolamine works by depressing the action of the nerve fibers near the ear and the vomiting center of the brain and central nervous system (CNS). The patch itself is designed with special layered materials that slowly release a small dose of the drug transdermally (through the skin) over a period of several days.

Patients who are instructed to apply their patch at home should wash their hands thoroughly both before and after the procedure. Scopolamine can be spread to the eyes by hand, which can cause blurred vision and pupil dilation. Patches should never be cut into pieces, as cutting destroys the time-release mechanism of the drug. The directions for use for the patch should be read thoroughly before application, and specific physician instructions should also be followed. The drug will start to work approximately four hours after the patch is applied.

## Diagnosis/Preparation

The dime-sized scopolamine patch is applied just behind either the left or right ear. The area should be clean and hairless prior to the application, which should occur the evening before a scheduled surgery. For women who are prescribed a scopolamine patch to reduce nausea and vomiting related to a **cesarean section**, the patch should be applied just one hour before the procedure to minimize the baby's exposure to the drug. Scopolamine does cross the placental barrier, but as of early 2003, clinical studies have not shown any negative affects on newborn babies of mothers who used the drug in a caesarean delivery.

Patients with a history of glaucoma, prostate enlargement, kidney or liver problems, bladder obstruction, gastrointestinal obstruction, or contact dermatitis (allergic skin rash) in response to topical drugs may not be suitable candidates for scopolamine patch therapy. A

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

When used for surgical implications, a scopolamine patch may be ordered by a physician, surgeon, or anesthesiologist, typically in a hospital setting or an ambulatory surgery center. The patch may be applied at home by the patient, or by a nurse or physician's assistant as part of preoperative preparation.

physician or anesthesiologist should take a full medical history before prescribing scopolamine to determine if the medication is appropriate.

## Aftercare

Patients who receive a scopolamine patch should not drive or operate heavy machinery until the therapy is complete. Patch therapy generally lasts about three days. Patches should be disposed of according to the manufacturer's directions in a secure place to ensure that small children or pets do not get access to them. If PONV has not resolved after patch therapy has ended, patients should talk to their doctor about their treatment options.

## Risks

Possible complications or side effects from transdermal scopolamine include but are not limited to: short-term memory loss, fatigue, confusion, hallucinations, difficulty urinating, and changes in heart rate. The drug can trigger seizures and psychotic delusions in patients with a history of these problems. Dizziness, nausea, headache, and hypotension (low blood pressure) have also been reported in some patients upon discontinuation of scopolamine patch therapy.

Patients who experience eye pain with redness and possible blurred vision should remove the patch immediately and call their doctor, since the symptoms could be signs of a rare but possible side effect of scopolamine called narrow-angle glaucoma. Blurriness with or without pupil dilation is also a potential but generally harmless side effect of the drug.

The FDA recommends that patients who are scheduled for a **magnetic resonance imaging (MRI)** scan remove the patch before the scan, as the patch's backing contains aluminum. The aluminum absorbs energy and heats up during the scan, which may cause a mild burn of the skin beneath the patch.

## QUESTIONS TO ASK THE DOCTOR

When preparing to receive scopolamine transdermal therapy, you might ask your doctor:

- When and how do I apply the patch?
- What should I do if the patch becomes loose or falls off?
- When can I remove or replace the patch?
- Are there any warning symptoms that should signal me to remove the patch?

### Normal results

When scopolamine patch therapy works, it reduces or eliminates post-surgical nausea and vomiting. Two-thirds of patients experience dry mouth, the most common side effect of the drug.

### Alternatives

Intravenous or intramuscular injection of scopolamine may be used as alternatives to patch therapy for some patients. Other antiemetics that may be prescribed for PONV include anticholinergic drugs, dopaminergic drugs (i.e., promethazine, droperidol), antihistamines (i.e., diphenhydramine), and the serotonin receptor antagonists (i.e., ondansetron, granisetron, tropisetron, dolasetron). **Corticosteroids** may also be recommended for PONV in some patients.

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Secobarbital see **Barbiturates**

## Second-look surgery

### Definition

Second-look surgery is performed after a procedure or course of treatment to determine if the patient is free of disease. If disease is found, additional procedures may or may not be performed at the time of second-look surgery.

### Purpose

Second-look surgery may be performed under numerous circumstances on patients with various medical conditions.

### Cancer

A second-look procedure is sometimes performed to determine if a cancer patient has responded successfully to a particular treatment. Examples of cancers that are assessed during second-look surgery are ovarian cancer and colorectal cancer. In many cases, before a round of chemotherapy and/or radiation therapy is started, a patient will undergo a surgical procedure called cytoreduction to reduce the size of a tumor. This debulking increases the sensitivity of the tumor and decreases the number of necessary treatment cycles. Following cytoreduction and chemotherapy, a second-look procedure may be necessary to determine if the area is cancer-free.

An advantage to second-look surgery following cancer treatment is that if cancer is found, it may be removed during the procedure in some patients. In other cases, if a tumor cannot be entirely removed, the surgeon can debulk the tumor and improve the patient's chances of responding to another cycle of chemotherapy. However, second-look surgery cannot definitively prove that a patient is free of cancer; some microscopic cancer cells can persist and begin to grow in other areas of the body. Even if no cancer is found during second-look surgery, the rate of cancer relapse is approximately 25%.

## KEY TERMS

**Adhesion**—A band of internal scar tissue that develops after injury or surgery.

**Anastomosis (plural, anastomoses)**—The surgical connection of two structures, such as blood vessels or sections of the intestine.

**Cholesteatoma**—A destructive and expanding sac that develops in the middle ear or mastoid process.

**Debulking**—The removal of part of a malignant tumor in order to make the remainder more sensitive to radiation or chemotherapy.

**Endometriosis**—The growth of tissue like the lining of a woman's uterus (endometrium) outside the uterus in other parts of the body.

**Endoscopy**—A surgical technique that uses an endoscope (a thin, lighted, telescope-like instrument) to visualize structures inside the human body.

**Infertility**—The inability to become pregnant or carry a pregnancy to term.

**Ischemia**—Inadequate blood supply to an organ or area of tissue due to obstruction of a blood vessel.

**Kidney stones**—Small solid masses that form in the kidney.

### *Pelvic disease*

Second-look surgery may benefit patients suffering from a number of different conditions that affect the pelvic organs. Endometriosis is a condition in which the tissue that lines the uterus grows elsewhere in the body, usually in the abdominal cavity, leading to pain and scarring. Endometrial growths may be surgically removed or treated with medications. A second-look procedure may be performed following the initial surgery or course of medication to determine if treatment was successful in reducing the number of growths. Additional growths may be removed at this time.

Second-look surgery may also be performed following the surgical removal of adhesions (bands of scar tissue that form in the abdomen following surgery or injury) or uterine fibroids (noncancerous growths of the uterus). If the results are positive, an additional procedure may be performed to remove the adhesions or growths. Patients undergoing treatment for infertility may benefit from a second-look procedure to determine if the cause of infertility has been cured before ceasing therapy.

### *Abdominal disease*

In patients suffering from bleeding from the gastrointestinal (GI) tract, recurrence of bleeding after attempted treatment remains a significant risk; approximately 10–25% of cases do not respond to initial treatment. Second-look surgery following treatment for GI bleeding may be beneficial in determining if bleeding has recurred and treating the cause of the bleeding before it becomes more extensive.

Patients suffering from a partial or complete blockage of the intestine are at risk of developing bowel ischemia (**death** of intestinal tissue due to a lack of oxygen). Initial surgery is most often necessary to remove the diseased segment of bowel; a second-look procedure is commonly performed to ensure that only healthy tissue remains and that the new intestinal connection (called an anastomosis) is healing properly.

### *Other conditions*

A variety of other conditions can be assessed with second-look surgery. Patients who have undergone surgical repair of torn muscles in the knee might undergo a procedure called second-look arthroscopy to assess whether the repair is healing. A physician may use second-look mastoidoscopy to visualize the middle ear after removal of a cholesteatoma (a benign but destructive growth in the middle ear). A second endoscopic procedure may be performed on a patient who underwent endoscopic treatment for sinusitis (chronic infection of the sinuses) to evaluate the surgical site and remove debris.

## Description

Second-look surgery may be performed within hours, days, weeks, or months of the initial procedure or treatment. This time interval depends on the patient's condition and the type of procedure.

### *Laparotomy*

A laparotomy is a large incision through the abdominal wall to visualize the structures inside the abdominal cavity. After placing the patient under **general anesthesia**, the surgeon first makes a large incision through the skin, then through each layer under the skin in the region that the surgeon wishes to explore. The area will be assessed for evidence of remaining disease. For example, in the case of second-look laparotomy following treatment for endometriosis, the abdominal organs will be examined for evidence of endometrial growths. In the case of cancer, a “washing” of the abdominal cavity may be performed; sterile fluid is instilled into the abdominal cavity and washed



around the organs, then extracted with a syringe. The fluid is then analyzed for the presence of cancerous cells. Biopsies may also be taken of various abdominal tissues and analyzed.

If the surgeon discovers evidence of disease or a failed surgical repair, additional procedures may be performed to remove the disease or repair the dysfunction. For example, if adhesions are encountered during a second-look procedure on an infertile female patient, the surgeon may remove the adhesions at that time. Upon completion of the procedure, the incision is closed.

### Laparoscopy

**Laparoscopy** is a surgical technique that permits a view of the internal abdominal organs without an extensive surgical incision. During laparoscopy, a thin lighted tube called a laparoscope is inserted into the abdominal cavity through a tiny incision. Images taken by the laparoscope are seen on a video monitor connected to the scope. The surgeon may then examine the abdominal cavity, albeit with a more limited operative view than with laparotomy. Procedures such as the removal of growths or repair of deformities can be performed by instruments inserted through other small incisions in the abdominal wall. After the procedure is completed, any incisions are closed with **stitches**.

### Other procedures

Depending on the area of the body in question, other procedures may be used to perform second-look surgery. These include:

- **Arthroscopy.** Arthroscopy uses a thin endoscope to visualize the inner space of a joint such as the knee or elbow. Second-look arthroscopy may be used to determine if previous surgery on the joint is healing properly.
- **Percutaneous nephrolithotomy (PNL).** This minimally invasive procedure is used to remove kidney stones. Second-look PNL may be used to remove fragments of stones that could not be removed during the initial procedure.
- **Hysteroscopy.** A hysteroscope is an instrument used to visualize and perform procedures on the inner cavity of the uterus. Second-look hysteroscopy may be used after surgery or medical treatment to treat adhesions or benign growths in the uterus to determine if they have been effectively removed.
- **Mastoidectomy.** This surgical procedure is used to treat cholesteatoma; a second-look procedure is

generally performed to ensure that the entire cholesteatoma was removed during the initial procedure.

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## Second opinion

### Definition

A second opinion is the result of seeking an evaluation by another doctor or surgeon to confirm the diagnosis and treatment plan of a primary physician, or to offer an alternative diagnosis and/or treatment approach.

### Purpose

Getting a second surgical opinion can fill an important emotional need as well as establishing medical needs and treatment goals. When a second opinion confirms initial findings, it can provide reassurance and feelings of acceptance for the patient, and may reduce anxiety and uncertainty.

From a cost-effectiveness point of view, second opinions can save health insurance providers money by establishing the certainty of a clinical need (or lack of need) for surgery, particularly when the diagnosis is life-threatening.

Patients with a diagnosis of cancer may also benefit from a second-opinion pathology review of their biopsy material. A Johns Hopkins study reported that 1.4% of patients scheduled for cancer-related surgery at their facility were found to have been misdiagnosed when their tissue samples were reevaluated by a second pathologist. Similarly, a study published in the *Annals of Surgical Oncology* in 2002 found that a pathological second opinion of breast cancers changed the initial diagnosis, prognosis, or treatment approach in 80% of the 340 study subjects.

Several clinical research studies, however, have found that patients often seek second opinions not necessarily because they doubt the diagnosis or recommendations of their first provider, but because they were dissatisfied with either the amount of information given to them or the style of communication of their doctor. A 2002 Northwestern University study found that only 46% of patients coming into a breast cancer treatment center for a second opinion had been offered a complete discussion of treatment options during their initial consultation.

### Description

Doctors often have differing viewpoints as to how a particular medical problem should be managed, whether through surgery or less-invasive treatment means. One surgeon may prefer to take a “watchful waiting” approach before recommending surgery, while

## KEY TERMS

**Informed consent**—Providing a patient with complete, objective information on the risks, benefits, and potential and probable outcomes of different surgical or therapeutic options so that they may make an informed decision or consent to treatment.

**Pathologist**—A physician with specialized training in recognizing and identifying diseases through the analysis of abnormal bodily tissues.

**Postoperative care**—Medical care and support required after surgery to promote healing and recovery.

**Watchful waiting**—Monitoring a patient’s disease state carefully to see if the condition worsens before trying surgery or another therapy. This term is often associated with prostate cancer.

another may believe in performing surgery as soon as possible to avoid later complications. In some cases, several surgical techniques may be viable options for a patient. Medicine is not as black-and-white as many patients are led to believe, and physicians are not infallible. For these reasons, and because surgery is a major procedure with associated risks that should not be taken lightly, second opinions are an important part of the process of **informed consent** and decision-making.

Although a physician may strive to be objective, personal views and subjective experiences can influence their treatment recommendations. In addition, both the education and experience of a doctor in a given medical area can also influence the advice they offer a patient. For these reasons, seeking a second opinion from another physician and/or surgeon can be invaluable in making a decision on a course of treatment.

Second opinions are most frequently sought in cases of elective (nonemergency) surgery, when the patient has time to consider options and make a more informed choice about his or her course of treatment. While a second surgical opinion may be requested in some cases of **emergency surgery**, they are not as common, simply because of the logistical limitations involved with getting a qualified second opinion if a patient requires immediate care.

In some cases, a doctor or surgeon may encourage seeking a second opinion, particularly when the preferred course of treatment is not clear-cut or another surgeon with advanced training or expertise may

provide more insights into surgical options. A doctor or surgeon may also recommend seeking a second opinion when the patient is suffering from multiple medical disorders.

Patients should remember that it is their right to seek a second opinion before committing to surgery or another treatment plan. Embarrassment or fear of disapproval from a primary care provider should not be a barrier to getting a second opinion. A competent physician will not consider the decision to seek a second opinion an insult to their ability or experience. Instead, they will consider the patient an informed individual who is proactive and responsible for his or her own health care.

Patients seeking a second-opinion consultation may ask the provider questions similar to those they asked their primary provider. Questions may include:

- Are there other options besides surgery?
- What are the risks and benefits of each treatment option?
- How might each possible treatment impact quality-of-life for the patient?
- What kind of success rate is associated with surgery and other potential therapies?
- How is the surgery performed?
- Is surgery a permanent, long-term, or temporary solution to the condition?
- What type of anesthesia will be used?
- If surgery is chosen by the patient, how soon must it be done?
- What type of aftercare and recovery time is required once the surgery is complete?
- How much pain is to be expected postoperatively, and how is it typically treated?
- What are the costs involved with surgery and other treatment options, including postoperative care?

Providing the second surgeon with appropriate background information is important, but so is refraining from detailed descriptions of what the first provider did or did not recommend before the consultation begins. Patients should allow the surgeon to draw objective conclusions based on the medical history and diagnostic data before them. If the second opinion differs from the first provider's opinion, and the patient feels comfortable doing so, he or she might then offer information on the first provider's recommendations to get further feedback and input for a final decision.

## Preparation

Before seeking a second opinion, patients should contact their health insurance provider to find out if the service is covered. Some insurance companies may request that a second opinion be sought before major **elective surgery**, and may reserve the right to designate a physician or surgeon to provide the patient evaluation. As of early 2008, **Medicare Part B** covered 80% of costs for surgical second opinions after deductible, and 80% for a third opinion if the first two opinions are contradictory. Other Medicare programs may cover second opinions as well; patients should check with their Medicare carrier for details.

There are several ways to find an appropriate health care professional to provide a second opinion. Patients can:

- Ask friends and family for references.
- Ask their primary care physician or another trusted health care provider for a referral.
- Contact an appropriate specialty medical organization (e.g., American College of Surgeons) for a referral.
- Call their local medical licensing board.
- Check with their insurance provider or Medicare carrier.
- Cancer patients can consult a list of multidisciplinary institutions that will provide a second opinion on request. The list is available at < <http://www.blochcancer.org/>>.

When seeking a second surgical opinion, patients should find a surgeon who is board certified in the appropriate specialty by an organization that is part of the American Board of Medical Specialties (ABMS). For example, surgery of the urinary tract may be performed by a provider who is board certified by the American Board of Urology and/or the American Board of Surgery (ABS), two member organizations of the ABMS. Diplomates of ABMS member boards are surgeons who have passed rigorous written and oral testing on these specialties and have met specific accredited educational and residency requirements. In some cases, surgeons may also be certified in subspecialties within a discipline (for example, a vascular surgeon may be board certified by the **vascular surgery** board of the ABS). The ABMS provides a verification service for patients to check on the certification status of their provider.

In addition, the surgeon may also be a Fellow of the American College of Surgery (ACS), as indicated by the designation F.A.C.S. after their name. This indicates that he or she has met standards of clinical

experience, education, ethical conduct, and professional expertise as prescribed by the ACS.

Once a second health care provider is selected, patients should speak with their primary doctor about providing the appropriate medical history, test results, and other pertinent information to the physician who will give the second opinion. The patient may have to sign an information release form to allow the files to be sent. If x rays, **magnetic resonance imaging (MRI)**, or other radiological testing was performed, the second physician may request to see the original films, rather than the radiologist's report of the results, in order to interpret them objectively. In some cases, the office of the surgeon giving the second opinion can arrange to have these materials transferred with a patient's written approval. Patients should call ahead to ensure that all needed materials arrive at the second provider's office before the appointment, to give that physician adequate time to review them and to avoid potentially costly repeat testing.

### Normal results

Second opinions that agree with the first provider's conclusions may help ease the patient's mind and provide a clearer picture of the necessary course of treatment or surgery. However, if a patient still feels uncomfortable with the treatment plan outlined by the first and second physicians, or strongly disagrees with their conclusions, a third opinion from another provider is an option.

In cases in which the second provider disagrees with the first provider on diagnosis and/or treatment, the patient has harder choices to face. Again, a third evaluation may be in order from yet another physician, and some insurance companies may actually require this step in cases of conflicting opinions. If a patient is very comfortable with and confident in their primary care provider, they may wish to revisit them to review the second opinion.

In all cases, a patient should remember that their personal preferences, beliefs, and lifestyle considerations must also be considered in their final decision on surgery or treatment, as they are the ones who will live with the results.

### Resources

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### ORGANIZATIONS

American Board of Medical Specialties (ABMS). 1007 Church St., Suite 404, Evanston, IL 60201. (866) ASK ABMS. <http://www.abms.org>.

American College of Surgeons (ACS). 63 N. St. Clair Drive, Chicago, IL 60611. (312) 202 5000. E mail: [postmaster@facs.org](mailto:postmaster@facs.org). <http://www.facs.org>.

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## Sedation, conscious

### Definition

Conscious sedation, produced by the administration of certain medications, is an altered level of consciousness that still allows a patient to respond to physical stimulation and verbal commands, and to maintain an unassisted airway.

### Purpose

The purpose of conscious sedation is to produce a state of relaxation and/or pain relief by using benzodiazepine-type and narcotic medications to facilitate a procedure such as a biopsy, radiologic imaging study, endoscopic procedure, radiation therapy, or **bone marrow aspiration**.

### Description

Sedation is used inside or outside the **operating room**. Outside the operating suite, medical specialists use sedation to calm and relax their patients.



If the patient is to undergo a minor surgical procedure, screening and assessment of medical conditions that may interfere with conscious sedation must be explored. These potential risk factors include advanced age, history of adverse reactions to the proposed medications, and a past medical history of severe cardiopulmonary (heart/lung) disease. Other than those risk factors, contraindications for conscious sedation include; recent ingestion of large food or fluid volumes or a physical class IV or greater.

Once it has been established that the patient would be a good candidate for conscious sedation, just prior to the surgery or procedure, the patient will receive the sedating drug intravenously. A clip-like apparatus will be placed on the patient's finger to monitor oxygen intake during the sedation. This oxygen monitoring is called pulse oximetry and is a valuable, continuous monitor of patient oxygenation.

Dosing of medications that produce conscious sedation is individualized, and the medication is administered slowly to gauge a patient's response to the sedative. The two most common medications used to sedate patients for medical procedures are midazolam and fentanyl.

Fentanyl is a medication classified as an opioid narcotic analgesic (pain reliever) that is 50 to 100 times more potent than morphine. Given intravenously, the onset of action of fentanyl is almost immediate, and peak analgesia occurs within 10 to 15 minutes. A single dose of fentanyl given intravenously can produce good analgesia for only 20 to 45 minutes for most patients because the drug's distribution shifts from the brain (central nervous system) to peripheral tissues. The key to correct dosage is titration, or giving the medication in small amounts until the desired patient response is achieved.

Midazolam is a medication classified as a short-acting benzodiazepine (sedative) that depresses the central nervous system. Midazolam is ineffective for pain and has no analgesic effect during conscious sedation. The drug is a primary choice for conscious sedation because midazolam causes patients to have no recollection of the medical procedure. In general, midazolam has a fast-acting, short-lived sedative effect when given intravenously, achieving sedation within one to five minutes and peaking within 30 minutes. The effects of midazolam typically last one hour but may persist for six hours (including the amnestic effect). Patients who receive midazolam for conscious sedation should not be allowed to drive home after the procedure.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Conscious sedation is administered by medical or pediatric specialists performing a procedure that may be diagnostic and/or therapeutic. It may be used in a hospital, outpatient care facility, or doctor's office.

## Monitoring

Patient monitoring during conscious sedation must be performed by a trained and licensed health care professional. This clinician must not be involved in the procedure, but should have primary responsibility of monitoring and attending to the patient. Equipment must be in place and organized for monitoring the patient's blood pressure, pulse, respiratory rate, level of consciousness, and, most important, the oxygen saturation (the measure of oxygen perfusion inside the body) with a **pulse oximeter** (a machine that provides a continuous real-time recording of oxygenation). The oxygen saturation is the most sensitive parameter affected during increased levels of conscious sedation. **Vital signs** and other pertinent recordings must be monitored before the start of the administration of medications, and then at a minimum of every five minutes thereafter until the procedure is completed. After the procedure has been completed, monitoring should continue every 15 minutes for the first hour after the last dose of medication(s) was administered. After the first hour, monitoring can continue as needed. Children who receive sedative medication with a long half-life may require extended observation.

## Risks and risk management

The American Academy of Pediatrics (AAP) has established safe practice guidelines to manage conscious sedation without an anesthesiologist for minor procedures. These AAP criteria include (1) a full-time licensed clinician (nurse, physician, physician assistant, surgeon assistant, respiratory therapist) who is strictly and exclusively monitoring the patient's breathing, level of consciousness, vital signs, and airway; (2) standard procedures for monitoring vital signs; and (3) immediate availability (on site) of airway equipment, resuscitative medications, suction apparatus, and supplemental oxygen delivery systems.

## QUESTIONS TO ASK THE DOCTOR

When should I stop taking my regular medications? When should I begin them again?

What side effects can I expect after the procedure? Nausea? Dizziness? Drowsiness? Is there anything I can do to ward off these side effects?

What are the risks of this procedure?

Which sedative will you use?

What steps will you take if there are complications?

Will I feel any pain?

If adverse reactions occur while using fentanyl, the antidote is a drug called naloxone. It provides rapid reversal of fentanyl's narcotic effect. The incidence of oversedation or decreased respiration is low using fentanyl if the medication is carefully titrated.

### Resources

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#### ORGANIZATIONS

American Association of Nurse Anesthetists. 222 South Prospect Avenue, Park Ridge, IL 60068 4001. (847) 692 7050. <http://www.aana.com>.

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## Sedimentation rate

### Definition

The sedimentation rate (or erythrocyte sedimentation rate) is a test that measures that degree of inflammation occurring in the body. Inflammation is the sum total of the body's reaction to infection, allergy, irritation, malignancy (cancer), or injury. The test is neither specific to a particular type of disease or condition, nor does it identify what tissues or organs are inflamed. In other words, while the sedimentation rate is a useful test to verify an impression of the possible presence of a particular illness, it cannot stand alone as a definitive diagnostic tool. The patient's history and symptoms must be correlated with the sedimentation rate and other laboratory tests in order to arrive at a clinical diagnosis.

The sedimentation rate is literally a measure of the distance that red blood cells (erythrocytes) fall through a test tube filled with blood in an hour's time. This process leaves clear plasma, devoid of red blood cells, at the top of the tube. When there is an inflammatory process occurring in the body, the body produces a variety of proteins that stick to red blood cells. These protein-red blood cell complexes are heavier than unaffected red blood cells, allowing them to fall more quickly and farther through the blood in the test tube. As a result, when inflammation is present in the body, the red blood cells drop through the test tube more quickly, and more of them accumulate at a lower part of the test tube, resulting in a higher sedimentation rate.

### Purpose

A sedimentation rate is usually done when an individual is having symptoms compatible with an inflammatory disorder, particularly polymyalgia rheumatica and temporal arteritis. Some symptoms that might prompt a practitioner to order a sedimentation rate include unexplained headache, joint pain or stiffness, anemia, unintentional weight loss, fevers, and severe fatigue. The sedimentation rate is also frequently used to monitor a disease process that has already been diagnosed, such as Hodgkin's lymphoma, or autoimmune disorders such as rheumatoid arthritis or systemic lupus erythematosus.

### Precautions

The sedimentation rate is not diagnostic. This means that getting a specific result does not definitively confirm the presence of any particular disease.

## KEY TERMS

**Autoimmune disorder**—A condition in which the body's immune system is accidentally attacking tissues or organs of the body, causing injury and disease.

**Inflammation**—Pain, swelling, redness, and heat that often occurs when tissues of the body are injured, infected, or irritated in some way.

**Malignancy**—Conditions that are cancerous, meaning that they produce abnormal cells capable of invading and destroying other local and distant tissues.

**Polymyalgia rheumatica**—A condition with symptoms of achiness and stiffness, primarily striking older adults.

**Temporal arteritis**—A condition in which inflammation of the blood vessels that supply the head and neck result in severe, chronic headache, particularly over one temple, as well as fever, weight loss, and severe fatigue.

Instead, the test is used to correlate with the clinical picture, meaning the history and the symptoms that an individual is experiencing.

### Description

This test requires blood to be drawn from a vein (usually one in the forearm), generally by a nurse or phlebotomist (an individual who has been trained to draw blood). A tourniquet is applied to the arm above the area where the needle stick will be performed. The site of the needle stick is cleaned with antiseptic, and the needle is inserted. The blood is collected in vacuum tubes. After collection, the needle is withdrawn, and pressure is kept on the blood draw site to stop any bleeding and decrease bruising. A bandage is then applied.

### Preparation

There are no restrictions on diet or physical activity, either before or after the blood test.

### Aftercare

As with any blood tests, discomfort, bruising, and/or a very small amount of bleeding is common at the puncture site. Immediately after the needle is withdrawn, it is helpful to put pressure on the puncture site until the bleeding has stopped. This decreases the chance of significant bruising. Warm packs may relieve minor discomfort. Some individuals may feel

briefly woozy after a blood test, and they should be encouraged to lie down and rest until they feel better.

### Risks

Basic blood tests, such as sedimentation testing, do not carry any significant risks, other than slight bruising and the chance of brief dizziness.

### Results

The normal sedimentation rate range in men is 0-15 mm/hour. The normal sedimentation rate range in women is 0-20 mm/hour. The normal sedimentation rate range in children is 0-10 mm/hour. The normal sedimentation rate range in newborn babies is 0-2 mm/hr. Women normally have higher sedimentation rates than men. People over the age of 50 years also have higher normal sedimentation rates than do younger individuals. Other factors that may increase the sedimentation rate without suggesting the presence of disease include obesity or pregnancy.

An elevated sedimentation rate can be caused by a number of conditions, including an episode of crisis in sickle cell disease, osteomyelitis, stroke, prostate cancer, coronary artery disease, rheumatoid arthritis, chronic infections, certain cancers (including Hodgkin's disease and renal cell carcinoma), ankylosing spondylitis, thyroid disease, temporal arteritis, scleroderma, polyarteritis nodosa, systemic lupus erythematosus, infections (appendicitis, osteomyelitis, pelvic inflammatory disease, pneumonia), and Kawasaki disease in children.

An extremely elevated sedimentation rate can be caused by multiple myeloma and polymyalgia rheumatica.

An abnormally low sedimentation rate can be caused by sickle cell anemia (not during painful crisis), use of steroid medications, polycythemia, or high serum glucose.

### Resources

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**ORGANIZATIONS**

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**OTHER**

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Segmental resection see **Segmentectomy**

## Segmentectomy

### Definition

Segmentectomy is the excision (removal) of a portion of any organ or gland. The procedure has several variations and many names, including segmental resection, wide excision, **lumpectomy**, tumorectomy, **quadrantectomy**, and partial **mastectomy**.

### Purpose

Segmentectomy is the surgical removal of a defined segment or portion of an organ or gland performed as a treatment. In this case, the purpose is the removal of a cancerous tumor. Common organs that have segments are the breasts, lungs, and liver.

### Demographics

Segmentectomies are usually performed on patients with lung, liver, or breast cancer.

Lung cancer is the second most common cancer among both men and women, and is the leading cause of cancer **death** for both genders. Lung cancer kills more people (approximately 157,000 per year) than cancers of the breast, prostate, colon, and pancreas combined. Almost 90% of all lung cancers are caused by cigarette smoking. Other causes include secondhand smoke and exposure to asbestos and other occupation-related substances.

In each of the racial and ethnic groups, the rates among men are about two to three times greater than the rates among women. Among men, age-adjusted lung cancer incidence rates (per 100,000) range from a low of about 14 among Native Americans to a high of 117 among African Americans, an eight-fold difference. For women, the rates range from approximately 15 per 100,000 among Japanese to nearly 51 among Alaska natives, approximately a three-fold difference.

Excluding cancers of the skin, breast cancer is the most common form of cancer among women in the United States. The increase in incidence is primarily due to increased screening by **physical examination** and **mammography**. Although breast cancer occurs among both women and men, it is quite rare among men. Caucasian non-Hispanic women have the highest rates of breast cancer, over twice the rate for Hispanic women. There are a low number of cases for Alaska native, Native American, Korean, and Vietnamese women.

Primary cancers of the liver account for approximately 1.5% of all cancer cases in the United States. About two-thirds of liver cancers are clearly associated with hepatitis B and hepatitis C viral infections and cirrhosis. This type of liver cancer occurs more frequently in men than in women by a ratio of two to one.

### Description

When cancer is confined to a segment of an organ, removal of that portion may offer cancer-control results equivalent to those of more extensive operations. This is especially true for breast and liver cancers. For breast and lung cancers, a segmentectomy is often combined with removal of some or all regional lymph nodes.

Treatment options for lung cancer depend on the stage of the cancer (whether it is in the lung only or has spread to other places in the body); tumor size; the type of lung cancer; presence (or lack) of symptoms; and the patient's general health.

A disease in which malignant (cancer) cells form in the tissues of the lung is called non-small cell lung cancer (NSCLC). There are five types of NSCLC; each consists of different types of cancer cells, which grow and spread in different ways. The types of NSCLC are named for the kinds of cells found in the cancer, and how the cells appear when viewed under a microscope.

Segmentectomy may be the treatment of choice for cancerous tumors in the occult, or hidden stage, as well as in stage 0, stage I, or stage II NSCLC. When the site and nature of the primary tumor is defined in occult stage lung cancer, it is generally removed by segmentectomy.

Segmentectomy is the usual treatment for stage 0 cancers of the lung, as they are limited to the layer of tissue that lines air passages, and have not invaded the nearby lung tissue. Chemotherapy or radiation therapy is not normally required.

Segmentectomy is recommended only for treating the smallest stage I cancers and for patients with other



## KEY TERMS

**Angiogram**—An examination of a part of the body by injecting dye into an artery so that the blood vessels show up on an x ray.

**Anterior mediastinotomy**—A surgical procedure to look at the organs and tissues between the lungs and between the breastbone and spine for abnormal areas. An incision (cut) is made next to the breastbone and a thin, lighted tube is inserted into the chest. Tissue and lymph node samples may be taken for biopsy.

**Biopsy**—Removal and examination of tissue, cells, or fluids from the living body.

**Bronchoscope**—A tubular illuminated instrument used for inspecting or passing instruments into the bronchi.

**Chemoprevention**—The use of drugs, vitamins, or other substances to reduce the risk of developing cancer or of the cancer returning.

**Chemotherapy**—Cancer treatment that uses drugs to stop the growth of cancer cells, either by killing the cells or by stopping them from dividing.

**Clinical breast exam**—An examination of the breast and surrounding tissue by a physician, who is feeling for lumps and looking for other signs of abnormality.

**Computed tomography**—An x-ray machine linked to a computer that takes a series of detailed pictures of the organs and blood vessels in the body.

**Conservation surgery**—Surgery that preserves the aesthetics of the area undergoing an operation.

**Excision**—To surgically remove.

**Excisional biopsy**—Procedure in which a surgeon removes all of a lump or suspicious area and an area of healthy tissue around the edges. The tissue is then examined under a microscope to check for cancer cells.

**Fine-needle aspiration**—A procedure in which a thin needle removes fluid and cells from a breast lump to be examined.

**Incisional biopsy**—A procedure in which a surgeon cuts out a sample of a lump or suspicious area.

**Laser therapy**—A cancer treatment that uses a laser beam (a narrow beam of intense light) to kill cancer cells.

**Lobectomy**—Removal of a section of the lung.

**Lymph node biopsy**—The removal of all or part of a lymph node to view under a microscope for cancer cells.

medical conditions that make removing part or the entire lobe of the lung (lobectomy) dangerous. If the patient does not have sufficient pulmonary function to tolerate this more extensive operation, a segmentectomy will be performed. Additional chemotherapy after surgery for stage I NSCLC is not routinely recommended. If a patient has serious medical problems, radiation therapy may be the primary treatment.

A cancerous tumor will be surgically removed by segmentectomy or lobectomy in cases of stage II NSCLC. A wedge resection might be done if the patient cannot withstand lobectomy. Sometimes **pneumectomy** (removal of the entire lung) is needed. Radiation therapy may be used to destroy cancer cells left behind after surgery, especially if malignant cells are present at the edge of the tissue removed by surgery. Some doctors may recommend additional radiation therapy even if the edges of the sample have no detectable cancer cells.

Segmentectomy is under investigation for the treatment of small-cell lung cancers.

Because of the need for radiotherapy after segmentectomy, some patients, such as pregnant women and those with syndromes not compatible with radiation treatment, may not be candidates for segmentectomy. As in any surgery, patients should alert their physician about all allergies and any medications they are taking.

### Diagnosis/Preparation

The following methods may be used to help diagnose breast cancer:

- complete physical exam and family medical history
- clinical breast exam
- mammography
- biopsy (incisional, excisional, or needle)
- ultrasonography
- fine-needle aspiration

Tests help to determine whether cancer cells have spread within the lungs or to other parts of the body after a diagnosis of lung cancer. The following tests

**Lymph nodes**—Small, bean-shaped organs located throughout the lymphatic system. Lymph nodes store special cells that can trap cancer cells and bacteria traveling through the body.

**Mammography**—An x ray of the breast

**Magnetic resonance imaging (MRI)**—A powerful magnet linked to a computer used to make detailed images of areas inside the body. These pictures are viewed on a monitor and can also be printed.

**Mediastinoscopy**—A surgical procedure to look at the organs, tissues, and lymph nodes between the lungs for abnormal areas. An incision (cut) is made at the top of the breastbone and a thin, lighted tube is inserted into the chest. Tissue and lymph node samples may be taken for biopsy.

**Needle biopsy**—The use of a needle to remove tissue from an area that looks suspicious on a mammogram but cannot be felt. Tissue removed in a needle biopsy goes to a lab to be checked for cancer cells.

**Photodynamic therapy**—A cancer treatment that uses a drug that is activated by exposure to light. When the drug is exposed to light, the cancer cells are killed.

**Positron emission tomography (PET) scan**—A procedure to find malignant tumor cells in the body. A

small amount of radionuclide glucose (sugar) is injected into a vein. The PET scanner rotates around the body and makes a picture of where the glucose is being used in the body. Malignant tumor cells show up brighter in the picture because they are more active and take up more glucose than normal cells.

**Radiation therapy**—A cancer treatment that uses high-energy x rays or other types of radiation to kill cancer cells.

**Radiologic exams**—The use of radiation or other imaging methods to find signs of cancer.

**Radiosurgery**—A method of delivering radiation directly to the tumor. This method does not involve surgery and causes little damage to healthy tissue.

**Radiotherapy**—The treatment of disease with high-energy radiation, such as x rays or gamma rays.

**Ultrasonography**—A procedure using high-frequency sound waves to show whether a lump is a fluid-filled cyst (not cancer) or a solid mass (which may or may not be cancer).

**Ultrasound test**—A device using sound waves that produce a pattern of echoes as they bounce off internal organs. The echoes create a picture of the organs.

and procedures may be used in the staging process to diagnose lung cancer:

- complete physical exam, including personal and family medical history
- chest x-ray
- computed tomography (CT) scan
- positron emission tomography (PET) scan
- other radiologic exams
- laboratory tests (tissue, blood, urine, or other substances in the body)
- bronchoscopy
- mediastinoscopy
- anterior mediastinotomy
- lymph node biopsy

Treatment is determined when the stage of the tumor is known.

Routine preoperative preparations, such as not eating or drinking after midnight on the night before surgery are typically ordered for a segmentectomy.

Information about expected outcomes and potential complications is also part of the preparation for this surgery.

## Aftercare

After a segmentectomy, patients are usually cautioned against doing moderate lifting for several days. Other activities may be restricted (especially if lymph nodes were removed) according to individual needs. Pain is often enough to limit inappropriate motion, and is generally controlled with medication. If pain medications are ineffective, the patient should contact the physician, as severe pain may be a sign of a complication requiring medical attention. Women who undergo segmentectomy of the breast are often instructed to wear a well-fitting support bra both day and night for approximately one week after surgery.

The length of the hospital stay depends on the specific surgery performed and the extent of organ or tissue removed, as well as other factors.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Segmentectomies are performed in a hospital by a general surgeon, a medical doctor who specializes in surgery. If there are complicating factors, a specialized surgeon may perform the surgery.

Radiation therapy usually begins four to six weeks after surgery, and continues for four to five weeks. The timing of additional therapy is specific to each patient.

### Risks

The risks for any surgical procedure requiring anesthesia include reactions to the medications and breathing problems. Bleeding and infection are risks for any surgical procedure. Infection in the area affecting a segmentectomy occurs in only 3–4% of patients. Pneumonia is also a risk.

### Normal results

Successful removal of the tumor with no major bleeding or infection at the wound site after surgery is considered a normal outcome.

### Morbidity and mortality rates

Although the incidence of breast cancer has been rising in the United States for the past two decades, the mortality rate has remained relatively stable since the 1950s. Mortality rates range from 15% of the incidence rate for Japanese women to 33% of the incidence rate for African American women. The highest age-adjusted mortality occurs among African American women, followed by Caucasian and Hawaiian women.

African American women have the highest mortality rates in the age groups 30–54 years and 55–69 years, followed by Hawaiian, and Caucasian non-Hispanic women. The mortality rate for Caucasian women exceeds that for African American women in the 70 year and older age group.

Five-year survival rates for liver cancer patients are usually less than 10% in the United States. The reported statistics for these cancers often include mortality rates that exceed the incidence rates. The discrepancy occurs when the cause of death is misclassified as “liver cancer” for patients whose cancer originated as a primary tumor in another organ and spread to the liver, becoming a secondary cancer.

## QUESTIONS TO ASK THE DOCTOR

- Is segmentectomy an option for treatment?
- When will it be known whether or not all the cancer has been removed?
- What benefits can be expected from this operation?
- What is the risk of tumor recurrence after undergoing this procedure?
- What should be done to prepare for surgery?
- What happens if this operation does not go as planned?

For primary liver cancer, non-Hispanic Caucasian men and women have the lowest age-adjusted mortality rates in the United States, roughly one-half that of the African American and Hispanic populations.

Liver cancer mortality rates for Asian American groups are several times higher than that of the Caucasian population. The highest age-adjusted mortality rates for all groups are among the Chinese population. Alaska Native and Native American populations have a very low incidence of liver cancer.

Factors that affect the prognosis (chance of recovery) for lung cancer include:

- stage of the cancer (whether it is in the lung only or has spread to other places in the body)
- tumor size
- type of lung cancer
- presence of symptoms
- shortness of breath during activities
- shortness of breath with less and less activity
- the patient’s general health

Current treatments are not a cure for most patients with non-small cell lung cancer. If it returns after treatment, it is called recurrent non-small cell lung cancer. The cancer may reappear in the brain, lung, or other parts of the body. Further treatment is then required.

### Alternatives

Other cancer treatments include:

- chemotherapy
- radiation therapy
- radiosurgery
- laser therapy
- photodynamic therapy
- chemoprevention

Using a segmentectomy to remove breast cancers (as a technique that conserves the aesthetic appearance of a breast) is being investigated for large tumors after several cycles of preoperative chemotherapy.

Cancers in some locations (such as where the windpipe divides into the left and right main bronchi) are difficult to remove completely by surgery without also removing an entire lung.

## Resources

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- Vastag, Brian. "Consensus Panel Recommendations for Treatment of Early Breast Cancer." *Journal of American Medical Association* 284 (2002): 2707-8.

### ORGANIZATIONS

- American Cancer Society. 1599 Clifton Road, N.E. Atlanta, GA 30329 4251. (800) 227 2345. <http://www.cancer.org>.
- National Alliance of Breast Cancer Organizations (NABCO). 9 East 37th Street, 10th Floor, New York, NY 10016. (888) 80 NABCO. <http://www.nabco.org>.
- National Comprehensive Cancer Network. 50 Huntingdon Pike, Suite 200, Rockledge PA 19046. (215) 728 4788. Fax: (215) 728 3877. Email: [information@nccn.org](mailto:information@nccn.org). <http://www.nccn.org/>.
- National Institutes of Health (NIH), Department of Health and Human Services. 9000 Rockville Pike. Bethesda, MD 20892. (800) 422 6237.

The U.S. Department of Health and Human Services. 200 Independence Avenue, S.W., Washington, D.C. 20201. (877) 696 6775.

Y ME National Breast Cancer Organization. Suite 500 212 West Van Buren St., Chicago, IL 60607 3908. (800) 986 9505. 312 986 8338. Fax: 312 294 8597. <http://www.y-me.org>.

### OTHER

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Selective dorsal rhizotomy see **Rhizotomy**  
Senna see **Laxatives**

## Sentinel lymph node biopsy

### Definition

Sentinel lymph node biopsy (SLNB) is a minimally invasive procedure in which a lymph node near the site of a cancerous tumor is first identified as a sentinel node and then removed for microscopic analysis. SLNB was developed by researchers in several different cancer centers following the discovery that the human lymphatic system can be mapped with radioactive dyes, and that the lymph node(s) closest to a tumor serve to filter and trap cancer cells. These nodes are known as sentinel nodes because they act like sentries to warn doctors that a patient's cancer is spreading.

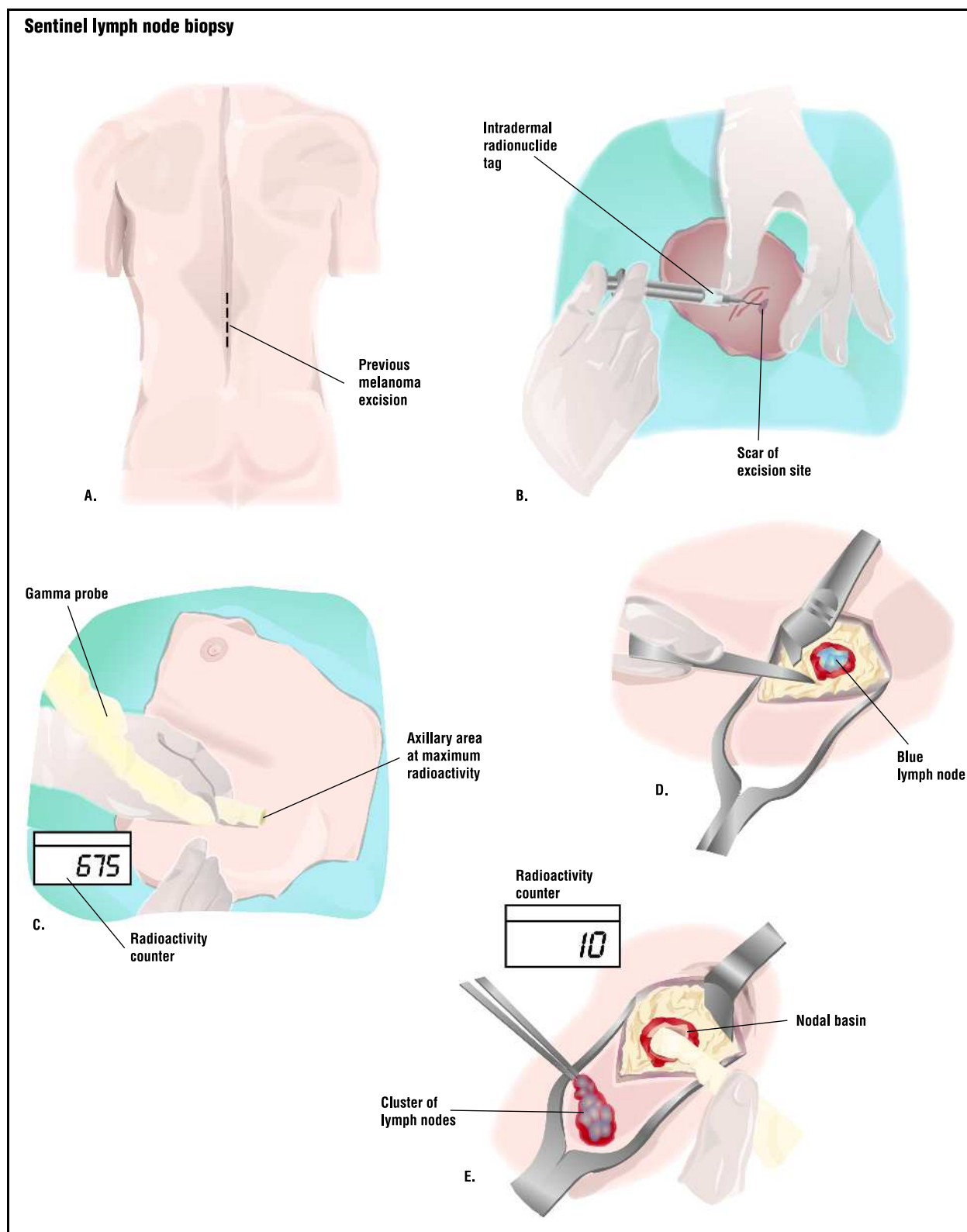
The first descriptions of sentinel nodes come from studies of penile and testicular cancers done in the 1970s. A technique that uses blue dye to map the lymphatic system was developed in the 1980s and applied to the treatment of melanoma in 1989. The extension of sentinel lymph node biopsy to the treatment of breast cancer began at the John Wayne Cancer Institute in Santa Monica, California, in 1991. As of 2003, SLNB is used in the diagnosis and treatment of many other cancers, including cancers of the head and neck, anus, bladder, lung, and male breast.

### Purpose

Sentinel lymph node biopsy has several purposes:

- Improving the accuracy of cancer staging. Cancer staging is a system that classifies malignant tumors according to the extent of their spread in the body. It is used to guide decisions about treatment.





At the site of a previous cancer removal, a radionuclide dye is injected (A and B). The area of maximum radioactivity is traced to a lymph node under the arm (C). The area is cut open, and the lymph node is identified by its blue dye (D). After the lymph node is removed, the area is checked for further radioactivity (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

- Catching the spread of cancer to nearby lymph nodes as early as possible.
- Defining homogeneous patient populations for clinical trials of new cancer treatments.

## Description

A sentinel lymph node biopsy is done in two stages. In the first part of the procedure, which takes one to two hours, the patient goes to the nuclear medicine department of the hospital for an injection of a radioactive tracer known as technetium 99. A doctor who specializes in nuclear medicine first numbs the area around the tumor with a local anesthetic and then injects the radioactive technetium. He or she usually injects a blue dye as well. The doctor will then use a gamma camera to take pictures of the lymph nodes before surgery. This type of imaging study is called lymphoscintigraphy.

After the lymphoscintigraphy, the patient must wait several hours for the dye and the radioactive material to travel from the tissues around the tumor to the sentinel lymph node. He or she is then taken to the **operating room** and put under **general anesthesia**. Next, the surgeon injects more blue dye into the area around the tumor. The surgeon then uses a hand-held probe connected to a gamma ray counter to scan the area for the radioactive technetium. The sentinel lymph node can be pinpointed by the sound made by the gamma ray counter. The surgeon makes an incision about 0.5 in long to remove the sentinel node. The blue dye that has been injected helps to verify that the surgeon is removing the right node. The incision is then closed and the tissue is sent to the hospital laboratory for examination.

## Preparation

Some cancer patients should not be given an SLNB. They include women with cancer in more than one part of the breast; women who have had previous breast surgery, including **plastic surgery**; women with breast cancer in advanced stages; and women who have had radiation therapy. Melanoma patients who have undergone wide excision (removal of surrounding skin as well as the tumor) of the original skin cancer are also not candidates for an SLNB.

Apart from evaluating the patient's fitness for an SLNB, no additional preparation is necessary.

## Aftercare

A sentinel lymph node biopsy does not require extensive aftercare. In most cases, the patient goes home after the procedure or after an overnight stay in the hospital.

## KEY TERMS

**Biopsy**—The removal of a piece of living tissue from the body for diagnostic purposes.

**Lymph**—A clear yellowish fluid derived from tissue fluid. It is returned to the blood via the lymphatic system.

**Lymph nodes**—Small masses of tissue located at various points along the course of the lymphatic vessels.

**Lymphedema**—Swelling of the arm as a result of removal of lymphatic tissue.

**Lymphoscintigraphy**—A technique for detecting the presence of cancer cells in lymph nodes by using a radioactive tracer.

**Prophylactic**—Intended to prevent or protect against disease.

**Sentinel lymph node**—The lymph node(s) closest to a cancerous tumor. They are the first nodes that receive lymphatic drainage from the tissues surrounding the tumor.

**Staging**—The classification of cancers according to the extent of the tumor.

The surgeon will discuss the laboratory findings with the patient. If the sentinel node was found to contain cancer cells, the surgeon will usually recommend a full axillary lymph node dissection (ALND). This is a more invasive procedure in which a larger number of lymph nodes—usually 12–15—is surgically removed. A drainage tube is placed for two to three weeks, and the patient must undergo physical therapy at home.

## Risks

Risks associated with an SLNB include the following:

- Mild discomfort after the procedure.
- Lymphedema (swelling of the arm due to disruption of the lymphatic system after surgery).
- Damage to the nerves in the area of the biopsy.
- Temporary discoloration of the skin in the area of the dye injection.
- False negative laboratory report. A false negative means that there is cancer in other lymph nodes in spite of the absence of cancer in the sentinel node. False negatives usually result from either poor timing of the dye injection, the way in which the pathologist

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

An SLNB is usually performed in a hospital that has a department of nuclear medicine, although it is sometimes done as an outpatient procedure. The radioactive material or dye is injected by a physician who specializes in nuclear medicine. The sentinel lymph node is removed by a surgeon with experience in the technique. It is then analyzed in the hospital laboratory by a pathologist, who is a doctor with special training in studying the effects of disease on body organs and tissues.

The accuracy of a sentinel lymph node biopsy depends greatly on the skill of the surgeon who removes the node. Recent studies indicate that most doctors need to perform 20–30 SLNBs before they achieve an 85% success rate in identifying the sentinel node(s) and 5% or fewer false negatives. They can gain the necessary experience through special residency programs, fellowships, or training protocols. It is vital for patients to ask their surgeon how many SLNBs he or she has performed, as those who do these biopsies on a regular basis generally have a higher degree of accuracy.

prepared the tissue for examination, or the existence of previously undiscovered sentinel nodes.

### Normal results

Sentinel lymph node biopsies have a high degree of accuracy, with relatively few false negatives. A negative laboratory report means that there is a greater than 95% chance that the other nearby lymph nodes are also free of cancer.

### Morbidity and mortality rates

Compared to axillary lymph node dissection, sentinel lymph node biopsy has a significantly lower rate of complications, including a lower rate of post-operative pain and infection, as well as a lower long-term risk of lymphedema.

### Alternatives

Breast cancer patients who should not have a sentinel lymph node biopsy usually undergo an axillary lymph node dissection to determine whether their cancer has spread. Melanoma patients who have already had a wide excision of the original melanoma

## QUESTIONS TO ASK THE DOCTOR

- Am I a candidate for sentinel lymph node biopsy?
- How many SLNBs have you performed?
- Do you perform this procedure on a regular basis?
- What is your false negative rate?

may have nearby lymph nodes removed to prevent the cancer from spreading. This procedure is called a prophylactic lymph node dissection.

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American Cancer Society (ACS). (800) ACS 2345. [www.cancer.org](http://www.cancer.org).

National Cancer Institute (NCI). NCI Public Inquiries Office, Suite 3036A, 6116 Executive Boulevard, MSC8332, Bethesda, MD 20892 8322. (800) 4 CANCEr or (800) 332 8615 (TTY). [www.nci.nih.gov](http://www.nci.nih.gov).

Society of Nuclear Medicine (SNM). 1850 Samuel Morse Drive, Reston, VA 20190. (703) 708 9000. [www.snm.org](http://www.snm.org).

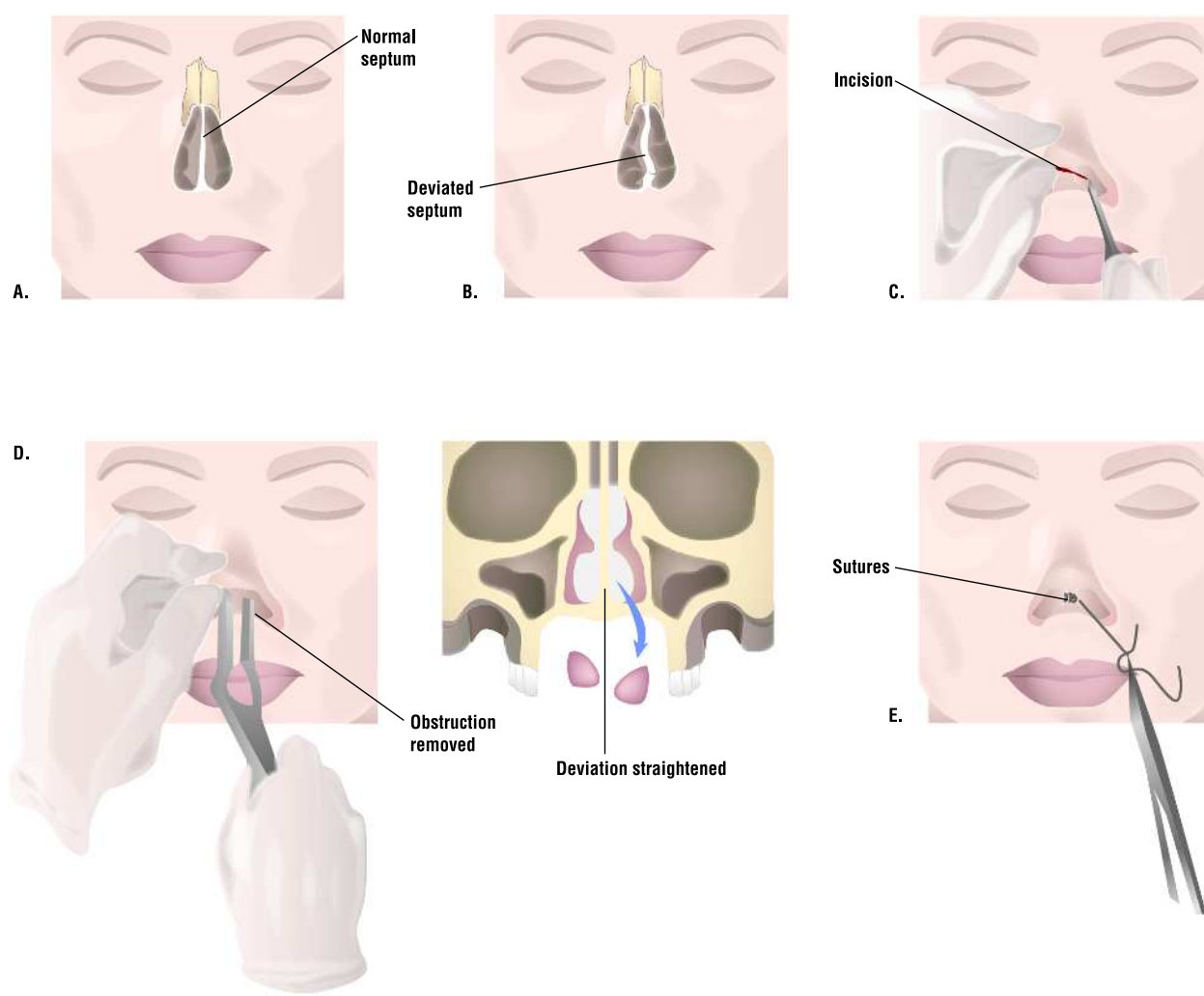
Rebecca Frey, Ph. D.

## Septoplasty

### Definition

Septoplasty is a surgical procedure to correct the shape of the septum of the nose. The goal of this procedure is to correct defects or deformities of the septum. The nasal septum is the separation between the two nostrils. In adults, the septum is composed partly of cartilage and partly of bone. Septal deviations are either congenital (present from birth) or develop as

### Septoplasty



Septoplasty is used to correct a deviated septum (B). First an incision is made to expose the nasal septum (C). Pieces of septum that are obstructing air flow are removed (D), and the incision is then closed (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)



a result of an injury. Most people with deviated septa do not develop symptoms. It is typically only the most severely deformed septa that produce significant symptoms and require surgical intervention. However, many septoplasties are performed during **rhinoplasty** procedures, which are most often performed for cosmetic purposes.

### Purpose

Septoplasty is performed to correct a crooked (deviated) or dislocated septum, often as part of **plastic surgery** of the nose (rhinoplasty). The nasal septum has three functions: to support the nose, to regulate air flow, and to support the mucous membranes (mucosa) of the nose. Septoplasty is done to correct the shape of the nose caused by a deformed septum or correct deregulated airflow caused by a deviated septum. Septoplasty is often needed when the patient is having an operation to reduce the size of the nose (reductive rhinoplasty), because this operation usually reduces the amount of breathing space in the nose.

During surgery, the patient's own cartilage that has been removed can be reused to provide support for the nose if needed. External septum supports are not usually needed. Splints may be needed occasionally to support cartilage when extensive cutting has been done. External splints can be used to support the cartilage for the first few days of healing. Tefla gauze is inserted in the nostril to support the flaps and cartilage and to absorb any bleeding or mucus.

### Demographics

About one-third of the population may have some degree of nasal obstruction. Among those with nasal obstruction, about one-fourth have deviated septa.

### Diagnosis/Preparation

The primary conditions that may suggest a need for septoplasty include:

- nasal air passage obstruction
- nasal septal deformity
- headaches caused by septal spurs
- chronic and uncontrolled nosebleeds
- chronic sinusitis associated with a deviated septum
- obstructive sleep apnea
- polypectomy (polyp removal)
- tumor excision
- turbinate surgery
- ethmoidectomy (removal of all or part of a small bone on the upper part of the nasal cavity)

## KEY TERMS

**Cartilage**—A tough, elastic connective tissue found in the joints, outer ear, nose, larynx, and other parts of the body.

**Obstructive sleep apnea**—A temporary cessation of breathing that occurs during sleep and is associated with poor sleep quality.

**Polyp**—A tumor commonly found in vascular organs such as the nose that are often benign but can become malignant.

**Rhinoplasty**—Plastic surgery of the nose.

**Septum (plural, septa)**—The dividing partition in the nose that separates the two nostrils. It is composed of bone and cartilage.

**Sinusitis**—Inflammation of the sinuses.

**Splint**—A thin piece of rigid material that is sometimes used during nasal surgery to hold certain structures in place until healing is underway.

**Spurs**—A sharp horny outgrowth of the skin.

**Wegener's granulomatosis**—A rare condition that consists of lesions within the respiratory tract.

Septal deformities can cause nasal airway obstruction. Such airway obstruction can lead to mouth breathing, chronic nasal infections, or obstructive sleep apnea. Septal spurs can produce headaches when these growths lead to increased pressure on the nasal septum. Polypectomy, ethmoidectomy, **tumor removal**, and turbinate surgical procedures often include septoplasty. Individuals who have used significant quantities of cocaine over a long period of time often require septoplasty because of alterations in the nasal passage structures.

Septal deviation is usually diagnosed by direct observation of the nasal passages. In addition, a computed tomography (CT) scan of the entire nasal passage is often performed. This scan allows the physician to fully assess the structures and functioning of the area. Additional tests that evaluate the movement of air through the nasal passages may also be performed.

Before performing a septoplasty, the surgeon will evaluate the difference in airflow between the two nostrils. In children, this assessment can be done very simply by asking the patient to breathe out slowly on a small mirror held in front of the nose.

As with any other operation under **general anesthesia**, patients are evaluated for any physical conditions that might complicate surgery and for any medications

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Septoplasty is performed by a medical doctor (M.D.) who has received additional training in surgery. Typically, septoplasty is performed by a board-certified plastic surgeon, a specialist called an otolaryngologist, or a head and neck surgeon. The procedure can be performed in a hospital or in a specialized surgical clinic.

that might affect blood clotting time. If a general anesthetic is used, then the patient is advised not to drink or eat after midnight the night before the surgery. In many cases, septoplasty can be performed on an outpatient basis using **local anesthesia**. Conditions that might preclude a patient from receiving a septoplasty include excessive cocaine abuse, Wegener's granulomatosis, malignant lymphomas, and an excessively large septal perforation.

### Aftercare

Patients who receive septoplasty are usually sent home from the hospital later the same day or in the morning after the surgery. All **dressings** inside the nose are usually removed before the patient leaves. Aftercare includes a list of detailed instructions for the patient that focus on preventing trauma to the nose.

The head needs to be elevated while resting during the first 24-48 hours after surgery. Patients will have to breathe through the mouth while the nasal packing is still in place. A small amount of bloody discharge is normal, but excessive bleeding should be reported to the physician immediately. **Antibiotics** are usually not prescribed unless the packing is left in place more than 24 hours. Most patients do not suffer significant amounts of pain, but those who do have severe pain are sometimes given narcotic pain relievers. Patients are often advised to place an ice pack on the nose to enhance comfort during the recovery period. Patients who have splint placement usually return seven to 10 days after the surgery for examination and splint removal.

### Risks

The risks from septoplasty are similar to those from other operations on the face: postoperative pain

## QUESTIONS TO ASK THE PRIMARY CARE PHYSICIAN

- What are my alternatives?
- Is surgery the answer for me?
- Can you recommend a surgeon who performs septoplasty?
- If surgery is appropriate for me, what are the next steps?

with some bleeding, swelling, bruising, or discoloration. A few patients may have allergic reactions to the anesthetics. The operation in itself, however, is relatively low-risk in that it does not involve major blood vessels or vital organs. Infection is unlikely if proper surgical technique is observed. One of the extremely rare but serious complications of septoplasty is cerebrospinal fluid leak. This complication can be treated with proper nasal packing, bed rest, and antibiotic use. Follow-up surgery may be necessary if the nasal obstruction relapses.

### Normal results

Normal results include improved breathing and airflow through the nostrils, and an acceptable outward shape of the nose. Most patients have significant improvements in symptoms following surgery.

### Morbidity and mortality rates

Significant morbidity associated with septoplasty is rare and is outlined in the Risks section above. Mortality is extremely rare and associated with the risks involving anesthesia. This procedure can be performed using local anesthesia on an outpatient basis or under general anesthesia during a short hospital stay. General anesthesia is associated with a greater mortality rate, but this risk is minimal.

### Alternatives

In cases of sinusitis or allergic rhinitis, nasal airway breathing can be improved by using nasal sprays, such as phenylephrine (Neo-Synephrine). Patients with a history of chronic, uncontrolled nasal bleeding should receive conservative therapy that includes nasal packing to identify the source of the bleeding before surgery is contemplated. Those who have been diagnosed with obstructive sleep apnea have a variety of conservative alternatives before surgery is seriously considered. These alternatives include weight loss,

## QUESTIONS TO ASK THE SURGEON

How many times have you performed septoplasty?  
 Are you a board-certified surgeon?  
 What type of outcomes have you had?  
 What are the most common side effects or complications?  
 What should I do to prepare for surgery?  
 What should I expect following the surgery?  
 Can you refer me to one of your patients who has had this procedure?  
 What type of diagnostic procedures are performed to determine if patients require surgery?  
 Will I need to see another specialist for the diagnostic procedures?

changes in sleep posture, and the use of appliances during sleep that enlarge the upper airway.

### Resources

#### BOOKS

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Mark Mitchell

## Serum chloride level

### Definition

Chloride is a mineral that is found throughout the body. Along with other electrolytes (such as sodium, potassium, and carbon dioxide), chloride is involved in maintaining an appropriate fluid balance throughout the body, including an appropriate blood volume; maintaining a stable blood pressure; and equilibrating the pH of the body fluids. For the body to function normally, serum chloride levels have to be maintained at a very narrow range; when chloride levels are too high or

too low, it can have serious health consequences. The body keeps its chloride levels in equilibrium by prompting the kidneys to resorb more (when the body needs chloride) or excrete more (when there is excess chloride). When serum chloride levels get too high, the condition is called hyperchloremia. When serum chloride levels get too low, the condition is called hypochloremia.

### Purpose

A serum chloride level is usually drawn as part of a larger panel of electrolytes. Other measurements in the electrolyte panel include sodium, potassium, and carbon dioxide. A serum chloride level is usually checked during a routine **physical examination**, as well as to evaluate patients who are experiencing prolonged or severe vomiting and/or diarrhea, fatigue, weakness, confusion, muscle spasms, or respiratory distress. Electrolyte panels are frequently used to diagnose, monitor, or otherwise evaluate patients with kidney disease, liver disease, high blood pressure, heart failure, and other chronic conditions.

### Precautions

Serum chloride levels can be affected by a number of medications. Patients who are on these medications should inform their doctor, so that test results can be interpreted appropriately. Medications that may affect serum chloride levels include steroid medications, **non-steroidal anti-inflammatory drugs** (such as ibuprofen), estrogen-containing medications, male hormones (androgens) some blood pressure medications, cholesterol-lowering agents (such as cholestyramine), and diuretic medications. Another factor that may skew the results of a serum chloride level involves the patient's level of hydration. When a patient is dehydrated, the serum chloride level will be elevated; when a patient is over-hydrated, the serum chloride level will be artificially lowered.

Patients who are taking anticoagulant medications should inform their healthcare practitioner, since this may increase their chance of bleeding or bruising after a blood test.

### Description

This test requires blood to be drawn from a vein (usually one in the forearm), generally by a nurse or phlebotomist (an individual who has been trained to draw blood). A tourniquet is applied to the arm above the area where the needle stick will be performed. The site of the needle stick is cleaned with antiseptic, and the needle is inserted. The blood is collected in vacuum tubes. After collection, the needle is withdrawn, and pressure is kept on the blood draw site to stop any bleeding and decrease bruising. A bandage is then applied.

## KEY TERMS

**Addison's disease**—A disease involving decreased functioning of the adrenal glands.

**Antidiuretic hormone (ADH)**—Also called vasopressin. A hormone produced by the hypothalamus and stored in and excreted by the pituitary gland. ADH acts on the kidneys to reduce the flow of urine, increasing total body fluid. When too much ADH is produced, resulting in the body retaining fluid, the sodium concentration becomes abnormally low.

**Cushing's syndrome**—A disorder affecting the adrenal glands and their secretion of cortisol.

**Diuretic**—A medication that increases the flow of urine through the kidneys and out of the body.

**Hyperchloremia**—Elevated serum chloride levels.

**Hypochloremia**—Low serum chloride levels.

**Metabolic acidosis**—A condition in which either too much acid or too little bicarbonate in the body results in a drop in the blood pH (towards acidity).

**Metabolic alkalosis**—A condition in which abnormal either too little acid or too much bicarbonate in the body results in an elevation in the blood pH (towards alkalinity).

**Respiratory acidosis**—A condition in which abnormal exchange of oxygen and carbon dioxide in the lungs results in too much carbon dioxide being accumulated, and a resultant drop in the blood pH (towards acidity).

**Respiratory alkalosis**—A condition in which abnormal exchange of oxygen and carbon dioxide in the lungs results in the exhalation of too much carbon dioxide, and a resultant rise in the blood pH (towards alkalinity).

## Preparation

There are no restrictions on diet or physical activity, either before or after the blood test.

## Aftercare

As with any blood tests, discomfort, bruising, and/or a very small amount of bleeding is common at the puncture site. Immediately after the needle is withdrawn, it is helpful to put pressure on the puncture site until the bleeding has stopped. This decreases the chance of significant bruising. Warm packs may relieve minor discomfort. Some individuals may feel briefly woozy after a blood test, and they should be encouraged to lie down and rest until they feel better.

## Risks

Basic blood tests, such as serum chloride levels, do not carry any significant risks, other than slight bruising and the chance of brief dizziness.

## Results

In adults, a normal serum chloride level is 98-106 milliequivalents per liter (mEq/L, or 98-106 millimoles per liter (mmol/L). In children, a normal serum chloride level is 90-110 milliequivalents per liter (mEq/L, or 90-110 millimoles per liter (mmol/L). In newborns, a normal serum chloride level is 96-106 milliequivalents per liter (mEq/L, or 96-106 millimoles per liter (mmol/L). In premature infants, a normal serum chloride level is 95-110 milliequivalents per liter (mEq/L, or 95-110 millimoles per liter (mmol/L).

### High levels

High serum chloride levels occur whenever there is low blood sodium (hyponatremia), or may also be due to:

- Dehydration: Increased loss of body water without sufficient replacement by drinking; often occurs in febrile illnesses, with severe diarrhea and/or vomiting, or in situations involving heavy exercise in hot weather, resulting in fluid loss through heavy sweating
- Hyperventilation
- Kidney disease
- Excessive consumption of salt
- Anemia
- Use of carbonic anhydrase inhibitors (glaucoma medications)
- Hyperparathyroidism (an overactive parathyroid gland)
- Metabolic acidosis
- Respiratory alkalosis
- Excess bromide

### Low levels

Low serum chloride levels may be due to any disorder that causes low blood sodium (hyponatremia) or may be due to:

- Cushing's syndrome
- Addison's disease
- Syndrome of inappropriate ADH secretion (SIADH)
- Repeated vomiting, or prolonged gastric suction
- Chronic diarrhea
- Serious burns
- Excess sweating



- Chronic lung diseases, including emphysema and chronic obstructive pulmonary disorder
- Congestive heart failure
- Kidney disease
- Cystic fibrosis
- Respiratory acidosis
- Metabolic alkalosis
- Overhydration

## Resources

### BOOKS

- Goldman L, Ausiello D., eds. *Cecil Textbook of Internal Medicine*. 23rd ed. Philadelphia: Saunders, 2008.
- McPherson RA et al. *Henry's Clinical Diagnosis and Management By Laboratory Methods*. 21st ed. Philadelphia: Saunders, 2007.

### ORGANIZATIONS

- American Association of Clinical Chemistry. 1850 K St., N.W Suite 625, Washington, DC 20006. <http://www.aacc.org>.

### OTHER

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Rosalyn Carson-DeWitt, MD

## Serum creatinine level

### Definition

Creatinine is actually a chemical waste product that is produced by the muscles. The chemical “creatinine” is an important chemical involved in the production of energy needed for muscle contraction. During the course of every day, about 2% of the body’s creatine becomes creatinine. Creatinine enters the bloodstream and goes to the kidneys. Healthy kidneys filter out this waste material from the blood. It passes into the urine and out of the body. Unhealthy kidneys are unable to filter out the creatinine from the blood. The creatinine remains circulating in the bloodstream, and levels rise as the muscles continue to produce more and more.

The serum creatinine level is used to predict how the kidneys are functioning. In many cases, the serum creatinine level will begin to rise before a patient is even aware of any symptoms of kidney malfunction. High creatinine levels indicate the need for further investigation into the possibility that kidney failure is ensuing. If a creatinine level is elevated, then other tests such as blood urea nitrogen (BUN) or urine

creatinine will be performed. Calculations involving serum and urine creatinine levels will give the creatinine clearance, a figure which reflects the capacity of the kidneys to filter small molecules out of the bloodstream. Calculations involving the serum creatinine level and the individual’s gender, height, weight, and age will allow estimation of the glomerular filtration rate, which can screen for kidney damage and disease.

Serum creatinine level is tied to muscle contraction, therefore, the normal value of an individual’s serum creatinine level will be dependent on the individual’s size and their overall muscle mass. In general, the normal serum creatinine level for men is higher than the normal serum creatinine level in either women or children. Because athletes tend to have greater muscle mass, their normal creatinine level may be higher than that of non-athletes.

### Purpose

A serum creatinine level is usually drawn as part of a larger metabolic panel or screen. Other tests performed in this panel include electrolytes (sodium, potassium, chloride, and carbon dioxide), as well as calcium, glucose, and BUN. A serum creatinine level is usually checked during a routine **physical examination**, as well as to evaluate patients for the presence of kidney disease, to monitor patients who have illnesses or who are taking medications that might affect the functioning of their kidneys, or to make sure that treatment for kidney disease is effective.

### Precautions

Serum creatinine levels can be affected by a number of medications. Patients who are on these medications should inform their doctor, so that test results can be interpreted appropriately. Medications that may affect serum creatinine levels include methyl-dopa, trimethoprim, vitamin C, cimetidine, certain **diuretics**, and cephalosporin **antibiotics**. Additionally, if the serum creatinine level is going to be used in calculations with the urine creatinine or the BUN levels to evaluate kidney functioning, results may be skewed by the following medications: vitamin C, phenytoin, cephalosporin antibiotics, captopril, aminoglycosides, trimethoprim, cimetidine, quinine, quinidine, procainamide, amphotericin B, steroid medications, and tetracycline antibiotics.

Patients who are taking anticoagulant medications should inform their healthcare practitioner, since this may increase their chance of bleeding or bruising after a blood test.

## KEY TERMS

**Blood urea nitrogen (BUN)**—Blood urea nitrogen is a chemical waste product of protein metabolism that circulates in the bloodstream. Healthy kidneys remove urea from the bloodstream and it leaves the body in the urine. When the kidneys are not functioning properly, they are unable to filter the urea out of the blood, and blood urea nitrogen levels become elevated.

**Creatine**—Creatine is a substance produced by proteins and stored in the muscles. Creatine is a source for energy, allowing muscle contraction to take place. Some creatine is converted to creatinine, and enters the bloodstream, where it is filtered out by healthy kidneys and leaves the body in the urine. When the kidneys are not functioning properly, creatinine levels in the blood become abnormally elevated.

**Diabetic nephropathy**—Kidney damage or disease brought on by the long-term effects of diabetes.

**Glomerulonephritis**—A condition in which the filtering structures within the kidneys become damaged, limiting the kidneys' ability to filter waste products from the blood.

**Preeclampsia**—A condition occurring in pregnancy in which high blood pressure leads to a number of complications, including a decreased ability of the kidneys to appropriately filter wastes from the blood.

**Urine creatinine level**—A value obtained by testing a 24-hour collection of urine for the amount of creatinine present.

## Description

This test requires serum to be drawn from a vein (usually one in the forearm), generally by a nurse or phlebotomist (an individual who has been trained to draw serum). A tourniquet is applied to the arm above the area where the needle stick will be performed. The site of the needle stick is cleaned with antiseptic, and the needle is inserted. The serum is collected in vacuum tubes. After collection, the needle is withdrawn, and pressure is kept on the serum draw site to stop any bleeding and decrease bruising. A bandage is then applied.

## Preparation

In the 24–48 hours prior to a serum creatinine level, patients should be advised to avoid strenuous **exercise** and to limit the amount of protein they ingest. Creatinine is a waste product of muscle contraction and, therefore, vigorous exercise in the 48 hours prior to a serum creatinine level could alter the results of the test. Similarly, ingesting more than eight ounces of meat

(particularly beef) or other protein sources in the 24 hours prior to the serum creatinine level may affect the results.

## Aftercare

As with any blood tests, discomfort, bruising, and/or a very small amount of bleeding is common at the puncture site. Immediately after the needle is withdrawn, it is helpful to put pressure on the puncture site until the bleeding has stopped. This decreases the chance of significant bruising. Warm packs may relieve minor discomfort. Some individuals may feel briefly woozy after a serum test, and they should be encouraged to lie down and rest until they feel better.

## Risks

Basic serum tests, such as serum creatinine levels, do not carry any significant risks, other than slight bruising and the chance of brief dizziness.

## Results

In adult men, a normal serum creatinine level is 0.6–1.2 milligrams per deciliter (mg/dL) or 53–106 micromoles/L (mcmol/L). In adult women, a normal serum creatinine level is 0.5–1.1 mg/dL or 44–97 mcmol/L. In teenagers, a normal serum creatinine level is 0.5–1.0 mg/dL. In children, a normal serum creatinine level is 0.3–0.7 mg/dL. In newborn babies, a normal serum creatinine level is 0.3–1.2 mg/dL.

## High levels

High serum creatinine levels suggest that the kidneys are suffering from damage or disease. Kidneys can be damaged by severe infections, shock, cancer, or conditions that limit the blood flow reaching the kidneys. High serum creatinine levels can also occur when the urinary tract is blocked, or due to:

- obstruction of the urinary tract from a kidney stone or tumor;
- acute tubular necrosis;
- diabetic nephropathy;
- pre eclampsia;
- glomerulonephritis;
- dehydration;
- heart failure;
- extreme blood loss;
- gout;
- muscular dystrophy;
- rhabdomyolysis (conditions resulting in the abnormal breakdown of muscle tissue);
- myasthenia gravis;

- acromegaly; or
- gigantism.

### Low levels

Low serum creatinine levels may be due to:

- abnormally low muscle mass, as may occur in muscle wasting diseases like muscular dystrophy, or due to aging;
- liver disease;
- extreme low-protein diets; or
- pregnancy

### Resources

#### BOOKS

Brenner, B. M., and F. C. Rector, eds. *Brenner & Rector's The Kidney*, 7th ed. Philadelphia: Saunders, 2004.

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#### ORGANIZATIONS

American Association for Clinical Chemistry, 1850 K Street, NW, Suite 625, Washington, DC, 20006, (800) 892 1400, <http://www.aacc.org>.

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Serum electrolyte tests **see** [Electrolyte tests](#)

## Serum glucose level

### Definition

The serum glucose or blood sugar level is a measurement of the amount of a particular form of simple sugar in the blood. When carbohydrates are ingested, they are broken down in the intestines into component parts, including sugars such as glucose. Glucose is absorbed from the small intestine into the bloodstream. It circulates throughout the body and is used by all of the body's tissues and organs to generate the energy necessary for their normal functioning. In order for glucose to enter the body's cells, insulin must be present. Insulin is a hormone produced in and excreted by the pancreas. Insulin functions to allow the transport of glucose into the cells of the body, as well as being involved in the body's storage of excess glucose in the form of glycogen or triglycerides.

The blood levels of glucose and insulin are intimately related. When carbohydrates are metabolized after a meal, the blood glucose begins to rise. Under normal circumstances, the pancreas then secretes insulin, in an amount relative to the blood glucose elevation. Between meals, or after heavy exertion, glucose levels may begin to drop below a safe threshold for the body's cells (particular cells of the brain and nervous system). In response to this lowering of blood glucose, the pancreas secretes a different hormone, called glucagon. Glucagon prompts the liver to convert glycogen into glucose, thereby elevating the blood glucose back into a safe range.

Abnormal levels of blood glucose can be life-threatening. High blood glucose is termed hyperglycemia; low blood glucose is termed hypoglycemia. Either of these conditions can result in organ failure, severe brain damage, coma, or **death**. Diabetes occurs when the pancreas fails to produce normal amounts of insulin, or when it completely stops producing any insulin at all (this is often referred to as insulin-dependent or type I diabetes). Diabetes can also occur when cells of the body become less responsive to the effects of insulin (this is often referred to as insulin-resistance, or type II diabetes). Diabetes causes abnormal perturbations of the serum glucose level. Chronic high levels of serum glucose (which may occur in poorly controlled diabetes) can result in severe damage over time to the heart, the eyes, the kidneys, the circulatory system, and the nervous system. In diabetics, sudden, acute increases in the serum glucose level can result in the condition called diabetic ketoacidosis, in which the extremely high levels of blood glucose lead a life-threatening illness. Diabetics can also suffer from sudden drops in serum glucose levels; if untreated, glucose deprivation can affect the organs and tissues of the body and may also be life-threatening.

### Purpose

A serum glucose level is usually drawn as part of a larger metabolic panel or screen. Other tests performed in this panel include electrolytes (sodium, potassium, chloride, and carbon dioxide), as well as calcium, creatinine, and BUN (blood urea nitrogen). A serum glucose level is usually checked during a routine **physical examination** or may be performed specifically to screen for diabetes, especially when there is a strong family history of diabetes, or when an individual has other specific risk factors, such as being overweight.

Serum glucose levels are also an important part of monitoring the health of pregnant women since some women develop gestational diabetes during pregnancy. Untreated, this can result in problems with the baby as

well as the mother. Gestational diabetes in early pregnancy can cause birth defects (particularly of the brain and/or heart) and increase the chance of miscarriage. Gestational diabetes in the second and third trimesters can cause the baby to grow very large. The baby's size can result in problems for the mother during labor and delivery. Additionally, once the baby is born, it can suffer sudden hypoglycemia. In utero, the baby will have acclimated to its mother's high serum glucose levels by producing high levels of insulin. After birth, suddenly deprived of that glucose, the baby's relatively high insulin levels can result in severe hypoglycemia.

A serum glucose level may be ordered when there are symptoms suspicious of diabetes, such as excessive thirst and/or hunger, urinary frequency, unintentional weight loss, severe fatigue and weakness, and poor healing. The diagnosis of diabetes requires that a random high serum glucose level be confirmed by a high fasting serum glucose level or by abnormal results of an **oral glucose tolerance test**. Patients who are diabetic may also be required to check their own blood glucose one or more times a day, to make sure that their condition is under good control.

A serum glucose level may be ordered when there are symptoms suspicious of low blood sugar (hypoglycemia), such as shakiness, sweating, anxiety, confusion, dizziness, or fainting.

### Precautions

The serum glucose level is highly affected by when an individual has last eaten, therefore, appropriate interpretation of the test results must take this into consideration. Serum glucose levels may be examined under random conditions, after an eight to ten hour fast (referred to as a fasting serum glucose level); two hours after a meal has been completed (referred to as a two-hour post-prandial serum glucose level); or after an individual has been given a standardized amount of a glucose-containing beverage (referred to as an oral glucose tolerance test or OGTT).

Serum glucose levels can be affected by a number of medications. Patients who are on these medications should inform their doctor, so that test results can be interpreted appropriately. Medications that may affect serum glucose levels include birth control pills, high blood pressure medications, phenytoin, furosemide, triamterene, hydrochlorothiazide, niacin, propranolol, and steroid medications. Additionally, the use of alcohol, the use of caffeine, recent illness, infection, or emotional distress may affect test results.

Patients who are taking anticoagulant medications should inform their healthcare practitioner,

since this may increase their chance of bleeding or bruising after a blood test.

### Description

This test requires serum to be drawn from a vein (usually one in the forearm), generally by a nurse or phlebotomist (an individual who has been trained to draw serum). A tourniquet is applied to the arm above the area where the needle stick will be performed. The site of the needle stick is cleaned with antiseptic, and the needle is inserted. The serum is collected in vacuum tubes. After collection, the needle is withdrawn, and pressure is kept on the serum draw site to stop any bleeding and decrease bruising. A bandage is then applied.

Self-glucose testing is often performed one or more times per day by diabetics themselves. This involves using a special sharp instrument, called a lancet, to prick a finger. Frequently, these lancets are placed in a spring-loaded mechanism to make it easier to accomplish the finger prick. A drop of blood from this finger prick is then put onto a special strip of paper and slipped into a machine called a blood glucose meter. The meter gives a digital readout of the serum glucose level. Alternatively, the drop of blood can be put onto a special strip of test paper which changes color based on the glucose level; this is less accurate than the blood glucose meter.

### Preparation

There are no special preparations necessary prior to a random serum glucose level. For a two-hour post-prandial serum glucose level, the individual should be instructed to eat a meal exactly two hours before the blood draw. For a fasting serum glucose level, the individual should ingest nothing other than water for a minimum of eight hours prior to the blood draw. Diabetics may be asked to delay their morning dose of insulin or oral diabetes medication (oral hypoglycemic agents) prior to the blood draw.

### Aftercare

As with any blood tests, discomfort, bruising, and/or a very small amount of bleeding is common at the puncture site. Immediately after the needle is withdrawn, it is helpful to put pressure on the puncture site until the bleeding has stopped. This decreases the chance of significant bruising. Warm packs may relieve minor discomfort. Some individuals may feel briefly woozy after a serum test, and they should be encouraged to lie down and rest until they feel better.



## KEY TERMS

**Gestational diabetes**—A type of diabetes that occurs during pregnancy. Untreated, it can cause severe complications for the mother and the baby; however, it usually does not lead to long-term diabetes in either the mother or the child.

**Glucose**—A simple sugar that is the product of carbohydrate metabolism. It is the major source of energy for all of the organs and tissues of the body.

**Glucagon**—A hormone produced in the pancreas that is responsible for elevating blood glucose when it falls below a safe level for the body's organs and tissues.

**Glycogen**—The form in which glucose is stored in the body.

**Hyperglycemia**—Elevated blood glucose levels.

**Hypoglycemia**—Low blood glucose levels.

**Insulin**—A hormone produced by the pancreas that is responsible for allowing the body's cells to utilize glucose. The deficiency or absence of insulin is one of the causes of the disease diabetes.

**Insulinoma**—A tumor within the pancreas that produces insulin, potentially causing the serum glucose level to drop to dangerously low levels.

**Ketoacidosis**—A potentially life-threatening condition in which abnormally high blood glucose levels result in the blood become too acidic.

**Pancreas**—An organ located near the liver and stomach, responsible for various digestive functions. The pancreas produces insulin and glucagon, hormones that are responsible for maintaining safe blood levels of glucose.

## Risks

Basic blood tests, such as serum glucose levels, do not carry any significant risks, other than slight bruising and the chance of brief dizziness.

## Results

Normal results of a random serum glucose test range from 70–125 milligrams per deciliter (mg/dL). Normal results of a two-hour post-prandial serum glucose level range from 70–145 mg/dL. Normal results of a fasting serum glucose level range from 70–99 mg/dL.

### High levels

High serum glucose levels suggest the possibility of diabetes; however, a single high, random serum glucose

level is not sufficient for definitively diagnosing diabetes. The American Diabetes Association has specific criteria that must be met in order to diagnose diabetes. They require that results are verified through testing on a minimum of two different days. Levels indicative of diabetes are as follows:

- random serum glucose level of 200 mg/dL in the presence of actual symptoms of diabetes (such as increased thirst and/or hunger, urinary frequency, unintentional weight loss, weakness and fatigue, numbness/tingling in hands and feet, blurred vision, or erection problems;
- fasting serum glucose level of at least 126 mg/dL;
- two-hour oral glucose tolerance test of at least 200 mg/dL.

Individuals who don't meet the criteria for an actual diagnosis of diabetes, but who have a higher-than-normal fasting serum glucose level, also known as an impaired fasting glucose (ranging from 100 mg/dL to 125 mg/dL), have an increased risk of eventually developing diabetes, and should be followed closely. These individuals are considered to have "prediabetes."

Other causes of high serum glucose levels include:

- severe stress;
- heart attack;
- stroke;
- Cushing's syndrome;
- steroid medications; and
- acromegaly (elevated growth hormone).

### Low levels

Low serum glucose levels may be due to:

- the presence of an insulinoma (a tumor that secretes insulin);
- Addison's disease;
- hypothyroidism (underactive thyroid);
- pituitary gland tumor;
- liver disease, including cirrhosis;
- kidney disease;
- malnutrition;
- eating disorders, including anorexia nervosa; and
- inappropriate doses of medicines used to treat diabetes, such as insulin or oral hypoglycemic agents.

## Resources

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- Kronenberg H. M., S. Melmed, K. S. Polonsky, P. R. Larsen. *Williams Textbook of Endocrinology*, 11th ed. Philadelphia: Saunders Elsevier, 2007.

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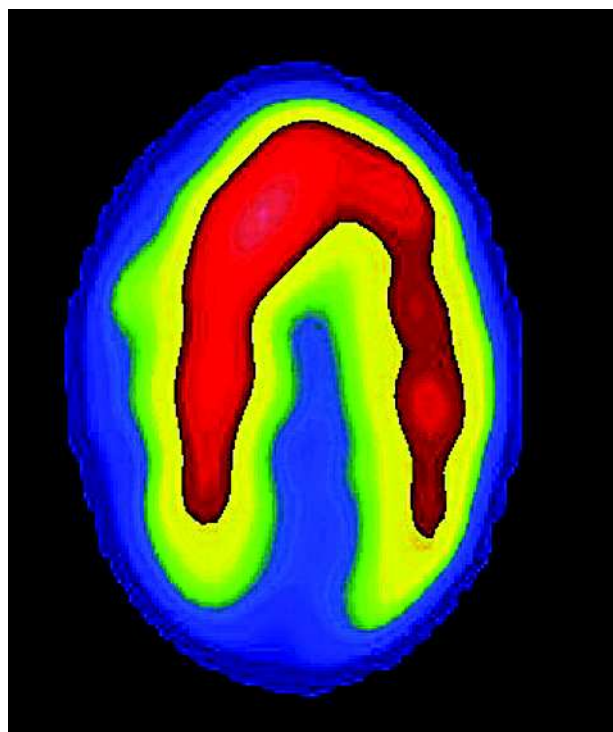
American Association for Clinical Chemistry, 1850 K Street, NW, Suite 625, Washington, DC, 20006, (800) 892 1400, <http://www.aacc.org>.

Rosalyn Carson-DeWitt, M.D.

## Sestamibi scan

### Definition

A sestamibi scan is a highly sensitive and highly specific nuclear medicine test used to locate and image an overactive parathyroid gland in a patient with known hyperparathyroidism. Information from the



**Sestamibi scan.** (ISM / Phototake. Reproduced by permission.)

test can help with planning for surgery to remove the overactive gland.

Located in the neck behind the thyroid gland, the four parathyroid glands are pea-sized endocrine glands that are responsible for the production of parathyroid hormone or PTH. PTH is important in the balance of calcium and phosphate throughout the body.

Under normal conditions, low calcium concentrations in the bloodstream prompt the parathyroid gland to put out increased amounts of PTH. PTH acts on several areas of the body. It directs the kidneys to absorb calcium back into the body, rather than flushing it out of the body in the urine. It activates osteoclasts in bone to degrade bone material, releasing calcium for use in the body. It increases the activity of vitamin D, which allows more calcium to be absorbed in the intestine.

Hyperparathyroidism is usually due to the presence of an adenoma, a benign (not cancerous) growth on one or more of the parathyroid glands. A sestamibi scan is used to generate images of the parathyroid glands prior to surgery so that the surgeon knows which of the four glands will require removal. Surgery to remove a parathyroid gland is called a **parathyroidectomy**.

During a sestamibi scan, the patient is given an injection of the radioactive material technetium-99, bound to a tiny protein called sestamibi. Unlike normal parathyroid glands, adenomatous parathyroid glands absorb the radioactive material, permitting visualization and localization of the tumor or tumors on the scan images. This test can be performed in preparation for an operation to remove the parathyroid adenoma, or during the course of such an operation (intraoperatively).

### Purpose

Hyperparathyroidism is a condition in which one or more of the parathyroid glands become overactive. Too much bone is broken down, and too much calcium circulates in the bloodstream (termed hypercalcemia). The consequences of this excess bone breakdown and excess circulating calcium include:

- Weakness
- Fatigue
- Depression
- Aching
- Decreased appetite
- Heartburn
- Nausea and vomiting
- Constipation

- High blood pressure
- Confusion
- Difficulty thinking
- Poor memory
- Excess thirst
- Frequent urination
- Thinner, weaker bones
- Increased risk of bone fracture
- Kidney stones

Hyperparathyroidism is often considered idiopathic, which means that there is no known underlying cause of the disorder. In about 5% of people with parathyroidism, there is a family tendency for the disorder, such as Familial multiple endocrine neoplasia type 1 or familial hypocalciuric hypercalcemia.

About 100,000 people in the United States are diagnosed with hyperparathyroidism annually. Women are twice as likely to get the disorder than men, and it is more common in people over the age of 60.

### Description

Prior to starting the scanner for a sestamibi scan, radioactive contrast is injected through an IV in the patient's arm. The radionuclide (the technetium-99 bound to sestamibi molecules) circulates in the blood stream, concentrating in diseased parathyroid glands. The patient lies on an examination table, and a gamma camera is positioned over the patient's neck. The camera consists of a crystal detector that detects emitted radiation from the radioactive contrast. A computer converts the signal into a digital image of the parathyroid glands. Scanning is done immediately after injection of the radionuclide, and 1½ to 2 hours after injection. Each scan takes about 10 minutes.

### Preparation

There is nothing patients need to do in preparation for a sestamibi scan. To avoid confusing results, patients who have recently had another type of nuclear scan may need to wait several days to allow that radioactive tracer to leave their bodies, prior to undergoing a sestamibi scan.

Women who are pregnant or who think they may be pregnant are advised against undergoing a sestamibi scan. Women who are breastfeeding and who require a sestamibi scan should feed their baby with formula for two days following the procedure, and should pump and discard their breast milk, since it will be contaminated with the radioactive dye.

## KEY TERMS

**Adenoma**—A benign tumor of an endocrine gland.

**Hypercalcemia**—Excess concentration of calcium in the blood.

**Hyperparathyroidism**—A condition in which the parathyroid gland is overactive; usually caused by the presence of an adenoma on one or more of the glands.

**Parathyroidectomy**—An operation performed in order to remove one or more parathyroid gland.

**Thyroid gland**—An endocrine organ in the neck which produces thyroid hormone. Thyroid hormone is involved in important growth and metabolic processes throughout the body.

### Aftercare

There is no aftercare necessary following a sestamibi scan. The patient can return immediately to a normal diet and normal activities.

### Risks

A sestamibi scan poses very little risk to the patient. Rarely, a patient may have an allergy to the radioactive contrast utilized.

### Normal results

Normal results of a sestamibi scan would reveal no uptake of the radionuclide tracer in the neck, suggesting that no parathyroid adenoma is present.

### Abnormal results

An abnormal sestamibi scan will reveal an area where the radionuclide has been absorbed by a parathyroid adenoma. Even small, single adenomas on a parathyroid gland will “light up,” due to their tendency to absorb the radionuclide. This allows highly accurate localization of the exact area requiring operation. In some cases, a falsely positive sestamibi scan may occur in patients with thyroid disease.

### Resources

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Rosalyn Carson-DeWitt, MD

Seton glaucoma surgery see **Tube-shunt surgery**

## Sex reassignment surgery

### Definition

Also known as sex change or gender reassignment surgery, sex reassignment surgery is a procedure that changes genital organs from one gender to another.

### Purpose

There are two main reasons to alter the genital organs from one sex to another.

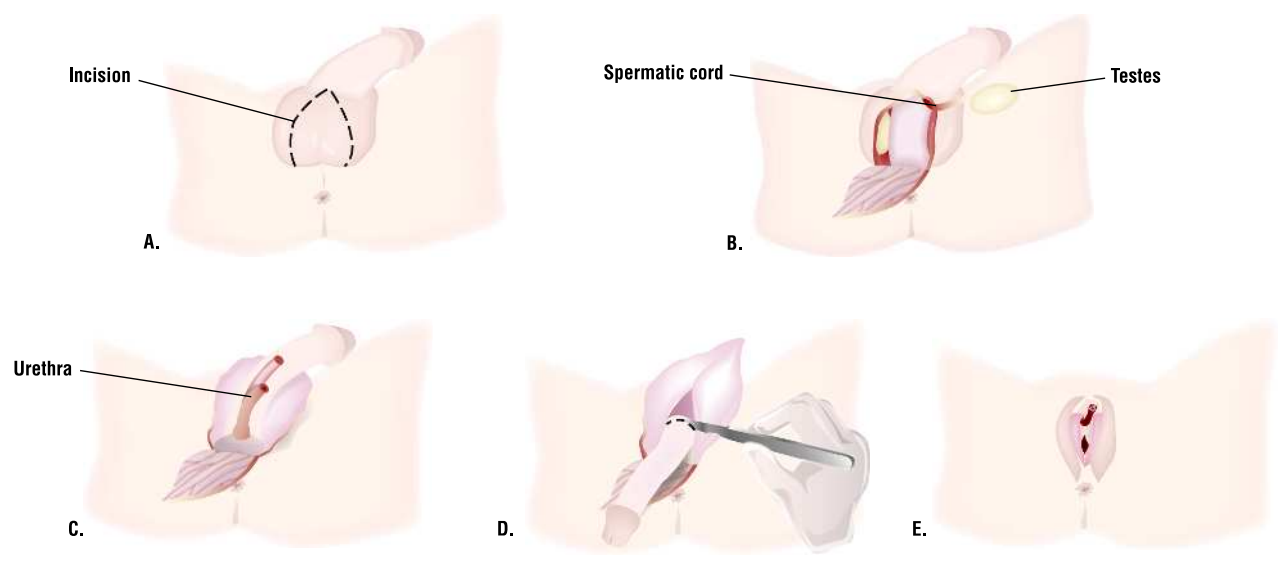
- Newborns with intersex deformities must be assigned to one sex or the other. These deformities represent intermediate stages between the primordial female genitals and the change into male genitals caused by male hormone stimulation.
- Both men and women occasionally believe they are physically a different sex than they are mentally and emotionally. This dissonance is so profound that they are willing to be surgically altered.

In both cases, technical considerations favor successful conversion to a female rather than a male. Newborns with ambiguous organs will almost always be assigned to the female gender unless the penis is at least an inch (2.5 cm) long. Whatever their chromosomes, they are much more likely to be socially well-adjusted as females, even if they cannot have children.

### Demographics

Reliable statistics are extremely difficult to obtain. Many sexual reassignment procedures are conducted in private facilities that are not subject to reporting requirements. Sexual reassignment surgery is often conducted outside of the United States. The number of gender reassignment procedures conducted in the United States each year is estimated at between 100

#### Sex change surgery



To change male genitalia to female genitalia, an incision is made into the scrotum (A). The flap of skin is pulled back, and the testes are removed (B). The skin is stripped from the penis but left attached, and a shorter urethra is cut (C). All but a stump of the penis is removed (D). The excess skin is used to create the labia (external genitalia) and vagina (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)



## KEY TERMS

**Androgens**—A class of chemical compounds (hormones) that stimulates the development of male secondary sexual characteristics.

**Chromosomes**—The carriers of genes that determine gender and other characteristics.

**Estrogens**—A class of chemical compounds (hormones) that stimulates the development of female secondary sexual characteristics.

**Hysterectomy**—Surgical removal of the uterus.

**Oophorectomy**—Surgical removal of the ovaries.

and 500. The number worldwide is estimated to be two to five times larger.

## Description

Converting male to female anatomy requires removal of the penis, reshaping genital tissue to appear more female, and constructing a vagina. A vagina can be successfully formed from a skin graft or an isolated loop of intestine. Following the surgery, female hormones (estrogen) will reshape the body's contours and stimulate the growth of satisfactory breasts.

Female to male surgery has achieved lesser success due to the difficulty of creating a functioning penis from the much smaller clitoral tissue available in the female genitals. Penis construction is not attempted less than a year after the preliminary surgery to remove the female organs. One study in Singapore found that a third of the persons would not undergo the surgery again. Nevertheless, they were all pleased with the change of sex. Besides the genital organs, the breasts need to be surgically altered for a more male appearance. This can be successfully accomplished.

The capacity to experience an orgasm, or at least "a reasonable degree of erogenous sensitivity," can be expected by almost all persons after gender reassignment surgery.

## Diagnosis/Preparation

Gender identity is an extremely important characteristic for human beings. Assigning sex must take place immediately after birth for the mental health of both children and their parents. Changing sexual identity is among the most significant changes that a human can experience. It should therefore be undertaken with extreme care and caution. By the time most adults come to surgery, they have lived for many years

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Gender reassignment surgery is performed by surgeons with specialized training in urology, gynecology, or plastic and reconstructive surgery. The surgery is performed in a hospital setting, although many procedures are completed in private clinics.

with a dissonant identity. The average in one study was 29 years. Nevertheless, even then they may not be fully aware of the implications of becoming a member of the opposite gender.

In-depth psychological counseling should precede and follow any gender reassignment surgical procedure.

Sex reassignment surgery is expensive. The cost for male to female reassignment is \$10,000 to \$20,000. The cost for female to male reassignment can exceed \$50,000.

## Aftercare

Social support, particularly from one's family, is important for readjustment as a member of the opposite gender. If surgical candidates are socially or emotionally unstable before the operation, over the age of 30, or have an unsuitable body build for the new gender, they tend not to fare well after gender reassignment surgery; however, in no case studied did the gender reassignment procedure diminish the ability to work.

## Risks

All surgery carries the risks of infection, bleeding, and a need to return for repairs. Gender reassignment surgery is irreversible, so a candidate must have no doubts about accepting the results and outcome.

## Normal results

Persons undergoing gender reassignment surgery can expect to acquire the external genitalia of a member of the opposite gender. Persons having male to female gender reassignment surgery retain a prostate. Individuals undergoing female to male gender reassignment surgery undergo a **hysterectomy** to remove the uterus and **oophorectomy** to remove their ovaries. Developing the habits and mannerisms characteristic of the patient's new gender requires many months or years.

## QUESTIONS TO ASK THE DOCTOR

Candidates for gender reassignment surgery should ask the following questions.

- What will my body look like afterward?
- Is the surgeon board certified in urology, gynecology, or plastic and reconstructive surgery?
- How many gender reassignment procedures has the surgeon performed?
- How many surgeries of the type similar to the one being contemplated (i.e., male to female or female to male) has the surgeon performed?
- What is the surgeon's complication rate?

### Morbidity and mortality rates

The risks that are associated with any surgical procedure are present in gender reassignment surgery. These include infection, postoperative pain, and dissatisfaction with anticipated results. Accurate statistics are extremely difficult to find. Intraoperative **death** has not been reported.

The most common complication of male to female surgery is narrowing of the new vagina. This can be corrected by dilation or using a portion of colon to form a vagina.

A relatively common complication of female to male surgery is dysfunction of the penis. Implanting a penile prosthesis is technically difficult and does not have uniformly acceptable results.

Psychiatric care may be required for many years after sex-reassignment surgery.

The number of deaths in male-to-female transsexuals was five times the number expected, due to increased numbers of suicide and death from an unknown cause.

### Alternatives

There is no alternative to surgical reassignment to alter one's external genitalia. The majority of persons who experience gender disorder problems never surgically alter their appearance. They dress as members of the desired gender, rather than gender of birth. Many use creams or pills that contain hormones appropriate to the desired gender to alter their bodily appearance. Estrogens (female hormones) will stimulate breast development, widening of the hips, loss of facial hair and a slight increase in voice pitch. Androgens (male hormones) will

stimulate the development of facial and chest hair and cause the voice to deepen. Most individuals who undergo gender reassignment surgery lead happy and productive lives.

### Resources

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#### ORGANIZATIONS

American Medical Association, 515 N. State Street, Chicago, IL, 60610, (800) 621-8335, <http://www.ama-assn.org/>.

American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209-3901, (703) 907-7300, [apa@psych.org](mailto:apa@psych.org), <http://www.psych.org/>.

American Psychological Association, 750 First Street, NE, Washington, DC, 20002-4242, (202) 336-5500, (800) 374-2721, <http://www.apa.org/>.

American Urological Association, 1000 Corporate Boulevard, Linthicum, MD, 21090, (410) 689-3700, (866) 746-4282, <http://www.auanet.org/>.

L. Fleming Fallon, Jr., M.D., Dr.P.H.

Shoulder arthroscopic surgery see **Rotator cuff repair; Bankart procedure**

## Shoulder joint replacement

### Definition

Shoulder joint replacement surgery is performed to replace a shoulder joint with artificial components (prostheses) when the joint is severely damaged by degenerative joint diseases such as arthritis, or in complex cases of upper arm bone fracture.

### Purpose

The shoulder is a ball-and-socket joint that allows the arms to be raised, twisted, bent, and moved forward, to the side and backward. The head of the upper arm bone (humerus) is the ball, and a circular cavity (glenoid) in the shoulder blade (scapula) is the socket. A soft-tissue rim (labrum) surrounds and deepens the socket. The head of the humerus is also covered with a smooth, tough tissue (articular cartilage), and the joint, also called the acromioclavicular (AC) joint, has a thin inner lining (synovium) that facilitates movement, while surrounding muscles and tendons provide stability and support.

The AC joint can be damaged by the following conditions to such an extent as to require replacement by artificial components:

- **Osteoarthritis.** This is a degenerative joint disease characterized by degeneration of the articular cartilage. When nonsurgical treatment is no longer effective and shoulder resection not possible, joint replacement surgery is usually indicated.
- **Rheumatoid arthritis.** Shoulder replacement surgery is the most commonly performed procedure for the arthritic shoulder with severe inflammatory or rheumatoid arthritis.
- **Severe fracture of the humerus.** A fracture of the upper arm bone can be so severe as to require replacement of the AC joint.
- **Osteonecrosis.** This condition usually follows a three- or four-part fracture of the humeral head that disrupts the blood supply, resulting in bone death and disruption of the AC joint.
- **Charcot's arthropathy.** Also called neuropathic arthropathy or arthritis, Charcot's arthropathy is a condition in which the shoulder joint is destroyed following loss of its nerve supply.

### Demographics

Shoulder arthritis is among the most prevalent causes of shoulder pain and loss of function. In the United States, arthritis of the shoulder joint is less common

than arthritis of the hip or knee. Individuals with arthritis in one joint are more likely to get it in another joint. Overall, arthritis is quite common in the United States, affecting about 21% of adult Americans, and 50% of American adults over the age of 65. Projections suggest that, by the year 2030, there will be 67 million Americans who have received the diagnosis of arthritis from their doctor. Osteoarthritis is also the most common joint disorder, extremely common by age 70. Men and women are equally affected, but onset is earlier in men.

### Description

Shoulder joint replacement surgery can either replace the entire AC joint, in which case it is referred to as total shoulder joint replacement or total shoulder **arthroplasty**; or replace only the head of the humerus, in which case the procedure is called a hemiarthroplasty.

### Implants

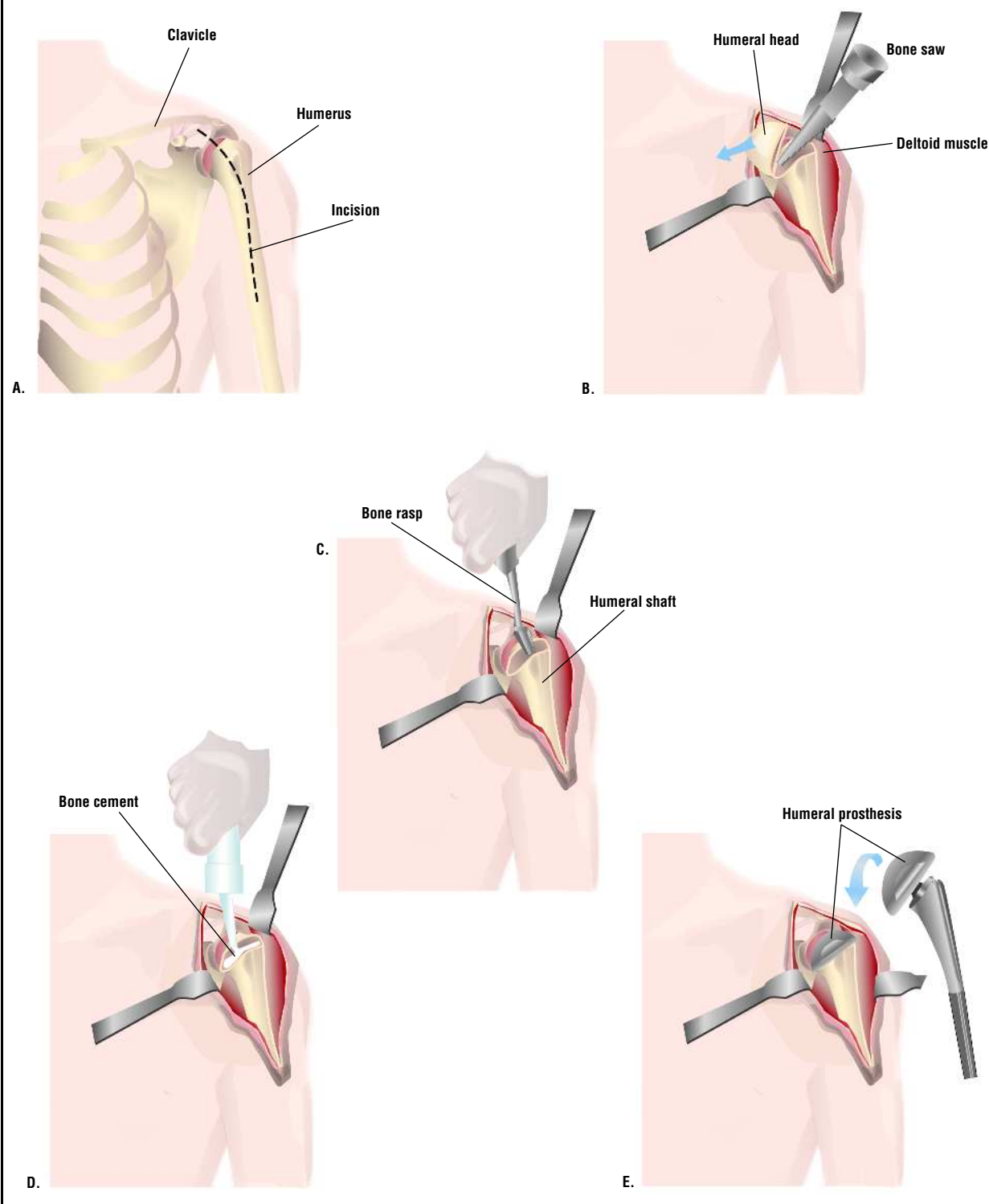
The two artificial components that can be implanted in the shoulder during shoulder joint replacement surgery are:

- **The humeral component.** This part replaces the head of the humerus. It is usually made of cobalt or chromium-based alloys and has a rounded ball attached to a stem that can be inserted into the bone. It comes in various sizes and may consist of a single piece or a modular unit.
- **The glenoid component.** This component replaces the glenoid cavity. It is made of very high-density polyethylene. Some models feature a metal tray, but the 100% polyethylene type is more common.

Shoulder joint replacement surgery is performed under either regional or **general anesthesia**, depending on the specifics of the case. The surgeon makes a 3–4 in (7.6–10.2 cm) incision on the front of the shoulder from the collarbone to the point where the shoulder muscle (deltoid) attaches to the humerus. The surgeon also inspects the muscles to see if any are damaged. He or she then proceeds to dislocate the humerus from the socket-like glenoid cavity to expose the head of the humerus. Only the portion of the head covered with articular cartilage is removed. The center cavity of the humerus (humeral shaft) is then cleaned and enlarged with reamers of gradually increasing size to create a cavity matching the shape of the implant stem. The top end of the bone is smoothed so that the stem can be inserted flush with the bone surface.

If the glenoid cavity of the AC joint is not damaged and the surrounding muscles are intact, the surgeon does not replace it, thus performing a simple hemiarthroplasty; however, if the glenoid cavity is

## Shoulder joint replacement



During a total shoulder joint replacement, an incision is first made in the shoulder and upper arm (A). The head of humerus is removed with a bone saw (B). The shaft of the humerus is reamed with a bone rasp to ready it for the prosthesis (C). After the shoulder joint, or glenoid cavity, is similarly prepared, bone cement is applied to areas to receive prostheses (D). The ball and socket prostheses are put in place, and the incision is closed (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)



## KEY TERMS

**Acromioclavicular (AC) joint**—The shoulder joint. Articulation and ligaments between the collarbone and the acromion of the shoulder blade.

**Acromion**—The triangular projection of the spine of the shoulder blade that forms the point of the shoulder and articulates with the collarbone.

**Arthroplasty**—The surgical repair of a joint.

**Charcot's arthropathy**—Also called neuropathic arthropathy, a condition in which the shoulder joint is destroyed following loss of its nerve supply.

**Glenoid cavity**—The hollow cavity in the head of the shoulder blade that receives the head of the humerus to make the glenohumeral or shoulder joint.

**Humerus**—The bone of the upper part of the arm.

**Inflammatory arthritis**—An inflammatory condition that affects joints.

**Osteoarthritis**—Non-inflammatory degenerative joint disease occurring chiefly in older persons, characterized by degeneration of the articular cartilage.

**Osteonecrosis**—Condition resulting from poor blood supply to an area of a bone and causing bone death.

**Rheumatoid arthritis**—Chronic inflammatory disease that destroys joints.

**Shoulder resection arthroplasty**—Surgery performed to repair a shoulder acromioclavicular (AC) joint. The procedure is most commonly recommended for AC joint problems resulting from osteoarthritis or injury.

damaged or diseased, the surgeon moves the humerus to the back and implants the artificial glenoid component as well. The surgeon prepares the surface by removing the cartilage and equalizes the glenoid bone to match the implant. Protrusions on the polyethylene glenoid implant are then fitted into holes drilled in the bone surface. Once a precise fit is achieved, the implant is cemented into position. The humerus, with its new implanted artificial head, is replaced in the glenoid socket. The surgeon reattaches the supporting tendons and closes the incision.

## Diagnosis/Preparation

Damage to the AC joint is usually assessed using X-rays of the joint and humerus. They provide information on the state of the joint space, the position of the humeral head in relation to the glenoid, the

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Shoulder replacement surgery is performed in a hospital by orthopedic surgeons with specialized training in shoulder joint replacement surgery.

presence of bony defects or deformity, and the quality of the bone. If glenoid wear is observed, a computed tomography (CT) scan is usually performed to evaluate the degree of bone loss.

The treating physician usually performs a general medical evaluation several weeks before shoulder joint replacement surgery to assess the patient's general health condition and risk for anesthesia. The results of this examination are forwarded to the orthopedic surgeon, along with a surgical clearance. Patients are advised to eat properly and take a daily iron supplement some weeks before surgery. Several types of tests are usually required, including blood tests, a cardiogram, a urine sample, and a chest X-ray. Patients may be required to stop taking certain medications until surgery is over.

## Aftercare

Following surgery, the operated arm is placed in a sling, and a support pillow is placed under the elbow to protect the repair. A drainage tube is used to remove excess fluid and is usually removed on the day after surgery.

A careful and well-planned rehabilitation program is very important for the successful outcome of a shoulder joint replacement. It should start no later than the first postoperative day. A physical therapist usually starts the patient with gentle, passive-assisted range of motion exercises. Before the patient leaves the hospital (usually two or three days after surgery), the therapist provides instruction on using a pulley device to help bend and extend the operated arm.

## Risks

Complications after shoulder replacement surgery occur less frequently than with other joint replacement surgeries; however, there are risks associated with the surgery, including infection, intra-operative fracture of the humerus or postoperative fractures, biceps tendon rupture, and postoperative instability and loosening of the glenoid implant. Advances in surgical

## QUESTIONS TO ASK THE DOCTOR

- What type of joint replacement surgery does my shoulder require?
- What are the risks associated with the surgery?
- How long will it take for my shoulder to recover from the surgery?
- How long will the artificial components last?
- Is there a risk of implant infection?
- How many shoulder joint replacement surgeries do you perform in a year?

techniques and prosthetic innovations are helping to significantly lower the occurrence of complications.

### Normal results

Pain relief is expected after shoulder joint replacement because the diseased joint surfaces have been replaced with smooth gliding surfaces. Improved motion, however, is variable and depends on the following:

- the surgeon's ability to reconstruct the shoulder's supporting tissues, namely the shoulder ligaments, capsule, and muscle attachments;
- the patient's preoperative muscle strength; and
- the patient's motivation and compliance in participating in postoperative rehabilitation therapy.

### Morbidity and mortality rates

Good to excellent outcomes usually follow shoulder joint replacement surgery, including pain relief and a functional range of motion that provides the ability to dress and perform the normal activities of daily living. In the hands of experienced orthopedic surgeons, such outcomes occur 90% of the time. Shoulders with artificial joints are reported to function well for more than 20 years. No **death** has ever been reported for shoulder joint replacement procedures.

### Alternatives

Arthritis treatment is very complex, as it depends on the type of arthritis and the severity of symptoms. Alternatives to joint replacement may include medications and therapy. It is known that arthritis is characterized by an increased rate of cartilage degradation and a decreased rate of cartilage production. An experimental therapy featuring the use of joint supplements such as glucosamine and chondroitin is being investigated for its

effectiveness to repair cartilage. The pain and inflammation resulting from arthritis are also commonly treated with nonsteroidal anti-inflammatory pain medication (NSAIDs) or cortisone injections (steroidal).

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- American Shoulder and Elbow Surgeons, 6300 N. River Road, Suite 727, Rosemont, IL, 60018, (847) 698 1629, <http://www.ases-assn.org>.

Monique Laberge, Ph.D.

## Shoulder resection arthroplasty

### Definition

Shoulder resection **arthroplasty** is surgery performed to repair a shoulder acromioclavicular (AC) joint. The procedure is most commonly recommended for AC joint problems resulting from osteoarthritis or injury.

### Purpose

The shoulder consists of three bones: the shoulder blade, the upper arm bone (humerus), and the collarbone (clavicle). The part of the shoulder blade that makes up the roof of the shoulder is called the acromion and the joint where the acromion and the collarbone join is called the acromioclavicular (AC) joint.

## KEY TERMS

**Acromioclavicular dislocation**—Disruption of the normal articulation between the acromion and the collarbone. The acromioclavicular joint (AC joint) is normally stabilized by several ligaments that can be torn in the process of dislocating the AC joint.

**Acromioclavicular (AC) joint**—Articulation and ligaments between the collarbone and the acromion of the shoulder blade.

**Acromion**—The triangular projection of the spine of the shoulder blade that forms the point of the shoulder and articulates with the collarbone.

**Arthroplasty**—The surgical repair of a joint.

**Arthrosis**—A disease of a joint.

**Glenoid cavity**—The hollow cavity in the head of the shoulder blade that receives the head of the humerus to make the glenohumeral or shoulder joint.

**Osteoarthritis**—Non-inflammatory degenerative joint disease occurring chiefly in older persons, characterized by degeneration of the articular cartilage.

Some joints in the body are more likely to develop problems due to normal wear and tear, or degeneration resulting from osteoarthritis, a progressive and degenerative joint disease. The AC joint is a common target for developing osteoarthritis in middle age. This condition can lead to pain and difficulty using the shoulder for everyday activities. Besides osteoarthritis, AC joint disease (arthrosis) may develop from an old injury to the joint such as an acromioclavicular dislocation, which is the disruption of the normal articulation between the acromion and the collarbone. This type of injury is quite common in competitive sports, but can also result from a simple fall on the shoulder.

The goal of shoulder resection arthroplasty is to restore function to an impaired shoulder, with its required motion range, stability, strength, and smoothness.

## Demographics

According to the National Ambulatory Medical Care Survey, osteoarthritis is one of the most common confirmed diagnoses in individuals over the age of 65, with the condition starting to develop in middle age.

As for AC joint injuries, they are seen especially in high-level athletes such as football or hockey players, and occur most frequently in the second decade of life.

Males are more commonly affected than females, with a male-to-female ratio of approximately five to one.

## Description

A resection arthroplasty involves the surgical removal of the last 0.5 in (1.3 cm) of the collarbone. This removal leaves a space between the acromion and the cut end of the collarbone where the AC joint used to be. The joint is replaced by scar tissue, which allows movement to occur, but prevents the rubbing of the bone ends. The end result of the surgery is that the flexible connection between the acromion and the collarbone is restored. The procedure is usually performed by making a small 2 in (5 cm) incision in the skin over the AC joint. In some cases, the surgery can be done arthroscopically. In this approach, the surgeon uses an endoscope to look through a small hole into the shoulder joint. The endoscope is an instrument of the size of a pen, consisting of a tube fitted with a light and a miniature video camera, which transmits an image of the joint interior to a television monitor. The surgeon proceeds to remove the segment of collarbone through a small incision with little disruption of the other shoulder structures.

## Diagnosis/Preparation

The diagnosis is made by physical exam. Tenderness over the AC joint is usually present, with pain upon compression of the joint. X-rays of the AC joint may show narrowing of the joint and bone spurs around the joint. A **magnetic resonance imaging (MRI)** scan may also be performed. An MRI scan is a special imaging test that uses magnetic waves to create pictures that show the tissues of the shoulder in slices and has the advantage of showing tendons as well as bones. In some cases, an **ultrasound** test may be also be performed to inspect the soft tissues of the joint.

Prior to arthroplasty surgery, all the standard preoperative blood and urine tests are performed. The patient also meets with the anesthesiologist to discuss any special conditions that may affect the administration of anesthesia.

## Aftercare

The rehabilitation following surgery for a simple resection arthroplasty is usually fairly rapid. Patients should expect the soreness to last for three to six weeks. Postoperatively, patients usually have the affected arm in a sling for two weeks. Thereafter, a progressive passive range of shoulder motion **exercise** is started, usually with range-of-motion exercises that gradually evolve into active stretching and strengthening. The patient's arm

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Shoulder resection arthroplasty is performed in a hospital. It is performed by experienced orthopedic surgeons who are specialists in AC joint problems. Some medical centers specialize in joint surgery and tend to have higher success rates than less specialized centers.

remains in the sling between sessions. At six weeks, healing is sufficient to encourage progressive functional use. Physiotherapy usually continues until range of motion and strength are maximized. The therapist may also use massage and other types of hands-on treatments to ease muscle spasm and pain. Heavy physical use of the shoulder is prohibited for an additional six weeks.

### Risks

Patients who undergo shoulder resection arthroplasty are susceptible to the same complications associated with any such surgery. These include wound infection, osteomyelitis, soft tissue ossification, and failure of fixation (remaining in place), with recurrent deformity. Symptomatic AC joint arthritis may develop in patients who undergo the surgery as a result of injury.

Specific risks associated with shoulder resection arthroplasty include:

- Fractures. Fractures of the humerus may occur after surgery, although the risk is considered low.
- Shoulder instability. Shoulder dislocations may occur during the early postoperative period due to soft tissue imbalance or to inadequate postoperative protection; late dislocation may result from glenoid cavity wear.
- Degenerative changes. Progressive degeneration of the AC joint is a common late complication.

### Normal results

Shoulder resection arthroplasty is generally very effective in reducing pain and restoring motion of the shoulder.

### Morbidity and mortality rates

In a four-year follow-up study on shoulder arthroplasty patients, all patients experienced pain relief. Functional improvement was good in 77% of patients. Average shoulder abduction improved from 37–79°

## QUESTIONS TO ASK THE DOCTOR

- How can I regain the use of my shoulder?
- What will it take to make my shoulder healthy again?
- Why do I have problems with my shoulder?
- What surgical procedures do you follow?
- How many shoulder resection arthroplasties do you perform each year?
- Will surgery on my shoulder condition allow me to resume my activities?

and forward flexion from 52–93°. No deaths resulting from shoulder resection arthroplasty have ever been reported.

### Alternatives

#### *Non-surgical treatments*

Doctors commonly attempt to treat AC joint problems using conservative treatments. Patients may be prescribed anti-inflammatory medications such as **aspirin** or ibuprofen. Treatment also may include disease-modifying drugs such as methotrexate and sulfasalazine, as well as gold injections. Researchers are also working on biologic agents that can interrupt the progress of osteoarthritis. These agents target specific chemicals in the body to prevent them from acting on the joints. Resting the sore joint and applying ice to it can also ease pain and inflammation. Injections of cortisone into the joint may also be prescribed. Cortisone is a strong steroidal medication that decreases inflammation and reduces pain. The effects of the drug are temporary, but it provides effective relief in the short term. Physicians may also prescribe sessions with a physical or occupational therapist, who may use various treatments to relieve inflammation of the AC joint, including heat and ice.

#### *Surgical alternatives*

Alternative surgical approaches include replacing the entire shoulder joint with a prosthesis (total shoulder arthroplasty) or replacing the head of the humerus (hemiarthroplasty).

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bowel disease, cancer, precancerous conditions, or causes of bleeding or pain.

### Purpose

Sigmoidoscopy is used most often in screening for colorectal cancer or to determine the cause of rectal bleeding. It is also used in diagnosis of inflammatory bowel disease, microscopic and ulcerative colitis, and Crohn's disease.

Cancer of the rectum and colon is the second most common cancer in the United States. About 148,300 new cases are diagnosed annually. Between 55,000 and 60,000 Americans die each year of cancer in the colon or rectum.

After reviewing a number of studies, experts recommend that people over 50 be screened for colorectal cancer using sigmoidoscopy every three to five years. Individuals with inflammatory bowel conditions such as Crohn's disease or ulcerative colitis, and thus at increased risk for colorectal cancer, may begin their screenings at a younger age, depending on when their disease was diagnosed. Many physicians screen such persons more often than every three to five years. Screening should also be performed in people who have a family history of colon or rectal cancer, or small growths in the colon (polyps).

Some physicians do this screening with a colonoscope, which allows them to see the entire colon. Most physicians prefer sigmoidoscopy, which is less time-consuming, less uncomfortable, and less costly.

Studies have shown that one-quarter to one-third of all precancerous or small cancerous growths can be seen with a sigmoidoscope. About one-half are found with a 1 ft (30 cm) scope, and two-thirds to three-quarters can be seen using a 2 ft (60 cm) scope.

In some cases, the sigmoidoscope can be used therapeutically in conjunction with other equipment such as electrosurgical devices to remove polyps and other lesions found during the sigmoidoscopy.

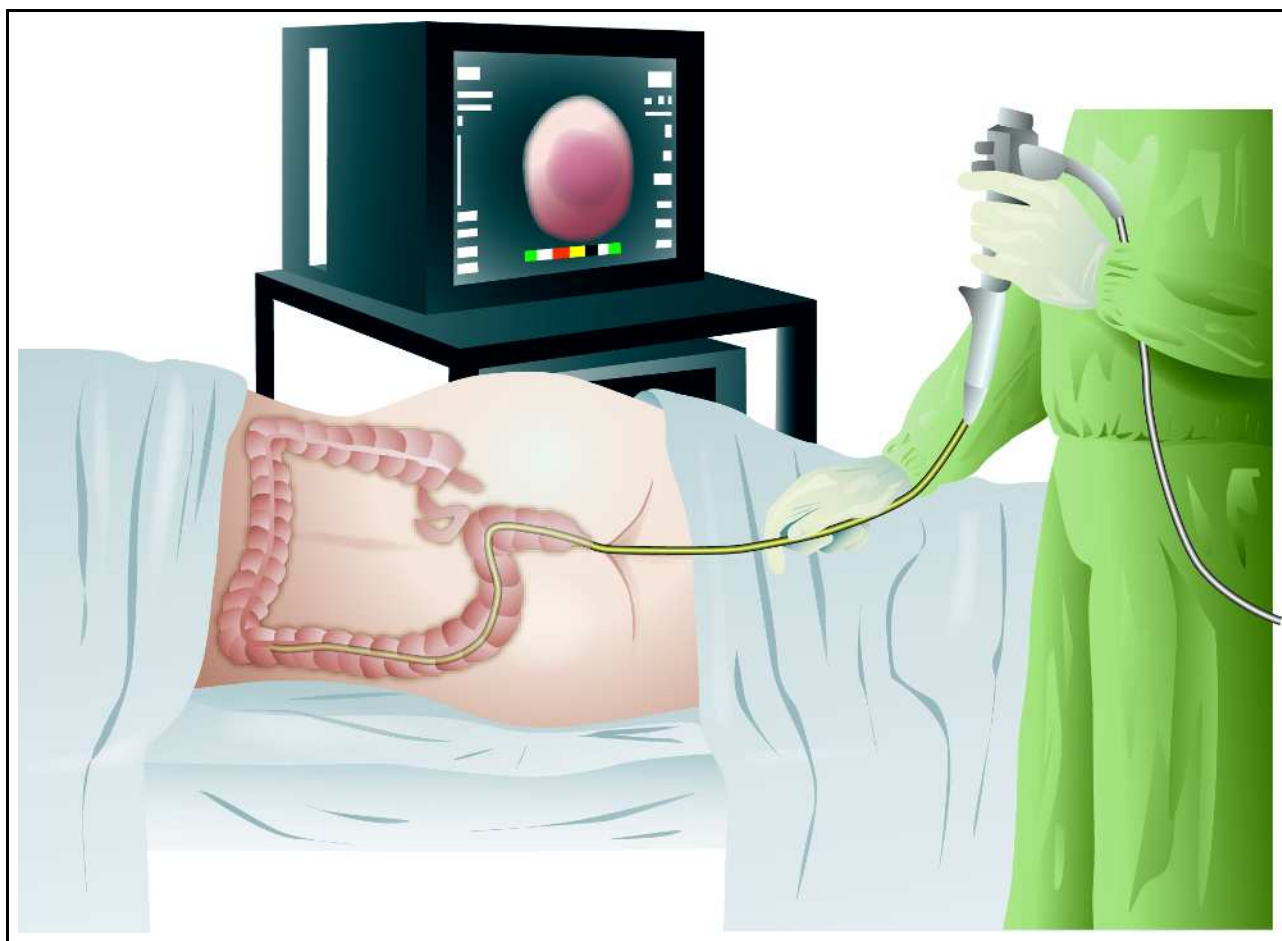
### Demographics

Experts estimate that in excess of 525,000 sigmoidoscopy procedures are performed each year. This number includes most of the persons who are diagnosed with colon cancer each year, a greater number who are screened and receive negative results, persons who have been treated for colon conditions and receive a sigmoidoscopy as a follow-up procedure, and individuals who are diagnosed with other diseases of the large colon.

## Sigmoidoscopy

### Definition

Sigmoidoscopy is a diagnostic and screening procedure in which a rigid or flexible tube with a camera on the end (a sigmoidoscope) is inserted into the anus to examine the rectum and lower colon (bowel) for



(Illustration by GGS Information Services. Cengage Learning, Gale.)

### Description

Sigmoidoscopy may be performed using either a rigid or flexible sigmoidoscope. A sigmoidoscope is a thin tube with fiberoptics, electronics, a light source, and camera. A physician inserts the sigmoidoscope into the anus to examine the rectum (the first 1 ft [30 cm] of the colon) and its interior walls. If a 2 ft (60 cm) scope is used, the next portion of the colon can also be examined for any irregularities. The camera of the sigmoidoscope is connected to a viewing monitor, allowing the interior of the rectum and colon to be enlarged and viewed on the monitor. Images can then be recorded as still pictures or the entire procedure can be videotaped. The still pictures are useful for comparison purposes with the results of future sigmoidoscopic examinations.

If polyps, lesions, or other suspicious areas are found, the physician biopsies them for analysis. During the sigmoidoscopy, the physician may also use forceps,

graspers, snares, or electrosurgical devices to remove polyps, lesions, or tumors.

A typical sigmoidoscopy procedure requires 15 to 20 minutes to perform. Preparation begins one day before the procedure. There is some discomfort when the scope is inserted and throughout the procedure, similar to that experienced when a physician performs a rectal exam using a finger to test for occult blood in the stool (another important screening test for colorectal cancer). Individuals may also feel some minor cramping pain. There is rarely severe pain, except for persons with active inflammatory bowel disease.

**Private insurance plans** almost always cover the cost of sigmoidoscopy examinations for screening in healthy individuals over 50, or for diagnostic purposes. **Medicare** covers the cost for diagnostic exams, and may cover the costs for screening exams. **Medicaid** benefits vary by state, but sigmoidoscopy is not a covered procedure in many states. Some community health clinics offer the

## KEY TERMS

**Biopsy**—The removal of a small portion of tissue during sigmoidoscopy to perform laboratory tests to determine if the tissue is cancerous.

**Colonoscopy**—A diagnostic endoscopic procedure that uses a long flexible tube called a colonoscope to examine the inner lining of the entire colon; may be used for colorectal cancer screening or for a more thorough examination of the colon.

**Colorectal cancer**—Cancer of the large intestine, or colon, including the rectum.

**Electrosurgical device**—A medical device that uses electrical current to cauterize or coagulate tissue during surgical procedures, often used in conjunction with laparoscopy, colonoscopy, or sigmoidoscopy.

**Inflammatory bowel diseases**—Ulcerative colitis or Crohn's disease: chronic conditions characterized by periods of diarrhea, bloating, abdominal cramps, and pain, sometimes accompanied by weight loss and malnutrition because of the inability to absorb nutrients.

**Pathologist**—A doctor who specializes in the diagnosis of disease by studying cells and tissues under a microscope.

**Polyp**—A small growth, usually not cancerous, but often precancerous when it appears in the colon.

procedure at reduced cost, but this can only be done if a local gastroenterologist (a physician who specializes in treating stomach and intestinal disorders) is willing to donate personal time to perform the procedure.

## Diagnosis/Preparation

The purpose of preparation for sigmoidoscopy is to cleanse the lower bowel of fecal material or stool so the physician can see the lining. Preparation begins 24 hours before the procedure, when an individual must begin a clear liquid diet. Preparation kits are available in drug stores. In normal preparation, about 20 hours before the exam, a person begins taking a series of **laxatives**, which may be oral tablets or liquid. The individual must stop drinking any liquid four hours before the exam. An hour or two prior to the examination, the person uses an enema or laxative suppository to finish cleansing the lower bowel.

Individuals need to be careful about medications before having sigmoidoscopy. They should not take **aspirin**, products containing aspirin, or products

containing ibuprofen for one week prior to the exam, because these medications can exacerbate bleeding during the procedure. They should not take any iron or vitamins with iron for one week prior to the exam, since iron can cause color changes in the bowel lining that interfere with the examination. They should take any routine prescription medications, but may need to stop certain medications. Prescribing physicians should be consulted regarding routine prescriptions and their possible effect(s) on sigmoidoscopy.

Individuals with renal insufficiency or congestive heart failure need to be prepared in an alternative way, and must be carefully monitored during the procedure.

## Aftercare

There is no specific aftercare necessary following sigmoidoscopy. If a biopsy was taken, a small amount of blood may appear in the next stool. Persons should be encouraged to pass gas following the procedure to relieve any bloating or cramping that may occur after the procedure. In addition, an infection may develop following sigmoidoscopy. Persons should be instructed to call their physician if a fever or pain in the abdomen develops over the few days after the procedure.

## Risks

There is a slight risk of bleeding from the procedure. This risk is heightened in individuals whose blood does not clot well, either due to disease or medication, and in those with active inflammatory bowel disease. Rarely, trauma to the bowel or other organs can occur, resulting in an injury (perforation) that must be repaired, or peritonitis, which must be treated with medication.

Sigmoidoscopy may be contraindicated in persons with severe active colitis or toxic megacolon (an extremely dilated colon). In general, people experiencing continuous ambulatory peritoneal dialysis are not candidates due to a high risk of developing intraperitoneal bleeding.

## Normal results

The results of a normal examination reveal a smooth colon wall, with sufficient blood vessels for good blood flow.

## Morbidity and mortality rates

For a cancer screening sigmoidoscopy, an abnormal result is one or more noncancerous or precancerous polyps, or clearly cancerous polyps. People with polyps have an increased risk of developing colorectal cancer in the future and may be required to undergo

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A colonoscopy procedure is usually performed by a gastroenterologist, a physician with specialized training in diseases of the colon. Alternatively, general surgeons or experienced family physicians perform sigmoidoscopic examinations. In the United States, the procedure is usually performed in an outpatient facility of a hospital or in a physician's professional office.

Persons with rectal bleeding may need full colonoscopy in a hospital setting. Individuals whose blood does not clot well (possibly as a result of blood-thinning medications) may require the procedure to be performed in a hospital setting.

additional procedures such as **colonoscopy** or more frequent sigmoidoscopic examinations.

Small polyps can be completely removed. Larger polyps may require the physician to remove a portion of the growth for laboratory biopsy. Depending on the laboratory results, a person is then scheduled to have the polyp removed surgically, either as an urgent matter if it is cancerous, or as an elective procedure within a few months if it is noncancerous.

In a diagnostic sigmoidoscopy, an abnormal result shows signs of active inflammatory bowel disease, either a thickening of the intestinal lining consistent with ulcerative colitis, or ulcerations or fissures consistent with Crohn's disease.

Mortality from a sigmoidoscopy examination is rare and is usually due to uncontrolled bleeding or perforation of the colon.

### Alternatives

A screening examination for colorectal cancer is a test for fecal occult blood. A dab of fecal material from toilet tissue is smeared onto a card. The card is treated in a laboratory to reveal the presence of bleeding. This test is normally performed prior to a sigmoidoscopic examination.

A less invasive alternative to a sigmoidoscopic examination is an X-ray of the colon and rectum. Barium is used to coat the inner walls of the colon. This lower GI (gastrointestinal) X-ray may reveal the outlines of suspicious or abnormal structures. It has the disadvantage of not allowing direct visualization

## QUESTIONS TO ASK THE DOCTOR

- Is the supervising physician appropriately certified to conduct a sigmoidoscopy?
- How many sigmoidoscopy procedures has the doctor performed?
- What other steps will be taken as a result of my test findings?

of the colon. It is less costly than a sigmoidoscopic examination.

A more invasive procedure is direct visualization of the colon during surgery. This procedure is rarely performed in the United States.

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#### ORGANIZATIONS

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- American College of Surgeons, 633 North Saint Claire Street, Chicago, IL, 60611, (312) 202 5000, <http://www.facs.org/>.
- American Society for Gastrointestinal Endoscopy, 1520 Kensington Road, Suite 202, Oak Brook, IL, 60523, (630) 573 0600, <http://www.asge.org>.
- Society of American Gastrointestinal Endoscopic Surgeons, 11300 West Olympic Boulevard, Suite 600, Los Angeles, CA, 90064, (310) 437 0544, (310) 437 0585, <http://www.sages.org>.

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## Simple mastectomy

### Definition

Simple **mastectomy** is the surgical removal of one or both breasts. The adjacent lymph nodes and chest muscles are left intact. If a few lymph nodes are removed, the procedure is called an extended simple mastectomy. Breast-sparing techniques may be used to preserve the patient's breast skin and nipple, which is helpful in cosmetic **breast reconstruction**.

### Purpose

Removal of a patient's breast is usually recommended when cancer is present in the breast or as a

prophylactic when the patient has severe fibrocystic disease and a family history of breast cancer. The choice of a simple mastectomy may be determined by evaluating the size of the breast, the size of the cancerous mass, where the cancer is located, and whether any cancer cells have spread to adjacent lymph nodes or other parts of the body. If the cancer has not been contained within the breast, it calls for a **modified radical mastectomy**, which removes the entire breast and all of the adjacent lymph nodes. Only in extreme circumstances is a radical mastectomy, which also removes part of the chest wall, indicated.

A larger tumor usually is an indication of more advanced disease and will require more extensive surgery such as a simple mastectomy. In addition, if a woman has small breasts, the tumor may occupy more area within the contours of the breast, necessitating a simple mastectomy in order to remove all of the cancer.

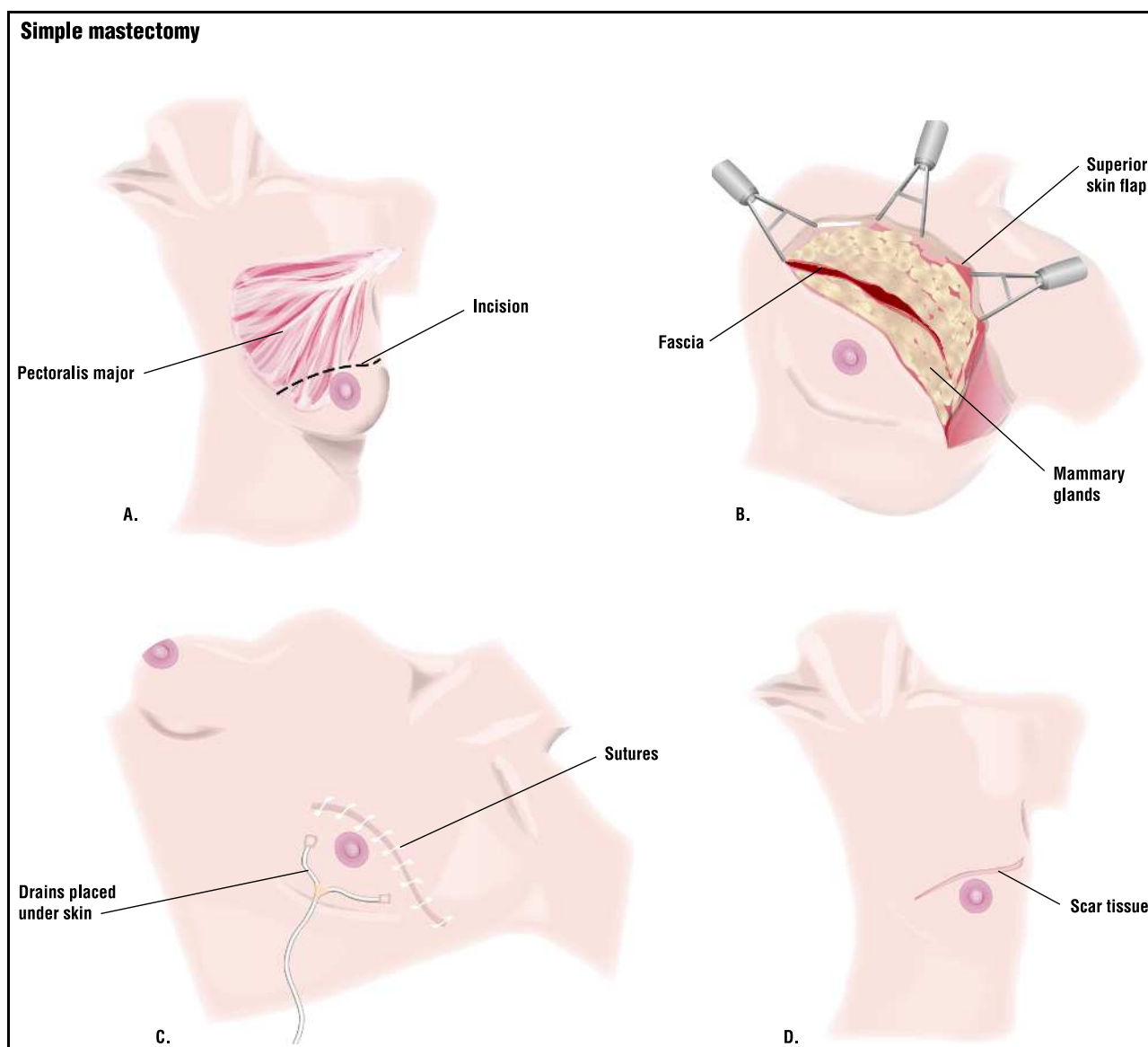
Very rapidly growing tumors usually require the removal of all breast tissue. Cancers that have spread to adjacent tissues such as the chest wall or skin make simple mastectomy a good choice. Similarly, multiple sites of cancer within a breast require that the entire breast be removed. In addition, simple mastectomy is also recommended when cancer recurs in a breast that has already undergone a **lumpectomy**, which is a less invasive procedure that just removes the tumor and some surrounding tissue without removing the entire breast.

Sometimes, surgeons recommend simple mastectomy for women who are unable to undergo the adjuvant radiation therapy required after a lumpectomy. Radiation treatment is not indicated for pregnant women, those who have had previous therapeutic radiation in the chest area, and patients with collagen vascular diseases such as scleroderma or lupus. In these cases, simple mastectomy is the treatment of choice.

Some women with family histories of breast cancer and who test positive for a cancer-causing gene choose to have one or both of their breasts removed as a preventative for future breast cancer. This procedure is highly controversial. Though prophylactic mastectomy reduces the occurrence of breast cancer by 90% in high-risk patients, it is not a foolproof method. There has been some incidence of cancer occurring after both breasts were removed.

### Demographics

According to the American Cancer Society in 2003, it was estimated that more than 260,000 new cases of breast cancer in women would occur that year. New cases of breast cancer in men were expected to reach



**In a simple mastectomy, the skin over the tumor is cut open (A). The tumor and tissue surrounding it is removed (B), and the wound is closed (C). (Illustration by GGS Information Services. Cengage Learning, Gale.)**

1,300. Rates of incidence have increased since 1980, due in part to the aging of the population. During the 1990s, breast cancer incidence increased only in women age 50 and over.

For approximately 80% of women, the first indication of cancer is the discovery of a lump in the breast, found either by themselves in a monthly self-exam or by a partner or by a mammogram, a special X-ray of the breast that looks for anomalies. Early detection of breast cancer means that smaller tumors are found, which require less intensive surgery and have better treatment outcomes. Simple mastectomy

has been the standard treatment of choice for breast cancer for the past 60 years. Newer breast-conserving surgery techniques have gained acceptance since the mid-1980s. For larger hospitals, facilities in urban areas, and health care institutions with a cancer center or high cancer patient volume, these newer techniques are being utilized at a more rapid rate, especially on the East Coast.

In 2003, the National Cancer Institute found that American women were 21% more likely to have a mastectomy than their counterparts in the United Kingdom. Though breast-conserving procedures are

## KEY TERMS

**Lumpectomy**—A less-invasive procedure that just removes the tumor and some surrounding tissue, without removing the entire breast.

**Lymphedema**—Swelling, usually of the arm after a mastectomy, caused by the accumulation of fluid from faulty drainage in the lymph system.

**Mammogram**—A special X-ray of the breast that looks for anomalies in the breast.

available and have proven to be viable options, some physicians and women still think breast removal will also remove all of their risk of cancer recurrence. It is clear that treatment options for cancer are highly individual and often emotionally charged.

## Description

Simple mastectomy is one of several types of surgical treatments for breast cancer. Some techniques are rarely used; others are quite common. These common surgical procedures include:

- **Radical mastectomy.** Radical mastectomy is rarely used, and then only in cases where cancer cells have invaded the chest wall and the tumor is very large. The breast, muscles under the breast, and all of the lymph nodes are removed. This produces a large scar and severe disability to the arm nearest the removed breast.
- **Modified radical mastectomy.** Modified radical mastectomy was the most common form of mastectomy until the 1980s. The breast is removed along with the lining over the chest muscle and all of the lymph nodes.
- **Simple mastectomy.** Simple, sometimes called total, mastectomy has been the treatment of choice in the late 1980s and 1990s. Generally, only the breast is removed; though, sometimes, one or two lymph nodes may be removed as well.
- **Partial mastectomy.** Partial mastectomy is used to remove the tumor, the lining over the chest muscle underneath the tumor, and a good portion of breast tissue, but not the entire breast. This is a good treatment choice for early stage cancers.
- **Lumpectomy.** Lumpectomy or breast-conserving surgery just removes the tumor and a small amount of tissue surrounding it. Some lymph nodes may be removed as well. This is the most commonly used surgical procedure for the treatment of breast cancer in the early twenty-first century.

Two other surgical procedures are variations on the simple mastectomy. The skin-sparing mastectomy is a new surgical procedure in which the surgeon makes an incision, sometimes called a keyhole incision, around the areola. The tumor and all breast tissue are removed, but the incision is smaller and scarring is minimal. About 90% of the skin is preserved and allows a cosmetic surgeon to perform breast reconstruction at the same time as the mastectomy. The subcutaneous mastectomy, or nipple-sparing mastectomy, preserves the skin and the nipple over the breast.

During a simple mastectomy, the surgeon makes a curved incision along one side of the breast and removes the tumor and all of the breast tissue. A few lymph nodes may be removed. The tumor, breast tissue, and any lymph nodes will be sent to the pathology lab for analysis. If the skin is cancer-free, it is sutured in place or used immediately for breast reconstruction. One or two drains will be put in place to remove fluid from the surgical area. Surgery takes from two to five hours; it is longer with breast reconstruction.

## Breast reconstruction

Breast reconstruction, especially if it is begun at the same time as the simple mastectomy, can minimize the sense of loss that women feel when having a breast removed. Although there may be other smaller surgeries later to complete the breast reconstruction, there will not be a second major operation nor an additional scar.

If there is not enough skin left after the mastectomy, a balloon-type expander is put in place. In subsequent weeks, the expander is filled with larger amounts of saline (salt water) solution. When it has reached the appropriate size, the expander is removed and a permanent breast implant is installed.

If there is enough skin, an implant is installed immediately. In other instances, skin, fat, and muscle are removed from the patient's back or abdomen and repositioned on the chest wall to form a breast.

None of these reconstructions have nipples at first. Nipples are later reconstructed in a separate surgery. Finally, the areola is tattooed in to make the reconstructed breast look natural.

Breast reconstruction does not prevent a potential recurrence of breast cancer.

## Diagnosis/Preparation

If a mammogram has not been performed, it is usually ordered to verify the size of the lump the patient has reported. A biopsy of the suspicious lump

and/or lymph nodes is usually ordered and sent to the pathology lab before surgery is discussed.

When a simple mastectomy has been determined, preoperative tests such as blood work, a chest X-ray, and an **electrocardiogram** may be ordered. Blood-thinning medications such as **aspirin** should be stopped several days before the surgery date. The patient is also asked to refrain from eating or drinking the night before the operation.

At the hospital, the patient will sign a consent form, verifying that the surgeon has explained what the surgery is and what it is for. The patient will also meet with the anesthesiologist to discuss the patient's medical history and determine the choice of anesthesia.

### Aftercare

If the procedure is performed as an **outpatient surgery**, the patient may go home the same day of the surgery. The length of the hospital stay for inpatient mastectomies ranges from one to two days. If breast reconstruction has taken place, the hospital stay may be longer.

The surgical drains will remain in place for five to seven days. Sponge baths will be necessary until the **stitches** are removed, usually in a week to 10 days. It is important to avoid overhead lifting, strenuous sports, and sexual intercourse for three to six weeks. After the surgical drains are removed, stretching exercises may be begun, though some physical therapists may start a patient on shoulder and arm mobility exercises while in the hospital.

Since breast removal is often emotionally traumatic for women, seeking out a support group is often helpful. Women in these groups offer practical advice about matters such as finding well-fitting bras and swimwear, and emotional support because they have been through the same experience.

For women who chose not to have breast reconstruction, it may be necessary to find the proper fitting breast prosthesis. Some are made of cloth, and others are made of silicone, which are created from a mold from the patient's other breast.

In some case, the patient may be required to undergo additional treatments such as radiation, chemotherapy, or hormone therapy.

### Risks

The risks involved with simple mastectomy are the same for any major surgery; however, there may be a need for more extensive surgery once the surgeon examines the tumor, the tissues surrounding it, and the lymph

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Simple mastectomy is performed by a general surgeon or a gynecological surgeon. If reconstructive breast surgery is to be done, a cosmetic surgeon performs it. Patients undergo simple mastectomies under general anesthesia as an inpatient in a hospital. There is a growing trend, due to reductions in insurance coverage and patient preference, to perform simple mastectomies without reconstructive breast surgery as outpatient procedures.

nodes nearby. A biopsy of the lymph nodes is usually performed during surgery and a determination is made whether to remove them. Simple mastectomy usually has limited impact on range of motion of the arm nearest the breast that is removed, but physical therapy may still be necessary to restore complete movement.

There is also the risk of infection around the incision. When the lymph nodes are removed, lymphedema may also occur. This condition is a result of damage to the lymph system. The arm on the side nearest the affected breast may become swollen. It can either resolve itself or worsen.

As in any surgery, the risk of developing a blood clot after a mastectomy is a serious matter. All hospitals use a variety of techniques to prevent blood clots from forming. It is important for the patient to walk daily when at home.

Finally, there is the risk that not all cancer cells were removed. Further treatment may be necessary.

### Normal results

The breast area will fully heal in three to four weeks. If the patient had breast reconstruction, it may take up to six weeks to recover fully. The patient should be able to participate in all of the activities she has engaged in before surgery. If breast reconstruction is done, the patient should realize that the new breast will not have the sensitivity of a normal breast. In addition, dealing with cancer emotionally may take time, especially if additional treatment is necessary.

### Morbidity and mortality rates

Deaths due to breast cancer have declined by 1.4% each year between 1989 and 1995, and by 3.2% each year thereafter. The largest decreases have been



## QUESTIONS TO ASK THE DOCTOR

- Why is this procedure necessary?
- How big is my tumor?
- Are there other breast-saving or less-invasive procedures for which I might be a candidate?
- What can I expect after surgery?
- Do you work with a cosmetic surgeon?
- Will I have to undergo radiation or chemotherapy after surgery?

among younger women, as a result of cancer education campaigns and early screening, which encourages more women to go to their physicians to be checked.

Research performed between 2000 and 2004 demonstrated that the five-year survival rate for cancers confined to the breast is 98%. For cancers that had spread to areas within the chest region, the rate was 83.5%, and it is only 26.7% for cancers occurring in other parts of the body after breast cancer treatment. The best survival rates were for early-stage tumors.

Two 20-year longitudinal studies concluded in 2002 indicated that the survival rate for patients with modified radical mastectomy (the removal of the entire breast and all lymph nodes) was no different from that of breast-conserving lumpectomy (the removal of the tumor alone). These studies suggest that the removal of the entire breast may not afford greater protection against future cancer than breast-conserving techniques; however, the majority of cancer recurrences happen within the first five years for both those with mastectomies and those with lumpectomies.

### Alternatives

Skin sparing mastectomy, also called nipple sparing mastectomy, is becoming a treatment of choice for women undergoing simple mastectomy. In this procedure, the skin of the breast, the areola, and the nipple are peeled back to remove the breast and its inherent tumor. Biopsies of the skin and nipple areas are performed immediately to assure that they do not have cancer cells in them. Then, a cosmetic surgeon performs a breast reconstruction at the same time as the mastectomy. The breast regains its normal contours once prostheses are inserted. Unfortunately, the nipple will lose its sensitivity and, of course, its function, since all underlying tissue has been removed. If cancer is found near the nipple, this procedure cannot be done.

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- American Society of Plastic Surgeons, 444 E. Algonquin Rd., Arlington Heights, IL, 60005, (847) 228 9900, <http://www.plasticsurgery.org>.
- National Cancer Institute, 6116 Executive Boulevard, MSC8322, Suite 3036A, Bethesda, MD, 20892 8322, (800) 422 6237, <http://www.cancer.gov>.

Janie Franz

Sinus x ray see **Skull x rays**

Skeletal traction see **Traction**

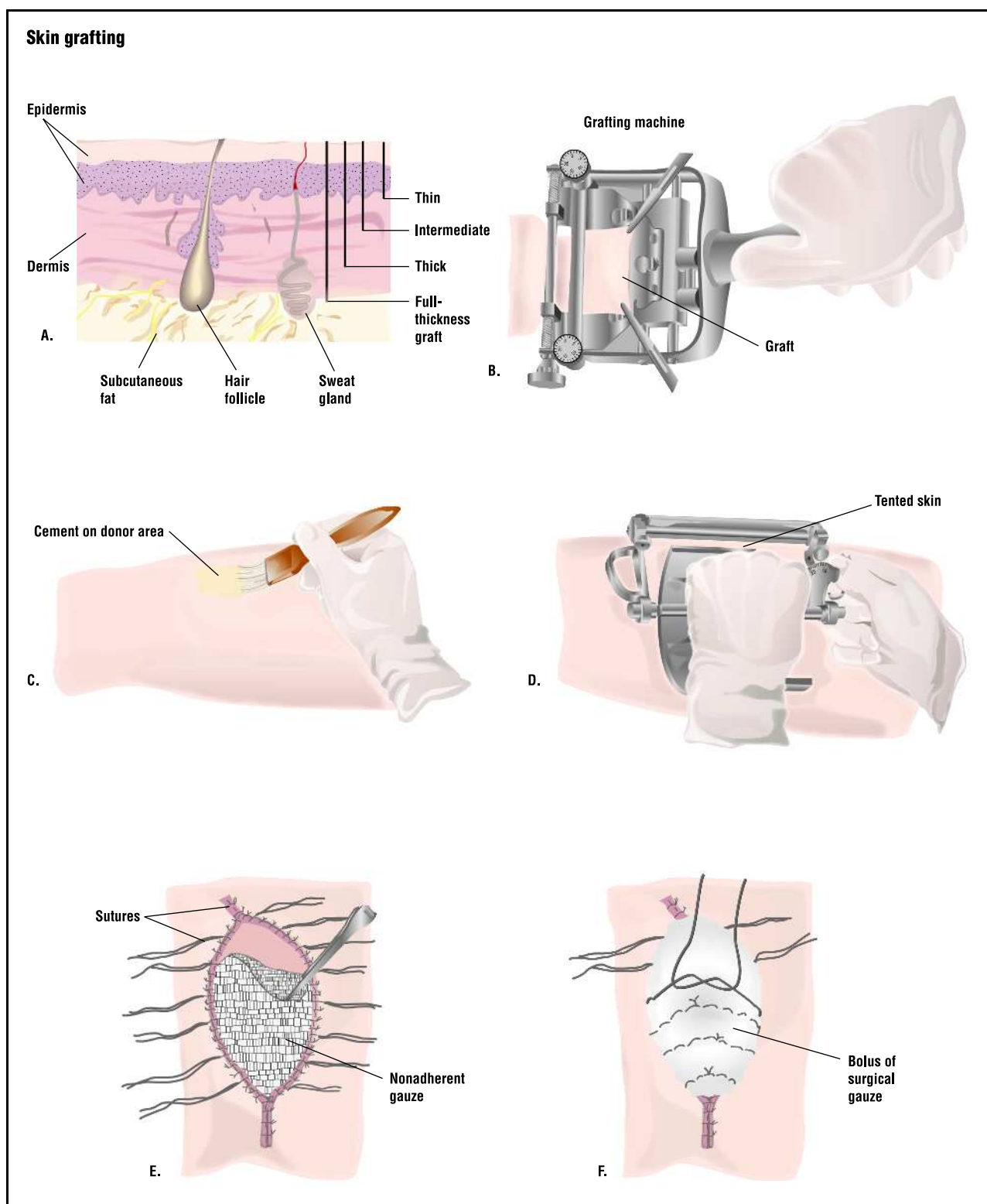
## Skin grafting

### Definition

Skin grafting is a surgical procedure in which skin or a skin substitute is placed over a burn or non-healing wound.

### Purpose

A skin graft is used to permanently replace damaged or missing skin or to provide a temporary wound covering. This covering is necessary because the skin



Skin grafts may be used in several thicknesses (A). To begin the procedure, a special cement is used on the donor skin area (C). The grafting machine is applied to the area, and sample taken (D). After the graft is stitched to the recipient area, it is covered with nonadherent gauze (E) and a layer of fluffy surgical gauze held in place with sutures (F). (Illustration by GGS Information Services. Cengage Learning, Gale.)

protects the body from fluid loss, aids in temperature regulation, and helps prevent disease-causing bacteria or viruses from entering the body. Skin that is damaged extensively by burns or non-healing wounds can compromise the health and well-being of the patient.

### Demographics

Although anyone can be involved in a fire and need a skin graft, the population groups with a higher risk of fire-related injuries and deaths include:

- children four years old and younger;
- adults 65 years and older;
- African Americans and Native Americans;
- low-income Americans;
- persons living in rural areas; and
- persons living in manufactured homes (trailers) or substandard housing.

### Description

The skin is the largest organ of the human body. It is also known as the integument or integumentary system because it covers the entire outside of the body. The skin consists of two main layers: the outer layer, or epidermis, which lies on and is nourished by the thicker dermis. These two layers are approximately 0.04–0.08 in (1–2 mm) thick. The epidermis consists of an outer layer of dead cells called keratinocytes, which provide a tough protective coating, and several layers of rapidly dividing cells just beneath the keratinocytes. The dermis contains the blood vessels, nerves, sweat glands, hair follicles, and oil glands. The dermis consists mainly of connective tissue, which is largely made up of a protein called collagen. Collagen gives the skin its flexibility and provides structural support. The fibroblasts that make collagen are the main type of cell in the dermis.

Skin varies in thickness in different parts of the body; it is thickest on the palms and soles of the feet, and thinnest on the eyelids. In general, men have thicker skin than women, and adults have thicker skin than children. After age 50, however, the skin begins to grow thinner again as it loses its elastic fibers and some of its fluid content.

#### *Injuries treated with skin grafts*

Skin grafting is sometimes done as part of elective **plastic surgery** procedures, but its most extensive use is in the treatment of burns. For first or second-degree burns, skin grafting is generally not required, as these burns usually heal with little or no scarring. With third-degree burns, however, the skin is destroyed to its full depth, in addition to damage done to underlying

### KEY TERMS

**Allograft**—Tissue that is taken from one person's body and grafted to another person.

**Autograft**—Tissue that is taken from one part of a person's body and transplanted to a different part of the same person.

**Collagen**—A protein that provides structural support for the skin. Collagen is the main component of connective tissue.

**Contracture**—An abnormal persistent shortening of a muscle or the overlying skin at a joint, usually caused by the formation of scar tissue following an injury.

**Débridement**—The removal of foreign matter and dead or damaged tissue from a traumatic or infected wound until healthy tissue is reached.

**Dermatome**—A surgical instrument used to cut thin slices of skin for grafts.

**Dermis**—The underlayer of skin, containing blood vessels, nerves, hair follicles, and oil and sweat glands.

**Epidermis**—The outer layer of skin, consisting of a layer of dead cells that perform a protective function and a second layer of dividing cells.

**Fibroblasts**—A type of cell found in connective tissue; produces collagen.

**Hematoma**—A localized collection of blood in an organ or tissue due to broken blood vessels.

**Integument**—A covering; in medicine, the skin as a covering for the body. The skin is also called the integumentary system.

**Keratinocytes**—Dead cells at the outer surface of the epidermis that form a tough protective layer for the skin. The cells underneath divide to replenish the supply.

**Xenograft**—Tissue that is transplanted from one species to another (e.g., pigs to humans).

tissues. People who suffer third-degree burns often require skin grafting.

Wounds such as third-degree burns must be covered as quickly as possible to prevent infection or loss of fluid. Wounds that are left to heal on their own can contract, often resulting in serious scarring; if the wound is large enough, the scar can actually prevent movement of limbs. Non-healing wounds, such as diabetic ulcers, venous ulcers, or pressure sores, can be

treated with skin grafts to prevent infection and further progression of the wounded area.

### *Types of skin grafts*

The term “graft” by itself commonly refers to either an allograft or an autograft. An autograft is a type of graft that uses skin from another area of the patient’s own body if there is enough undamaged skin available, and if the patient is healthy enough to undergo the additional surgery required. An allograft uses skin obtained from another human being. Donor skin from cadavers is frozen, stored, and available for use as allografts. Skin taken from an animal (usually a pig) is called a xenograft because it comes from a nonhuman species. Allografts and xenografts provide only temporary covering because they are rejected by the patient’s immune system within seven to 10 days. They must then be replaced with an autograft.

**SPLIT-THICKNESS GRAFTS.** The most important part of any skin graft procedure is proper preparation of the wound. Skin grafts will not survive on tissue with a limited blood supply (cartilage or tendons) or tissue that has been damaged by radiation treatment. The patient’s wound must be free of any dead tissue, foreign matter, or bacterial contamination. After the patient has been anesthetized, the surgeon prepares the wound by rinsing it with saline solution or a diluted antiseptic (Betadine) and removes any dead tissue by débridement. In addition, the surgeon stops the flow of blood into the wound by applying pressure, tying off blood vessels, or administering a medication (epinephrine) that causes the blood vessels to constrict.

Following preparation of the wound, the surgeon then harvests the tissue for grafting. A split-thickness skin graft involves the epidermis and a little of the underlying dermis; the donor site usually heals within several days. The surgeon first marks the outline of the wound on the skin of the donor site, enlarging it by 3–5% to allow for tissue shrinkage. The surgeon uses a dermatome (a special instrument for cutting thin slices of tissue) to remove a split-thickness graft from the donor site. The wound must not be too deep if a split-thickness graft is going to be successful, since the blood vessels that will nourish the grafted tissue must come from the dermis of the wound itself. The graft is usually taken from an area that is ordinarily hidden by clothes, such as the buttock or inner thigh, and spread on the bare area to be covered. Gentle pressure from a well-padded dressing is then applied, or a few small sutures used to hold the graft in place. A sterile non-adherent dressing is then applied to the raw donor area for approximately three to five days to protect it from infection.

**FULL-THICKNESS GRAFTS.** Full-thickness skin grafts may be necessary for more severe burn injuries. These grafts involve both layers of the skin. Full-thickness autografts are more complicated than partial-thickness grafts, but provide better contour, more natural color, and less contraction at the grafted site. A flap of skin with underlying muscle and blood supply is transplanted to the area to be grafted. This procedure is used when tissue loss is extensive, such as after open fractures of the lower leg, with significant skin loss and underlying infection. The back and the abdomen are common donor sites for full-thickness grafts. The main disadvantage of full-thickness skin grafts is that the wound at the donor site is larger and requires more careful management. Often, a split-thickness graft must be used to cover the donor site.

A composite skin graft is sometimes used, which consists of combinations of skin and fat, skin and cartilage, or dermis and fat. Composite grafts are used in patients whose injuries require three-dimensional reconstruction. For example, a wedge of ear containing skin and cartilage can be used to repair the nose.

A full-thickness graft is removed from the donor site with a scalpel rather than a dermatome. After the surgeon has cut around the edges of the pattern used to determine the size of the graft, he or she lifts the skin with a special hook and trims off any fatty tissue. The graft is then placed on the wound and secured in place with absorbable sutures.

### **Aftercare**

Once a skin graft has been put in place, it must be maintained carefully even after it has healed. Patients who have grafts on their legs should remain in bed for seven to 10 days with their legs elevated. For several months, the patient should support the graft with an Ace bandage or Jobst stocking. Grafts on other areas of the body should be similarly supported after healing to decrease the amount of contracture.

Grafted skin does not contain sweat or oil glands, and should be lubricated daily for two to three months with mineral oil or another bland oil to prevent drying and cracking.

Aftercare of patients with severe burns typically includes psychological or psychiatric counseling as well as **wound care** and physical rehabilitation, particularly if the patient’s face has been disfigured. The severe pain and lengthy period of recovery involved in burn treatment are often accompanied by anxiety and depression. If the patient’s burns occurred in combat, a transportation disaster, terrorist attack, or other fire involving large numbers of people, he or she is at high



risk of developing post-traumatic stress disorder (PTSD). Anti-anxiety medication may be a helpful adjunct to treatment in these patients. Additionally, because burn patients are at high risk of developing stress ulcers in their gastrointestinal system, with a high rate of bleeding, GI medications that prevent stress ulcers are often given to burn patients.

### Risks

The risks of skin grafting include those inherent in any surgical procedure that involves anesthesia. These include reactions to the medications, breathing problems, bleeding, and infection. In addition, the risks of an allograft procedure include transmission of an infectious disease from the donor.

The tissue for grafting and the recipient site must be as sterile as possible to prevent later infection that could result in failure of the graft. Failure of a graft can result from inadequate preparation of the wound, poor blood flow to the injured area, swelling, or infection. The most common reason for graft failure is the formation of a hematoma, or collection of blood in the injured tissues.

### Normal results

A skin graft should provide significant improvement in the quality of the wound site, and may prevent the serious complications associated with burns or non-healing wounds. Normally, new blood vessels begin growing from the donor area into the transplanted skin within 36 hours. Occasionally, skin grafts are unsuccessful or don't heal well. In these cases, repeat grafting is necessary. Even though the skin graft must be protected from trauma or significant stretching for two to three weeks following split-thickness skin grafting, recovery from surgery is usually rapid. A dressing may be necessary for one to two weeks, depending on the location of the graft. Any **exercise** or activity that stretches the graft or puts it at risk for trauma should be avoided for three to four weeks. A one to two-week hospital stay is most often required in cases of full-thickness grafts, as the recovery period is longer.

### Morbidity and mortality rates

According to the American Burn Association, there are more than 1 million burn injuries in the United States each year that require medical attention. Approximately one-half of these require hospitalization, and roughly 25,000 of those burn patients are admitted to a specialized burn unit. About 4,500 people die from burns each year in the United States.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Patients with less severe burns are usually treated in a doctor's office or a hospital emergency room. Patients with any of the following conditions, however, are usually transferred to hospitals with specialized burn units: third-degree burns; partial-thickness burns over 10% of their total body area; electrical or chemical burns; smoke inhalation injuries; or preexisting medical disorders that could complicate management, prolong recovery, or affect mortality. In addition, burned children in hospitals without qualified personnel should be admitted to a hospital with a burn unit. A surgical team that specializes in burn treatment and skin grafts will perform the necessary procedures. The team may include neurosurgeons, ophthalmologists, oral surgeons, thoracic surgeons, psychiatrists, and trauma specialists as well as plastic surgeons and dermatologists.

In the United States, about 500,000 people seek medical treatment for burns every year. About 4,000 people die of their burn injury yearly (including 3,500 due to injuries from residential fires, and 500 due to injuries from fires resulting from a car or airplane crash, and chemical and electrical burns). 40,000 people are admitted to hospitals annually for burn treatment; 25,000 of these are admitted to specialized burn center.

About 38% of all burn unit admissions are for burns covering more than 10% of the patient's total body surface area. 10% of these admissions are for burns exceeding 30% of the patient's total body surface area. 70% of all burn unit admissions are for male patients, and 30% are for female patients. The source of burns breaks down as follows: 46% from fire or flame, 32% from hot water scalding, 8% from hot object contact, 4% from electrical burns, 3% from chemical burns, and 6% other source of burn. The survival rate for patients admitted to specialized burn centers is about 94.4%.

Treatment for severe burns has improved dramatically in the past 20 years. In the early twenty-first century, patients can survive with burns covering up to about 90% of the body, although they often face permanent physical impairment.

### Alternatives

There has been great progress in the development of artificial skin replacement products in the early twenty-first century. Although nothing works as well as the patient's own skin, artificial skin products are important

## QUESTIONS TO ASK THE DOCTOR

- Can you explain the process of skin grafting to me?
- Will I be sent to a hospital with a special burn unit?
- How long will I have to stay in the hospital?
- How long will recovery take?
- When will I be able to resume normal activities?
- What will the injured area look like after grafting?

due to the limitation of available skin for allografting in severely burned patients. Unlike allografts and xenografts, artificial skin replacements are not rejected by the patient's body and actually encourage the generation of new tissue. Artificial skin usually consists of a synthetic epidermis and a collagen-based dermis. The artificial dermis consists of fibers arranged in a lattice that acts as a template for the formation of new tissue. Fibroblasts, blood vessels, nerve fibers, and lymph vessels from surrounding healthy tissue grow into the collagen lattice, which eventually dissolves as these cells and structures build a new dermis. The synthetic epidermis, which acts as a temporary barrier during this process, is eventually replaced with a split-thickness autograft or with an epidermis cultured in the laboratory from the patient's own epithelial cells.

Several artificial skin products are available for burns or non-healing wounds, including Integra<sup>®</sup>, Dermal Regeneration Template<sup>®</sup> (from Integra Life Sciences Technology), Apligraf<sup>®</sup> (Novartis), Transcyte<sup>®</sup> (Advance Tissue Science), and Dermagraft<sup>®</sup>. Researchers have also obtained promising results growing or cultivating the patient's own skin cells in the laboratory. These cultured skin substitutes reduce the need for autografts and can reduce the complications of burn injuries. Laboratory cultivation of skin cells may improve the prognosis for severely burned patients with third-degree burns over 50% of their body. The recovery of these patients has been hindered by the limited availability of uninjured skin from their own bodies for grafting. Skin substitutes may also reduce treatment costs and the length of hospital stays. In addition, other research has demonstrated the possibility of using stem cells collected from bone marrow or blood for use in growing skin grafts.

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#### ORGANIZATIONS

American Burn Association, 625 N. Michigan Avenue, Suite 2550, Chicago, IL, 60611, (312) 642-9260, (312) 642-9130, [info@ameriburn.org](mailto:info@ameriburn.org), <http://www.ameriburn.org>.

American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, (800) 342-2383, AskADA@diabetes.org, <http://www.diabetes.org>.

American Society of Plastic Surgeons, 444 E. Algonquin Road, Arlington Heights, IL, 60005, (847) 228-9900, <http://www.plasticsurgery.org>.

National Institutes of Health, 9000 Rockville Pike, Bethesda, MD, 20892, (301) 496-4000, [NIHinfo@od.nih.gov](mailto:NIHinfo@od.nih.gov), <http://www.nih.gov/>.

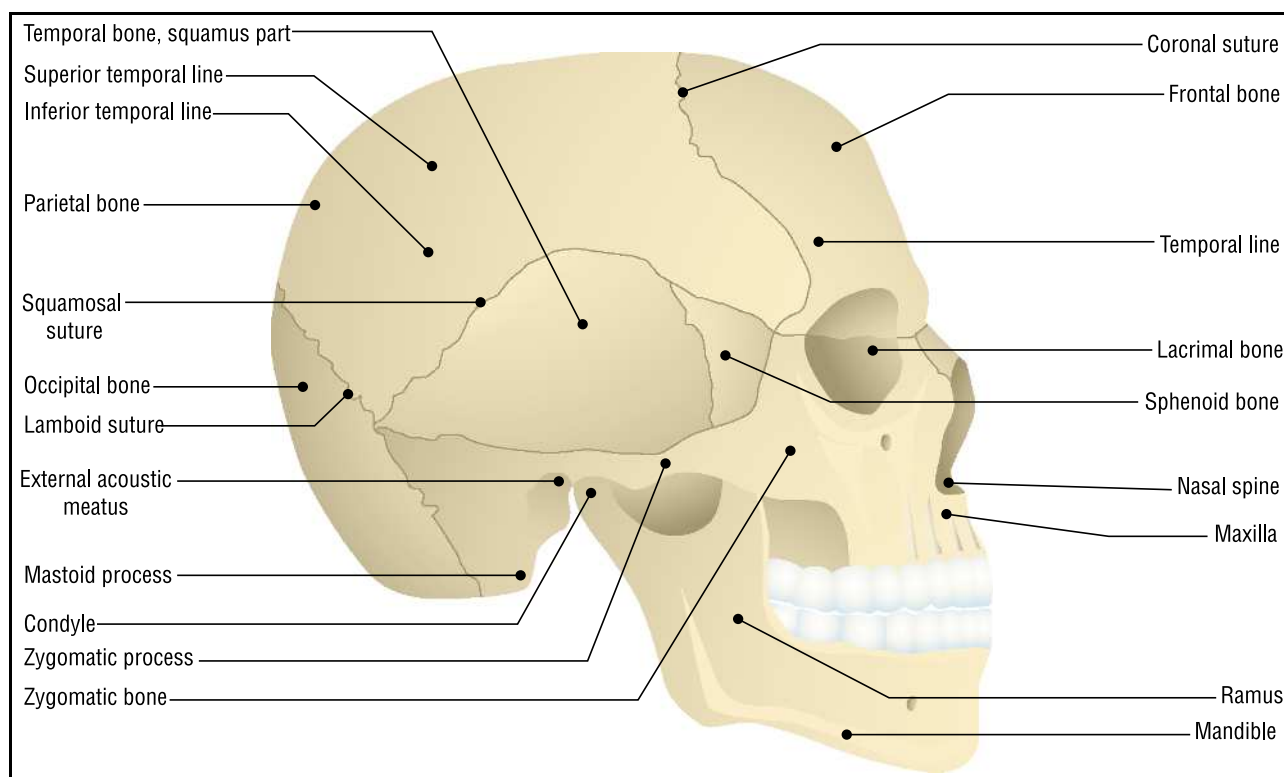
Lisa Christenson, Ph.D.  
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Roselyn Carson-DeWitt, M.D.

Skin smoothing see **Dermabrasion**

## Skull x rays

### Definition

Skull X-rays are performed to examine the nose, sinuses, and facial bones. These studies may also be referred to as sinus X-rays. X-ray studies produce films, also known as radiographs, by aiming X-rays



(Illustration by GGS Information Services. Cengage Learning, Gale.)

at soft bones and tissues of the body. X-ray beams are similar to light waves, except their shorter wavelength allows them to penetrate dense substances, producing images and shadows on film.

### Purpose

Doctors may order skull X-rays to aid in the diagnosis of a variety of diseases or injuries.

#### *Sinusitis*

Sinus X-rays may be ordered to confirm a diagnosis of sinusitis, or sinus infection.

#### *Fractures*

A skull X-ray may detect bone fractures resulting from injury or disease. The skull X-ray should clearly show the entire skull, jaw bones, and facial bones.

#### *Tumors*

Skull radiographs may indicate tumors in facial bones, tissues, or sinuses. Tumors may be benign (not cancerous) or malignant (cancerous).

### Other

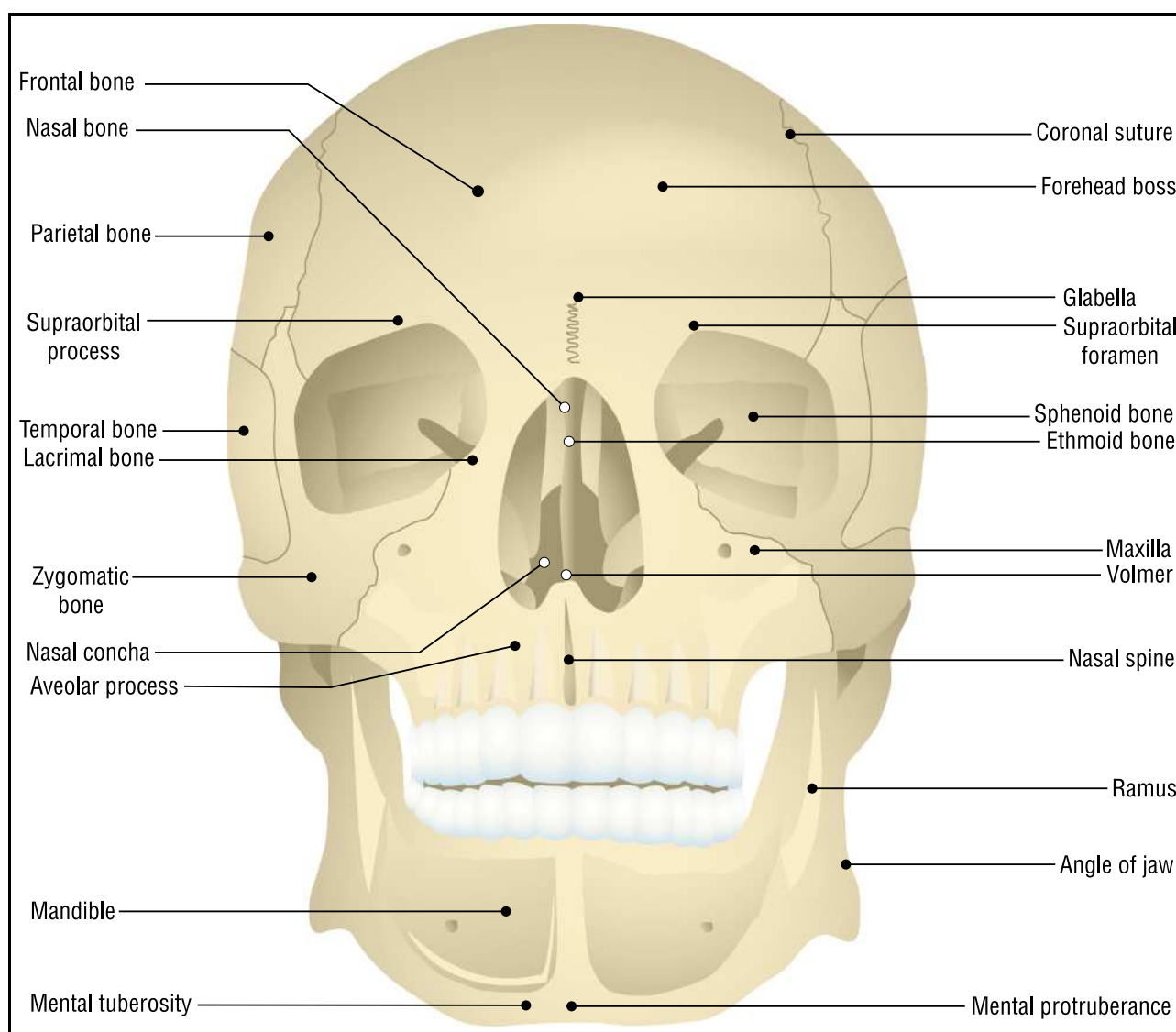
Birth defects (referred to as congenital anomalies) may be detected on a skull X-ray by changes in bone structure. Abnormal tissues or glands resulting from various conditions or diseases may also be shown on a skull radiograph.

### Description

Skull or sinus X-rays may be performed in a doctor's office that has X-ray equipment and a technologist available. The exam may also be performed in an outpatient radiology facility or a hospital radiology department.

In many instances, particularly for sinus views, the patient will sit upright in a chair, perhaps with the head held stable by a foam vise. A film cassette is located behind the patient. The X-ray tube is in front of the patient and may be moved to allow for different positions and views. A patient may also be asked to move his or her head at various angles and positions.

In some cases, technologists will ask the patient to lie on a table and will place the head and neck at various angles. In routine skull X-rays, as many as five different



(Illustration by GGS Information Services. Cengage Learning, Gale.)

views may be taken to allow a clear picture of various bones and tissues. The length of the test will vary depending on the number of views taken, but in general, it should last about 10 minutes. The technologist will usually ask a patient to wait while the films are being developed to ensure that they are adequate before going to the radiologist.

### Preparation

There is no preparation for the patient prior to arriving at the radiology facility. Patients will be asked to remove jewelry, dentures, or other metal objects that may produce artifacts on the film. The referring doctor or X-ray technologist can answer any questions

regarding the procedure. Any woman who is or may be pregnant should tell the technologist.

### Aftercare

There is no aftercare required following skull or sinus X-ray procedures.

### Risks

There are no common side effects from skull or sinus X-ray. The patient may feel some discomfort in the positioning of the head and neck, but will have no complications. Any X-ray procedure carries minimal radiation risk; and children and pregnant women should



## KEY TERMS

**Radiograph**—The actual picture or film produced by an X-ray study.

**X-ray**—A form of electromagnetic radiation with shorter wavelengths than normal light. X-rays can penetrate most structures.

be protected from radiation exposure to the abdominal or genital areas.

### Normal results

Normal results should indicate sinuses, bones, tissues, and other observed areas are of normal size, shape, and thickness for the patient's age and medical history. Results, whether normal or abnormal, will be provided to the referring doctor in a written report.

Abnormal results may include:

#### *Sinusitis*

Air in sinuses will show up on a radiograph as black, but fluid will be cloudy or white (opaque). This helps the radiologist to identify fluid in the sinuses. In chronic sinusitis, the radiologist may also note thickening or destruction of the bony wall of an infected sinus.

#### *Fractures*

Radiologists may recognize even tiny facial bone fractures as a line of defect.

#### *Tumors*

Tumors may be visible if the bony sinus wall is distorted or destroyed. Abnormal findings may result in follow-up imaging studies.

#### *Other*

Skull X-rays may also detect disorders that show up as changes in bone structure, such as Paget's disease of the bone or acromegaly (a disorder associated with excess growth hormones from the pituitary gland). Areas of calcification, or gathering of calcium deposits, or destruction may indicate a condition such as an infection of bone or bone marrow (osteomyelitis).

### Resources

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Mettler, F. A. *Essentials of Radiology*, 2nd ed. Philadelphia: Saunders, 2004.

#### ORGANIZATIONS

Brain Injury Association, 1608 Spring Hill Road, Suite 110, Vienna, VA, 22182, (703) 761 0750, <http://www.biausa.org/>.

National Cancer Institute, 6116 Executive Boulevard, MSC8322, Suite 3036A, Bethesda, MD, 20892 8322, (800) 422 6237, <http://www.cancer.gov>.

Radiological Society of North America, 820 Jorie Boulevard, Oak Brook, IL, 60523 2251, (630) 571 2670, <http://www.rsna.org>.

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## Sling procedure

### Definition

The sling procedure, or suburethral sling procedure, refers to a particular kind of surgery using ancillary material to aid in closure of the urethral sphincter function of the bladder. It is performed as a treatment of severe urinary incontinence. The sling procedure, also known as the suburethral fascial sling or the pubovaginal sling, has many forms due to advances in the types of material used for the sling. Some popular types of sling material are teflon (polytetrafluoroethylene), Gore-Tex®, and rectus fascia (fibrous tissue of the rectum). The surgery can be done through the vagina or the abdomen and some clinicians perform the procedure using a laparoscope—a small instrument that allows surgery through very small incisions in the belly button and above the pubic hairline. The long-term efficacy and durability of the laparoscopic suburethral sling procedure for management of stress incontinence are undetermined. A new technique, the tension-free vaginal tape sling procedure (TVT), has gained popularity in recent years and early research indicates high success rates and few postoperative complications. This procedure is done under local anesthetic and offers new opportunities for treatment of stress incontinence. However, TVT has not been researched for its long-term effects. Finally, there are many surgeons who use the sling procedure for all forms of incontinence.

## Purpose

Incontinence is very common and not fully understood. Generally defined as the involuntary loss of urine, incontinence comes in many forms and has many etiologies. Four established types of incontinence, according to the Agency for Health Care Policy and Research, affect approximately 13 million adults—most of them older women. Actual prevalence may be higher because incontinence is widely under reported and under diagnosed. The four types of incontinence are: stress incontinence, urge incontinence (detrusor overactivity or instability), mixed incontinence, and overflow incontinence. There are also other types of incontinence tied to specific conditions, such as neurogenic bladder in which neurological signals to the bladder are impaired.

Stress incontinence is the most frequently diagnosed form of incontinence and occurs largely with physical activity, laughter and coughing, and sneezing. The inability to hold urine can be due to weakness in the internal and external urinary sphincter or due to a weakened urethra. These two conditions, intrinsic sphincter deficiency (ISD) and urethral hypermobility or genuine stress incontinence (GSI), pertain to the inability of the “gatekeeper” sphincter muscles to stay taut and/or the urethra failing to hold urine under pressure from the abdomen. In women, as the pelvic structures relax due to age, injury, or illness, the uterus prolapses and the urethra becomes hypermobile. This allows the urethra to descend at an angle that permits loss of urine and puts pressure upon the sphincter muscles, both internal and external, allowing the mouth of the bladder to stay open.

Urge incontinence, the other frequent type of incontinence, pertains to overactivity of the sphincter in which the muscle contracts frequently, causing the need to urinate. Stress incontinence is often allied with sphincter overactivity and is often accompanied by urge incontinence.

Severe stress incontinence occurs most frequently in women younger than 60 years old. It is thought to be due to the relaxation of the supporting structures of the pelvis that results from childbirth, obesity, or lack of **exercise**. Some researchers believe that aging, perhaps due to estrogen deficiency, is a major cause of severe urinary incontinence in women, but no link has been found between incontinence and estrogen deficiency. Surgery for stress or mixed incontinence is primarily offered to patients who have failed, are not satisfied with, or are unable to comply with more conservative approaches. It is often performed during other surgeries such as urethra prolapse, cystocele surgery, urethral reconstruction, and **hysterectomy**.

## KEY TERMS

**Intrinsic sphincter deficiency (ISD)**—One of the major factors in stress incontinence. Loss of support of the urethra causes the internal sphincter muscles to be unable to keep the bladder neck closed due to lack of contractive ability.

**Pubovaginal sling**—A general term for a procedure that places a sling around the urethra without the use of tension between the sling and the urethra. The is often referred to as the Tension-Free Vaginal Tape (TVT) procedure.

**Stress incontinence**—Incontinence that occurs when abdominal pressure is placed upon the urethra from movements such as coughing, sneezing, laughter, and exercise.

**Urethral fascial sling**—A support and compression aid to urethral function using auxillary material made of patient or donor tissue to undergird the urethra.

The sling procedure gets its name from the tissue attached under the mid- or proximal urethra and sutured at its ends onto a solid structure like the rectus sheath, pubic bone, or pelvic side walls. The procedure is used in the severest cases of stress incontinence, particularly those that have a concomitant sphincter inadequacy (ISD). The sling supports the urethra as it receives pressure from the abdomen and helps the internal sphincter muscles to keep the urethral opening closed. The procedure is the most popular because it has the highest success rate of all surgical remedies for severe stress incontinence related to sphincter inadequacies in both men and women.

## Demographics

Urinary incontinence (UI) plagues 10–35% of adults and at least half of the million nursing home residents in the United States. Other studies indicate that between 10% and 30% of women experience incontinence during their lifetimes, compared to about 5% of men. One reason that more women than men have incontinent episodes is the relatively shorter urethras of women. Women have urethras of about 2 in (5 cm) and men have urethras of 10 in (25.4 cm). Studies have documented that about 50% of all women have occasional urinary incontinence, and as many as 10% have regular incontinence. Nearly 20% of women over age 75 experience daily urinary incontinence. Incontinence is a major factor in individuals entering long term care facilities. Women at highest risk are those who have given birth

to more than three children and women who were given oxytocin to induce labor. Oxytocin puts more pressure on the pelvic muscles than does ordinary labor. Women who smoke have twice the rate of incontinence, according to one study of 600 women. Those women who do high-impact exercises are at much higher risk for incontinence. According to the medical literature, those at highest risk for urinary leakage are gymnasts, followed by softball, volleyball, and basketball players. Finally, women who have diabetes or are obese have higher rates of incontinence. Women who require sling procedures have often had other surgeries for incontinence, necessitating sling procedure to treat intrinsic sphincter deficiency caused by operative trauma. A rarer cause of stress incontinence in older women is urethral instability. In men, stress incontinence is usually caused by sphincter damage after surgery on the prostate.

### Description

Anti-incontinence surgery is used to address the failure of two parts of female urinary continence: loss of support to the bladder neck or central urethra and intrinsic sphincter deficiency (ISD). The surgery does not restore function to the urethra or to the ability for closure to the sphincter. It replaces the mechanism for continence with supporting and compressive aids. Stabilizing the supporting elements of the urethra (ligaments, fascia, and muscles) was thought for many years to be the most important factor in curing incontinence. Called anatomic or genuine stress urinary incontinence (SUI), retropubic procedures, like the Burch procedure, sought only to restore the urethra to a fixed position. However, it became clear with the high failure rate of these procedures that ISD was present and unless surgery could confer some added compressive ability to the closure of the bladder, SUI would persist.

The urethral sling procedure is effective in the treatment of the severest types of incontinence (Types II and III) by re-establishing the “hammock effect” of the proximal or central point of the urethra during abdominal straining. The surgery involves the placement of a piece of material under the urethra at its arterial or vesical juncture and anchoring it on either side of the pubic bone or to the abdominal wall or vaginal wall. This technique involves the creation of a sling from a strip of tissue from the patient’s own abdominal fascia (fibrous tissue) or from a cadaver. Synthetic slings also are used, but some are prone to break down over time.

The urethral sling procedure is most often performed as open surgery, which involves entering the pelvic area from the abdomen or from the vagina while the patient is under general or regional anesthesia.

Broad-spectrum **antibiotics** are offered intravenously. If the patient is fitted with a urethral catheter, ampicillin and gentamicin are administered instead. The patient is placed in stirrups. Surgery takes place as a 6-to-9-cm by 1.5-cm sling is harvested from rectal tissue and sutured under the urethra at each end within the retropubic space (the area that undergirds the urethra). Synthetic tissue or fascia from a donor may also be used.

The goal of the surgery is to create a compression aid to the urethra. This involves an individualized approach to the tension needed on the sling. While the sling procedure is relatively easy to complete, the issue of tension on the sling is hard to determine and involves the use of tests during surgery for determining the compression effect of the sling on the urethra. Some manual tests are performed or a more sophisticated urodynamic test, like cystourethrography, may determine tension. It is important for the surgeon to test tension during surgery because of the high rate of retention of urine (inability to void) after surgery associated with this procedure and the miscalculation of the required tension.

### Diagnosis/Preparation

Candidates for surgical treatment of incontinence must undergo a full clinical, neurological, and radiographic evaluation before there can be direct analysis of the condition to be treated and the desired outcome. Both urethral and bladder functions are evaluated and there is an attempt to determine the conditions associated with stress incontinence. In many women, incontinence may be due to vaginal prolapse. Stress incontinence can be identified by observation of urine during pelvic examination or by a sitting or standing **stress test** where patients are asked to cough or strain and evidence of leakage is obtained. Gynecologists often use a Q-tip test to determine the angle and change in the position of the urethra during straining. Other tests include subtracted cystometry to measure how much the bladder can hold, how much pressure builds up inside the bladder as it stores urine, and how full it is when the patients feels the urge to urinate.

The frequency of stress incontinence as measured by typical symptoms ranges between 33% and 65%. The frequency of stress incontinence is around 12% when measured or defined by cystometric findings. The ability to distinguish SUI as the cause of incontinence, as opposed to ISD, becomes more complicated; but it is a very important factor in the decision to have surgery. A combination of pelvic examination for urethral hypermobility and leak point pressure as measured by coughing or other abdominal straining

has been shown to be very effective in distinguishing ISD, and identifying the patient who needs surgery.

### Aftercare

IV ketorolac and oral and intravenous pain medication are administered, as are postoperative antibiotics. A general diet is available usually on the evening of surgery. When the patient is able to walk, usually the same day, the urethral catheter is removed. The patient must perform self-catheterization to check urine volume every four hours to protect the urethral wall. If the patient is unwilling to perform catheterization, a tube can be placed suprapubically (in the back of the pubis) for voiding. Catheterization lasts about eight days, with about 98% of patients able to void at three months. Patients are discharged on the second day postoperatively, unless they have had other procedures and need additional recovery time. Patients may not lift heavy objects or engage in strenuous activity for approximately six weeks. Sexual intercourse may be resumed in the fourth week following surgery. Follow-up visits are scheduled for three to four weeks after surgery.

### Risks

Although the sling treatment has a very high success rate, it is also associated with a prolonged period of voiding difficulties, intraoperative bladder or urethra injury, infections associated with screw or staple points, and rejection of sling material from a donor or erosion of synthetic sling material. Patients should not be encouraged to undergo a sling procedure unless the risk of long-term voiding difficulty and the need for intermittent self-catheterization are understood. Fascial slings seem to be associated with the fewest complications for sling procedure treatment. Synthetic slings have a greater risk of having to be removed due to erosion and inflammation.

### Normal results

Regardless of the procedure used, a proportion of patients will remain incontinent. Results vary according to the type of sling procedure used, the type of attachment used for the sling, and the type of material used for the sling. Normal results for the sling procedure overall are recurrent stress incontinence of 3–12% after bladder sling procedures. In general, reported cure rates are lower for second and subsequent surgical procedures. A recent qualitative study published in the *American Journal of Obstetrics and Gynecology* of 57 patients who underwent patient-contributed fascial sling procedures indicates good success with fascial

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The surgery is performed by a urological surgeon who has trained specifically for this procedure. The surgery takes place in a general hospital.

sling procedures. At a median of 42 months after the procedure, the postoperative objective cure rate for stress urinary incontinence was 97%, with 88% of patients indicating that the sling had improved the quality of their lives. Eighty-four percent of patients indicated that the sling relieved their incontinence long term, and 82% of patients stated that they would undergo the surgery again. The study also found that voiding function was a common side effect in 41% of the patients.

### Morbidity and mortality rates

The most common complications of sling procedures are voiding problems (10.4%), new detrusor instability (7–27%), and lower urinary tract damage (3%). Some of the complications depend upon tension issues as well as on the materials used for the sling. There are recent and well designed studies of patient fascia and donor fascia used for slings in five centers with follow-up from 30 to 51 months that report no erosions or vaginal wall complications in any patients. Prolonged retention or voiding issues occurred in 2.3% of patients and de novo or spontaneous urge incontinence developed in 6%. These figures relate only to a large study utilizing patient or donor fascia and one that did not control for other factors like techniques of anchoring. In general, studies of the sling procedure are small and have many variables. There are no long-term studies (over five years) of this most popular procedure.

### Alternatives

Alternatives to anti-incontinent sling procedure surgery depend upon the severity of the incontinence and the type. Severe stress incontinence with intrinsic sphincter deficiency can benefit from bulking agents for the urethra to increase compression, as well as external devices like a pessary that is placed in the vagina and holds up the bladder to prevent leakage. Urethral inserts can be placed in the urethra until it is time to use the bathroom. The patient learns to put the insertion in and take it out as needed. There are also



## QUESTIONS TO ASK THE DOCTOR

- Do I have a urethral closure problem as a part of my incontinence?
- How many sling procedures have you performed?
- How soon will I be able to tell if I am going to have urine retention difficulties?
- If this surgery does not work, are there other procedures that will allow me a better quality of life?
- Is patient satisfaction a formal part of your evaluation of the success of the procedure you use?
- What type of material do you use for the sling and why do you choose this material?

urine seals that are small foam pads inserted in garments. Milder forms of incontinence can benefit from an assessment of medication usage, pelvic muscle exercises, bladder retraining, weight loss, and certain devices that stimulate the muscles around the urethra to strengthen them. For mild urethral mobility, procedures for tacking or stabilizing the urethra at the neck called Needle Neck Suspension, as well as procedures to hold the urethra in place with sutures, like the Burch method, are alternative forms of surgery.

### Resources

#### BOOKS

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#### ORGANIZATIONS

American Foundation for Urologic Disease/The Bladder Health Council. 1128 North Charles St., Baltimore, MD 21201. (410) 468 1800. Fax: (410) 468 1808. admin@afud.org. <http://www.afud.org>.

The Simon Foundation for Continence. P.O. Box 835, Wilmette, IL 60091. (800) 23 simon or (847) 864 3913. <http://www.simonfoundation.org/html/>.

### OTHER

National Kidney and Urological Diseases Information Clearinghouse. *Bladder Control in Women*. Intellihealth. April 17, 2003 [cited June 25, 2003]. <http://www.intelihealth.com/IH/ih/IH/WSIHW000/9103/24149/35872.html?d=dmContent>.

“Urinary Incontinence.” MD Consult Patient Handout. [cited June 25, 2003]. [www.MDConsult.com](http://www.MDConsult.com).

Nancy McKenzie, Ph.D.

Small bowel follow-through (SBFT): Small intestine radiography and fluoroscopy see **Upper GI exam**

## Smoking cessation

### Definition

Smoking cessation means “quitting smoking,” or “withdrawal from nicotine.” Tobacco is highly addictive, therefore, quitting the habit often involves irritability, headache, mood swings, and cravings associated with the sudden cessation or reduction of tobacco use by a nicotine-dependent individual.

### Purpose

There are many good reasons to stop smoking; one of them is that smoking cessation may speed post-surgery recovery. Smoking cessation helps a person heal and recover faster, especially in the incision area, or if the surgery involved any bones. Research shows that patients who underwent hip and knee replacements, or surgery on other bone joints, healed better and recovered more quickly if they had quit or cut down their tobacco intake several weeks before the operation. Smoking weakens the bone mineral that keeps the skeleton strong and undermines tissue and vessel health. One study suggested that even quitting tobacco for a few days could improve tissue blood flow and oxygenation, and might have a positive effect on wound healing. If a patient has had a history of heart problems, his chances of having a second heart attack will be lowered. Quitting may also reduce wound complications, and lower the risk of cardiovascular trouble after surgery. If surgery was performed to remove cancerous tumors, quitting will reduce the

## KEY TERMS

**Addiction**—Compulsive, overwhelming involvement with a specific activity. The activity may be smoking, gambling, alcohol, or may involve the use of almost any substance, such as a drug.

**Appetite suppressant**—To decrease the appetite.

**Constrict**—To squeeze tightly, compress, draw together.

**Convulsion**—To shake or effect with spasms; to agitate or disturb violently.

**Depressant**—A drug or other substance that soothes or lessens tension of the muscles or nerves.

**Detoxification**—To remove a poison or toxin or the effect of such a harmful substance; to free from an intoxicating or addictive substance in the body or from dependence on or addiction to a harmful substance.

**Endorphins**—Any of a group of proteins with analgesic properties that occur naturally in the brain.

**Gestational age**—The length of time of growth and development of the young in the mother's womb.

**Metabolism**—The sum of all the chemical processes that occur in living organisms; the rate at which the body consumes energy.

**Nicotine**—A poisonous, oily alkaloid in tobacco.

**Oxygenation**—To supply with oxygen.

**Paraphernalia**—Articles of equipment or accessory items.

**Premature**—Happening early or occurring before the usual time.

**Psychoactive**—Affecting the mind or behavior.

**Respiratory infections**—Infections that relate to or affect respiration or breathing.

**Smoking cessation**—The act of quitting smoking or withdrawal from nicotine.

**Stimulant**—A drug or other substance that increases the rate of activity of a body system.

**Tremor**—A trembling, quivering, or shaking.

**Withdrawal**—Stopping of administration or use of a drug; the syndrome of sometimes painful physical and psychological symptoms that follow the discontinuance.

risk of a second tumor, especially if cancer in the lung, head, or neck has been successfully treated.

### Description

Quitting smoking is one of the best things a person can do to increase their life expectancy. On average, male smokers who quit at 35 years old can be expected to live to be 76 years old instead of 69 years if they were still smoking. Women who quit would live to be 80 years old instead of 74 years.

### *Effects of smoking on the body*

Nicotine acts as both a stimulant and a depressant on the body. Saliva and bronchial secretions increase along with bowel tone. Some inexperienced smokers may experience tremors or even convulsions with high doses of nicotine because of the stimulation of the central nervous system. The respiratory muscles are then depressed following stimulation.

Nicotine causes arousal as well as relaxation from stressful situations. Tobacco use increases the heart rate about 10–20 beats per minute; and because it constricts the blood vessels, it increases the blood pressure reading by 5–10 mm Hg.

Sweating, nausea, and diarrhea may also increase because of the effects of nicotine upon the central nervous system. Hormonal activities of the body are also affected. Nicotine elevates the blood glucose levels and increases insulin production; it can also lead to blood clots. Smoking does have some positive effects on the body by stimulating memory and alertness, and enhancing cognitive skills that require speed, reaction time, vigilance, and work performance. Smoking tends to alleviate boredom and reduce stress as well as reduce aggressive responses to stressful events because of its mood-altering ability. It also acts as an appetite suppressant, specifically decreasing the appetite for simple carbohydrates (sweets) and inhibiting the efficiency with which food is metabolized. The fear of weight gain prevents some people from quitting smoking. The addictive effects of tobacco have been well documented. It is considered mood- and behavior-altering, psychoactive, and prone to abuse. Tobacco's addictive potential is believed to be comparable to the addictive potentials of alcohol, cocaine, and morphine.

### *Health problems associated with smoking*

In general, chronic use of nicotine may cause an acceleration of coronary artery disease, hypertension,

reproductive disturbances, esophageal reflux, peptic ulcer disease, fetal illnesses and **death**, and delayed wound healing. The smoker is at greater risk of developing cancer (especially in the lung, mouth, larynx, esophagus, bladder, kidney, pancreas, and cervix); heart attacks and strokes; and chronic lung disease. Using tobacco during pregnancy increases the risk of miscarriage, intrauterine growth retardation (resulting in the birth of an infant small for gestational age), and the infant's risk for sudden infant death syndrome.

The specific health risks of tobacco use include: nicotine addiction, lung disease, lung cancer, emphysema, chronic bronchitis, coronary artery disease and angina, heart attack, atherosclerotic and peripheral vascular disease, aneurysms, hypertension, blood clots, strokes, oral/tooth/gum diseases including oral cancer, and cancer in the kidney, bladder, and pancreas. Nicotine is also associated with decreased senses of taste and smell. During pregnancy, nicotine may cause increased fetal death, premature labor, low birth weight infants, and sudden infant death syndrome.

Smoking is also increasingly harmful to a person's social acceptability. According to the National Institute on Drug Abuse (NIDA), students at the high school and college levels in the early twenty-first century are increasingly disapproving of smoking. In just one year, disapproval of smoking among high school seniors increased from 76.2% in 2004 to 79.8% in 2005. For young adults, smoking complicates finding housing, as many landlords will not rent to smokers and many potential roommates do not want to share their apartment with a smoker.

Nonsmokers who are regularly exposed to secondhand smoke also may experience specific health risks including:

- Increased risk of lung cancer.
- An increased frequency of respiratory infections in infants and children (e.g. bronchitis and pneumonia), asthma, and decreases in lung function as the lungs mature.
- Acute, sudden, and occasionally severe reactions including eye, nose, throat, and lower respiratory tract symptoms.

The specific health risks for smokeless tobacco users include many of the diseases of smokers, as well as a 50-fold greater risk for oral cancer with long-term or regular use.

In diabetics taking medication for high blood pressure, it has been reported that smoking may increase the risk of kidney disease and/or kidney failure.

### *Making a plan to quit*

Long lead times for elective procedures like joint operations offer a good opportunity for doctors to encourage their patients to quit smoking, but only the smoker has the power to stop smoking. Before a smoker decides to quit, he should make sure he wants to quit smoking for himself, and not for other people. The following are some suggestions the smoker may want to consider:

- The first step is to set a quit date. Women should set their quit date to begin at the end of their period for best results.
- Make a written list of why you want to quit smoking.
- Consider using an aid to help you quit, which can be the patch, nicotine gum, Zyban, nicotine spray, soft laser therapy, nasal inhaler, or some other method. If you plan to use Zyban, set your quit date for one week after you begin to use it.
- Smoke only in certain places, preferably outdoors.
- Switch to a brand of cigarettes that you don't like.
- Buy a piggy bank or an attractive box or jar and put the money in it that you would ordinarily spend on cigarettes. At an average cost of \$5 per pack, the money in your savings bank will quickly add up.
- Do not buy cigarettes by the carton.
- Cut coffee consumption in half. You will not need to give it up.
- Practice putting off lighting up when the urge strikes.
- Go for a walk every day or begin an exercise program.
- Stock up on non-fattening safe snacks to help with weight control after quitting.
- Enlist the support of family and friends.
- Clean and put away all ashtrays the day before quitting.

Smokers who are trying to quit should remind themselves that they are doing the smartest thing they have ever done. Because of the preparation for smoking cessation, the smoker won't be surprised by or fearful of quitting. The quitter will be willing to do what's necessary, even though it won't be easy. Remember, this will likely add years to the lifespan. The quitting smoker should be prepared to spend more time with nonsmoking friends, if other smokers don't support the attempt to quit.

Since hospitals are smoke-free environments, if a smoking patient is in the hospital for **elective surgery**, it may be a good opportunity to quit smoking. It might be best to set the quit date around the time of the surgery and let the attending doctor know. As the smoker takes the first step, professional hospital staff will be there to give the support and help needed.

Medical staff can start the patient on nicotine replacement therapy to help control the cravings and increase the chances of quitting permanently.

### *Methods of quitting*

Cold turkey, or an abrupt cessation of nicotine, is one way to stop smoking. Cold turkey can provide cost savings because paraphernalia and smoking cessation aids are not required; however, not everyone can stop this way as tremendous willpower is needed.

Laser therapy is an entirely safe and pain free form of acupuncture that has been in use since the 1980s. Using a painless soft laser beam instead of needles the laser beam is applied to specific energy points on the body, stimulating production of endorphins. These natural body chemicals produce a calming, relaxing effect. It is the sudden drop in endorphin levels that leads to withdrawal symptoms and physical cravings when a person stops smoking. Laser treatment not only helps relieve these cravings, but helps with stress reduction and lung detoxification. Some studies indicate that laser therapy is the most effective method of smoking cessation, with an extraordinarily high success rate.

Acupuncture—small needles or springs are inserted into the skin—is another aid in smoking cessation. The needles or springs are sometimes left in the ears and touched lightly by the patient between visits.

Some smokers find hypnosis particularly useful, especially if there is any kind of mental conflict, such as phobias, panic attacks, or weight control. As a smoker struggles to stop smoking, the conscious mind, deciding to quit, battles the inner mind, which is governed by habit and body chemistry. Hypnosis, by talking directly to the inner mind, can help to resolve that inner battle.

Some people are helped to quit smoking by psychotherapy. As of 2007, cognitive behavioral therapy, or CBT, is considered the most effective form of psychotherapy for smoking cessation. A research team at Yale University reported in the fall of 2007 that CBT was more effective than brief behavioral interventions in helping adolescent smokers stay in a smoking cessation program as well as actually quitting smoking.

Aversion techniques attempt to make smoking seem unpleasant. This technique reminds the person of the distasteful aspects of smoking, such as the smell, dirty ashtrays, coughing, the high cost, and health issues. The most common technique prescribed by psychologists for “thought stopping”—stopping unwanted thoughts—is to wear a rubber band around the wrist. Every time there is an unwanted thought (a craving to smoke) the band is supposed to be pulled so that it hurts. The

thought then becomes associated with pain and gradually neutralized.

Rapid smoking is a technique in which smoking times are strictly scheduled once a day for the first three days after quitting. Phrases are repeated such as “smoking irritates my throat” or “smoking burns my lips and tongue.” This technique causes over-smoking in a way that makes the taste and sensations associated with smoking very unpleasant.

There are special mouthwashes available, which, when used before smoking, alter the taste, giving cigarettes a very unpleasant taste. The intention is to create a link in the smoker’s mind between cigarettes and a bad taste in the mouth.

Smoking cessation aids wean a person off nicotine slowly, and the nicotine can be delivered where it does the least bodily harm. Unlike cigarettes, these aids do not introduce other harmful poisons to the body. They can be used for a short period of time; however, nicotine from any source (smoking, nicotine gum, or the nicotine patch) can make some health problems worse. These include heart or circulation problems, irregular heartbeat, chest pain, high blood pressure, overactive thyroid, stomach ulcers, or diabetes.

The four main brands of the patch are Nicotrol, Nicoderm, Prostep, and Habitrol. All four transmit low doses of nicotine to the body throughout the day. The patch comes in varying strengths ranging from 7 mg to 21 mg. The patch must be prescribed and used under a physician’s care. Package instructions must be followed carefully. Other smoking cessation programs or materials should be used while using the patch.

Nicorette gum allows the nicotine to be absorbed through the membrane of the mouth between the cheek and gums. Past smoking habits determine the right strength to choose. The gum should be chewed slowly.

The nicotine nasal spray reduces cravings and withdrawal symptoms, allowing smokers to cut back slowly. The nasal spray acts quickly to stop the cravings, as it is rapidly absorbed through the nasal membranes. One of the drawbacks is a risk of addiction to the spray.

The nicotine inhaler uses a plastic mouthpiece with a nicotine plug, delivering nicotine to the mucous membranes of the mouth. It provides nicotine at about one-third the nicotine level of cigarettes.

Bupropion hydrochloride, sold under the trade name Zyban, is an oral medication that is making an impact in the fight to help smokers quit. It is a treatment for nicotine dependence. Another new medication,



approved by the Food and Drug Administration (FDA) in 2006, is varenicline tartrate, sold under the trade name Chantix. Chantix is thought to work by affecting parts of the brain affected by nicotine in two ways: by providing some nicotine effects to ease withdrawal symptoms and by blocking the effects of nicotine from cigarettes if the patient resumes smoking. In November 2007, however, the FDA issued a warning regarding mood changes reported in persons taking Chantix. The drug is still considered safe, but anyone taking it in order to stop smoking should contact their doctor at once if they feel depressed or notice other sudden mood changes.

The nicotine lozenge is another smoking cessation aid recently added to the growing list of tools to combat nicotine withdrawal.

As of 2007, scientists are researching the possibility of developing medications that inhibit the function of CYP2A6, an enzyme that makes people more susceptible to nicotine addiction. Some people have a genetic variant that decreases the amount of CYP2A6 in the body, which is thought to protect these individuals against nicotine addiction. Thus medications that lower the amount of this enzyme might offer a new approach to smoking cessation.

### *Withdrawal symptoms*

Generally, the longer one has smoked and the greater the number of cigarettes (and nicotine) consumed, the more likely it is that withdrawal symptoms will occur and the more severe they are likely to be. When a smoker switches from regular to low-nicotine cigarettes or significantly cuts back smoking, a milder form of nicotine withdrawal involving some or all of these symptoms can occur.

These are some of the withdrawal symptoms that most former smokers experience in the beginning of their new smoke-free life:

- dry mouth;
- mood swings;
- irritability;
- feelings of depression;
- gas in the digestive tract;
- tension;
- sleeplessness or sleeping too much;
- difficulty in concentration;
- intense cravings for a cigarette;
- increased appetite and weight gain; and
- headaches.

These side effects are all temporary conditions that will probably subside in a short time for most

people. These symptoms can last from one to three weeks and are strongest during the first week after quitting. Drinking plenty of water during the first week can help detoxify the body and shorten the duration of the withdrawal symptoms. A positive attitude, drive, commitment, and a willingness to get help from health care professionals and support groups will help a smoker kick the habit.

Researchers from the University of California San Diego strongly suggest that any of the above cessation aids should be used in combination with other types of smoking cessation help, such as counseling and/or support programs. These products are not designed to help with the behavioral aspects of smoking, but only the cravings associated with them. Counseling and support groups can offer tips on coping with difficult situations that can trigger the urge to smoke.

### **Even a new heart can't break a bad habit**

Why do some people who have heart transplants continue to smoke? In a three-year study at the University of Pittsburgh of 202 heart transplant recipients, 71% of the recipients were smokers before surgery. The overall rate of post-transplant smoking was 27%. All but one of the smokers resumed the smoking habit they had before the transplant. The biggest reason for resuming smoking was addiction to nicotine. Smoking is a complex behavior, involving social interactions, visual cues, and other factors. Those who smoked until less than six months before the transplant were much more likely to resume smoking early and to smoke more. One of the major causes of early relapse was because of depression and anxiety within two months after the transplant. Another strong predictor of relapse was having a caretaker who smoked. The knowledge of these risk factors could help develop strategies for identifying those in greatest need of early intervention. According to European studies, the five-year survival rate for post-transplant smokers is 37%, compared to 80% for nonsmoking recipients. Smokers can develop inoperable lung cancers within five years after a transplant, thus resulting in a shorter survival rate. There is an alarming incidence of head and neck cancers in transplant recipients who resume smoking.

Overall, there is a 90% relapse rate in the general population; however, the more times a smoker tries to quit, the greater the chance of success with each new try.

### **Resources**

#### **BOOKS**

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- Mesmer. *Stop Smoking With America's Foremost Hypnotist*. Audio CD. Victoria, BC: Ace Mirage Entertainment, 2000.
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- "Prevention and Cessation of Cigarette Smoking: Control of Tobacco Use," patient version. National Cancer Institute. 2008. [http://www.cancer.gov/cancertopics/pdq/prevention/control of tobacco use/Patient](http://www.cancer.gov/cancertopics/pdq/prevention/control%20of%20tobacco%20use/Patient) (April 7, 2008).

#### ORGANIZATIONS

- Action on Smoking and Health, 2013 H Street, NW, Washington, DC, 20006, (202) 659 4310, <http://ash.org>.
- American Cancer Society, 1875 Connecticut Avenue, NW, Suite 730, Washington, DC, 20009, (800) ACS 2345, <http://www.cancer.org>.
- Centers for Disease Control and Prevention, Mail Stop K 50, 4770 Buford Highway, NE, Atlanta, GA, 30341, (800) 232 4636, <http://www.cdc.gov/tobacco/osh/index.htm>.

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## Snoring surgery

### Definition

Snoring is defined as noisy or rough breathing during sleep, caused by vibration of loose tissue in the upper airway. Surgical treatments for snoring include several different techniques for removing tissue from the back of the patient's throat, reshaping the nasal passages or jaw, or preventing the tongue from blocking the airway during sleep.

### Purpose

The purpose of snoring surgery is to improve or eliminate the medical and social consequences of heavy snoring. Most insurance companies, however, regard surgical treatment of snoring as essentially a cosmetic procedure—which means that patients must cover its expenses themselves. The major exception is surgery to correct a deviated septum or other obstruction in the nose, on the grounds that nasal surgery generally improves the patient's breathing during the day as well as at night.

### Snoring as a medical problem

The connection between heavy snoring, breathing disorders, and other health problems is a relatively recent discovery. Obstructive sleep apnea (OSA) is a breathing disorder that was first identified in 1965. OSA is marked by brief stoppages in breathing during sleep resulting from partial blockage of the airway. A person with OSA may stop breathing temporarily as often as 20–30 times per hour. He or she usually snores or makes choking and gasping sounds between these episodes. The person is not refreshed by nighttime sleep and may suffer from morning headaches as well as daytime sleepiness. He or she may be misdiagnosed

## KEY TERMS

**Continuous positive airway pressure (CPAP)**—A ventilation device that blows a gentle stream of air into the nose during sleep to keep the airway open.

**Deviated septum**—An abnormal configuration of the cartilage that divides the two sides of the nose. It can cause breathing problems if left uncorrected.

**Injection snoreplasty**—A technique for reducing snoring by injecting a chemical that forms scar tissue near the base of the uvula, helping to anchor it and reduce its fluttering or vibrating during sleep.

**Obstructive sleep apnea (OSA)**—A potentially life-threatening condition characterized by episodes of breathing cessation during sleep alternating with snoring or disordered breathing. The low levels of oxygen in the blood of patients with OSA may eventually cause heart problems or stroke.

**Palate**—The roof of the mouth.

**Polysomnography**—A test administered in a sleep laboratory to analyze heart rate, blood circulation,

muscle movement, brain waves, and breathing patterns during sleep.

**Primary snoring**—Simple snoring; snoring that is not interrupted by episodes of breathing cessation.

**Somnoplasty**—A technique that uses radiofrequency signals to heat a thin needle inserted into the tissues of the soft palate. The heat from the needle shrinks the tissues, thus enlarging the patient's airway. Somnoplasty is also known as radiofrequency volumetric tissue reduction (RFVTR).

**Uvula**—A triangular piece of tissue that hangs from the roof of the mouth above the back of the tongue. Primary snoring is often associated with fluttering or vibrating of the uvula during sleep.

**Uvulopalatopharyngoplasty (UPPP)**—An operation to remove the tonsils and other excess tissue at the back of the throat to prevent it from closing the airway during sleep.

as suffering from clinical depression when the real problem is physical tiredness. In addition, the high levels of carbon dioxide that build up in the blood when a person is not breathing normally may eventually lead to high blood pressure, irregular heartbeat, heart attacks, and stroke. In children, heavy snoring appears to be a major risk factor for attention-deficit/hyperactivity disorder.

Although people with OSA snore, not everyone who snores has OSA. It is thought that OSA affects about 4% of middle-aged males and 2% of middle-aged females. Most adults who snore have what is called primary snoring, which means that the loud sounds produced in the upper airway during sleep are *not* interrupted by episodes of breathing cessation. Other terms for primary snoring are simple snoring, benign snoring, rhythmical snoring, continuous snoring, and socially unacceptable snoring (SUS). Although primary snoring is not associated with severe disorders to the same extent as OSA, it has been shown to have some negative consequences for health, including such things as chronic daily headaches.

### *Snoring as a social problem*

As the term SUS suggests, primary snoring can cause the same social problems for a person as does snoring associated with OSA. People who snore heavily often keep other family members, roommates, or

even neighbors from getting a good night's sleep, which leads to considerable anger and resentment. Studies have found that the nonsnoring partner or roommate loses an average of an hour's sleep each night. According to Dr. Kingman Strohl, head of a sleep disorders program in a Veterans Administration hospital, even the average volume of snoring (60 decibels or dB) is as loud as normal speech. Some people, however, snore around 80–82 dB, the sound level of a loud yell; a few have been recorded as reaching 90 dB, the sound level of loud rock music. One study found that 80% of people married to heavy snorers end up sleeping in separate rooms. A group of Swedish researchers reported that heavy snoring has the same level of negative effects on quality of life among adult males as high blood pressure, chronic obstructive pulmonary disease, heart disease, and similar chronic medical conditions.

### *Risk factors for snoring*

Some people are at higher risk of developing problem snoring than others. Risk factors in addition to sex and age include:

- Genetic factors. The size and shape of the uvula, soft palate, tonsils, and other parts of the airway are largely determined by heredity.
- Family history of heavy snoring.

- Obesity. Severe overweight increases a person's risk of developing OSA.
- Lack of exercise. Physical activity helps to keep the muscles of the throat firm and strong as well as the larger muscles of the body.
- Heavy consumption of alcohol and tobacco.
- A history of frequent upper respiratory infections or allergies.
- Trauma to the nose, face, or throat.

## Demographics

Snoring is a commonplace problem in the general population in North America. About 19% to 37% of all Americans snore, and more than half of all middle-aged men snore. Men are more affected because of the architecture of their throat, and because of hormonal patterns and how those hormones affect fat distribution and the muscles of the upper airway. About 12% of children over the age of five are reported to snore frequently and loudly. Among adults, 45% snore occasionally, while 25% snore almost every night. The problem usually grows worse as people age; 50% of people over age 65 are habitual snorers.

Problem snoring is worse among males than among females in all age brackets. With regard to racial and ethnic differences, a sleep research study published in 2003 reported that frequent snoring is more common (in the United States) among African American women, Hispanic women, and Hispanic men than their Caucasian counterparts, even after adjusting for weight and body mass index (BMI). African American, Native American, and Asian American males have the same rates of snoring as Caucasian males. Further research is needed to determine whether these differences are related to variations in the rates and types of health problems in these respective groups.

According to international researchers, heavy snoring appears to be more common in persons of Asian origin than in persons of Middle Eastern, European, or African origin.

## Description

With the exception of UPPP, all of the surgical treatments for snoring described in this section are outpatient or office-based procedures.

### *Uvulopalatopharyngoplasty (UPPP)*

Uvulopalatopharyngoplasty, or UPPP, is the oldest and most invasive surgical treatment for snoring. It was first performed in 1982 by a Japanese surgeon named S. Fujita. UPPP requires **general anesthesia**, one to two

nights of inpatient care in a hospital, and a minimum of two weeks of recovery afterward. In a uvulopalatopharyngoplasty, the surgeon resects (removes) the patient's tonsils, part of the soft palate, and the uvula. The procedure works by enlarging the airway and removing some of the soft tissue that vibrates when the patient snores. It is not effective in treating snoring caused by obstructions at the base of the tongue.

UPPP has several drawbacks in addition to its cost and lengthy recovery period. It can result in major complications, including severe bleeding due to removal of the tonsils as well as airway obstruction. In addition, the results may not be permanent; between 50% and 70% of patients who have been treated with UPPP report that short-term improvements in snoring do not last longer than a year.

### *Laser-assisted uvulopalatoplasty*

Laser-assisted uvulopalatoplasty, or LAUP, is an outpatient surgical treatment for snoring in which a carbon dioxide laser is used to vaporize part of the uvula, a small triangular piece of tissue that hangs from the soft palate above the back of the tongue. The patient is seated upright in a comfortable chair in the doctor's office. The doctor first sprays a local anesthetic—usually lidocaine—over the back of the patient's throat, covering the patient's soft palate, tonsils, and uvula. The second step is the injection of more anesthetic into the muscle tissue in the uvula. After waiting for the anesthetic to take effect, the surgeon uses a carbon dioxide laser to make two vertical incisions in the soft palate on either side of the uvula. A third incision is used to remove the tip of the uvula. The surgeon also usually removes part of the soft palate itself. The total procedure takes about half an hour.

LAUP is typically performed as a series of three to five separate treatments. Additional treatment sessions, if needed, are spaced four to eight weeks apart.

LAUP was developed in the late 1980s by Dr. Yves-Victor Kamami, a French surgeon whose first article on the technique was published in 1990. Kamami claimed a high rate of success for LAUP in treating OSA as well as snoring. The procedure has become controversial because other surgeons found it less effective than the first reports indicated, and also because most patients suffer considerable pain for about two weeks after surgery. Although some surgeons report a success rate as high as 85% in treating snoring with LAUP, the effectiveness of the procedure is highly dependent on the surgeon's experience and ability.



### *Somnoplasty*

Somnoplasty, or radiofrequency volumetric tissue reduction (RFVTR) is a newer technique in which the surgeon uses a thin needle connected to a source of radiofrequency signals to shrink the tissues in the soft palate, throat, or tongue. It was approved by the U.S. Food and Drug Administration (FDA) for the treatment of snoring in 1997. The needle is inserted beneath the surface layer of cells and heated to a temperature between 158°F and 176°F (70° and 80°C). The upper layer of cells is unaffected, but the heated tissue is destroyed and gradually reabsorbed by the body over the next four to six weeks. Somnoplasty stiffens the remaining layers of tissue as well as reducing the total volume of tissue. Some patients require a second treatment, but most find that their snoring is significantly improved after only one. The procedure takes about 30 minutes and is performed under **local anesthesia**.

Somnoplasty appears to have a higher success rate (about 85%) than LAUP and is considerably less painful. Most patients report two to three days of mild swelling after somnoplasty compared to two weeks of considerable discomfort for LAUP.

### *Tongue suspension procedure*

The tongue suspension procedure, which is also known as the Repose<sup>TM</sup> system, is a minimally invasive surgical treatment for snoring that stabilizes the base of the tongue during sleep, preventing it from falling backward and obstructing the airway. The Repose system was approved by the FDA in 1998. It consists of a titanium screw inserted into the lower jaw on the floor of the mouth and a suture passed through the base of the tongue that is then attached to the screw. The attachment holds the tongue forward during sleep.

The Repose system is done as an outpatient procedure under total anesthesia. It takes about 15–20 minutes to complete. The advantages of the tongue suspension procedure include the fact that it is reversible, since no incision is made; and that it can be combined with UPPP, LAUP, or a **tonsillectomy**. Its disadvantages include its relatively long healing time (one to two weeks) and the fact that it appears to be more effective in treating OSA than primary snoring. One team of American and Israeli researchers who conducted a multicenter trial concluded that the tongue suspension procedure requires further evaluation.

### *Injection snoreplasty*

Injection snoreplasty was developed by a team of Army physicians at Walter Reed Hospital and introduced to other ear, nose and throat specialists at a

professional conference in 2000. In injection snoreplasty, the surgeon gives the patient a local anesthetic and then injects a hardening agent known as sodium tetradecyl sulfate underneath the skin of the roof of the mouth just in front of the uvula. The chemical, which is also used in sclerotherapy, creates a blister that hardens into scar tissue. The scar tissue pulls the uvula forward, reducing the vibration or flutter that causes snoring.

Preliminary research indicates that injection snoreplasty is safe, has a higher rate of success than LAUP (about 92%), and is also less painful. Most patients need only one treatment, and can manage the discomfort the next day with a mild **aspirin** substitute and throat spray. The primary drawback of injection snoreplasty is that it treats only tissues in the area of the uvula. Snoring caused by tissue vibrations elsewhere in the throat requires another form of treatment. Injection snoreplasty costs about \$500 per treatment.

## **Diagnosis/Preparation**

### *Diagnosis*

The most important task in diagnosing a patient's snoring is to distinguish between primary snoring and obstructive sleep apnea. The reason for care in the diagnosis is that surgical treatment without the recommended tests for OSA can complicate later diagnosis of the disorder.

The sounds made when a person snores have a number of different physical causes. Snoring noises may result from one or more of the following:

- An unusually long soft palate and uvula. These structures narrow the airway between the nose and the throat. They act like noisy flutter valves when the person breathes in and out during sleep.
- Too much tissue in the throat. Large tonsils and adenoids can cause snoring, which is one reason why tonsillectomies are sometimes recommended to treat heavy snoring in children.
- Nasal congestion. When a person's nose is stuffy, their attempts to breathe create a partial vacuum in the throat that pulls the softer tissues of the throat together. This suction can also produce a snoring noise. Nasal congestion helps to explain why some people snore only when they have a cold or during pollen season.
- Anatomical deformations of the nose. People who have had their noses or cheekbones fractured or who have a deviated septum are more likely to snore, because their nasal passages develop a twisted or crooked shape and vibrate as air passes through them.

- **Sleeping position.** People are more likely to snore when they are lying on the back because the force of gravity draws the tongue and soft tissues in the throat backward and downward, blocking the airway.
- **Obesity.** Obesity adds to the weight of the tissues in the neck, which can cause partial blockage of the airway during sleep.
- **Use of alcohol, sleeping medications, or tranquilizers.** These substances relax the throat muscles, which may become soft or limp enough to partially close the airway.

Because snoring may be related to lifestyle factors, upper respiratory infections, seasonal allergies, and sleeping habits as well as the anatomy of the person's airway, a complete medical history is the first step in determining suitable treatments. In some cases the patient may have been referred by his or her dentist on the basis of findings during a dental procedure. A primary care doctor can take a history and perform a basic examination of the patient's nose and throat. In addition, the primary care doctor may give the patient one or more short questionnaires to evaluate the severity of daytime sleepiness and other problems related to snoring. The test most commonly used is the Epworth Sleepiness Scale (ESS), which was developed by an Australian physician, Dr. Murray Johns, in 1991. The ESS lists eight situations (reading, watching TV, etc.) and asks the patient to rate his or her chances of dozing off in each situation on a four-point scale (0–3, with 3 representing a high chance of falling asleep). A score of 6 or lower indicates that the person is getting enough sleep; a score higher than 9 is a danger sign. The ESS is often used to measure the effectiveness of various treatments for snoring as well as to evaluate patients prior to surgery.

The next stage in the differential diagnosis of snoring problems is a detailed examination of the patient's airway by an otolaryngologist, who is a physician who specializes in diagnosing and treating disorders involving the nose and throat. The American Sleep Apnea Association (ASAA) maintains that no one should consider surgery for snoring until their airway has been examined by a specialist. The otolaryngologist will be able to determine whether the size and shape of the patient's uvula, soft palate, tonsils and adenoids, nasal cartilage, and throat muscles are contributing factors, and to advise the patient on specific procedures. It may be necessary for the patient to undergo more than one type of treatment for snoring, as some surgical procedures correct only one or two structures in the nose or throat.

A complete airway examination consists of an external examination of the patient's face and neck; an endoscopic examination of the nasal passages and throat; the use of a laryngeal mirror or magnifying laryngoscope to study the lower portions of the throat; and various imaging studies. The otolaryngologist may use a nasopharyngoscope, which allows for evaluation of obstructions below the palate and the tongue, and may be performed with the patient either awake or asleep. The nasopharyngoscope is a flexible fiberoptic device that is introduced into the airway through the patient's nose. Other imaging studies that may be done include acoustic reflection, computed tomography (CT) scans, or **magnetic resonance imaging (MRI)**.

In addition to the airway examination, patients considering surgical treatment for snoring must make an appointment for sleep testing in a specialized laboratory. The American Academy of Sleep Medicine recommends this step in order to exclude the possibility that the patient has obstructive sleep apnea. Sleep testing consists of an overnight stay in a special sleep laboratory. Before the patient goes to sleep, he or she will be connected to a polysomnograph, which is an instrument that monitors the patient's breathing, heart rate, temperature, muscle movements, airflow, body position, and other measurements that are needed to evaluate the cause(s) of sleep disorders. A technician records the data in a separate room. As of 2003, some companies are developing portable polysomnographs that allow patients to connect the device to a computer in their home and transmit the data to the sleep center over an Internet connection.

### Preparation

Apart from the extensive diagnostic testing that is recommended, preparation for outpatient snoring surgery is usually limited to taking a mild sedative before the procedure. Preparation for UPPP requires a **physical examination**, EKG, blood tests, and a preoperation interview with the anesthesiologist to evaluate the patient's fitness for general anesthesia.

### Aftercare

Aftercare following outpatient snoring surgery consists primarily of medication for throat discomfort, particularly when swallowing. The patient can resume normal work and other activities the same day as the procedure, and speaking is usually not affected.

### Risks

In addition to the risk of an allergic reaction to the local anesthetic, snoring surgery is associated with the following risks:

- Severe pain following the procedure that lasts longer than two to three days. This complication occurs more frequently with LAUP than with somnoplasty or injection snoreplasty.
- Causation or worsening of obstructive sleep apnea. LAUP has been reported to cause OSA in patients who had only primary snoring before the operation.
- Nasal regurgitation. This complication refers to food shooting or leaking through the nose when the patient swallows.
- Dehydration. This complication has been reported with the tongue suspension procedure.
- Permanent change in the quality of the patient's voice.
- Recurrence of primary snoring.

### Normal results

In general, surgical treatment for snoring appears to be most effective in patients whose primary problem is nasal obstruction. The results of snoring surgery depend to a large degree on a good "fit" between the anatomy of a specific patient's airway and the specific procedure performed, as well as on the individual surgeon's skills.

### Morbidity and mortality rates

Mortality rates for UPPP are related to complications of OSA rather than to the procedure itself. With regard to the outpatient procedures for snoring, mortality rates are very close to zero because these surgeries are performed under local anesthesia. Complication rates, however, are high with both UPPP and LAUP. According to one European study, as many as 42% of patients have complications following UPPP, with 14% reporting general dissatisfaction with the results of surgery. Specific complication rates for UPPP are 15% for recurrence of snoring; 13% for nasal regurgitation; 10% for excessive throat secretions; 9% for swallowing problems; and 7% for speech disturbances. Complications for LAUP have been estimated to be 30–40% for recurrence of snoring; 30% for causing or worsening of OSA; 5–10% for persistent nasal regurgitation; 1% for permanent change in vocal quality.

As of early 2003, no morbidity figures have been published for somnoplasty or injection snoreplasty.

### Alternatives

#### *Oral devices and appliances*

Oral appliances are intended to reduce snoring by changing the shape of the oral cavity or preventing the tongue from blocking the airway. There are three basic

### WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Snoring surgery is done by a head and neck surgeon, a plastic surgeon, or an otolaryngologist, who is a doctor with special training in treating disorders of the ear, nose, and throat. UPPP is performed under general anesthesia and requires an overnight hospital stay. LAUP, somnoplasty, the tongue suspension procedure, and injection snoreplasty are performed as outpatient surgery, usually in a doctor's office or other outpatient facility.

Prosthetic devices to alter the position of the jaw or restrain the tongue during sleep are prescribed and fitted by general dentists or orthodontists.

Polysomnography as a part of a diagnostic workup is done in a special sleep laboratory by experts who are trained in the use of the equipment and interpretation of the results. Advances in technology, however, may allow patients to be monitored at home with portable polysomnographs and a computer with an Internet connection.

types of mouthpieces: those that push the lower jaw forward; those that raise the soft palate; and those that restrain the tongue from falling backward during sleep. To work properly, oral appliances should be fitted by an experienced dentist or orthodontist and checked periodically for proper fit. Their major drawback is a low rate of patient compliance; one German study found that only 30% of patients fitted with these devices were still using them after four years. In addition, oral appliances cannot be used by patients with gum disease, **dental implants**, or teeth that are otherwise in poor condition.

#### *Continuous positive airway pressure (CPAP) devices*

CPAP devices are masks that fit over the nose during sleep and deliver air into the airway under enough pressure to keep the airway open. If used correctly, CPAP devices can be an effective alternative to surgery. Their main drawback is a relatively low rate of patient compliance; the mask must be used every night, and some people feel mildly claustrophobic when using it. In addition, patients are often asked to lose weight or stop smoking while using CPAP, which are lifestyle adjustments that some would rather not make.

## QUESTIONS TO ASK THE DOCTOR

- How often have you performed surgery for primary snoring? Which procedures have you performed most frequently?
- What is your opinion of somnoplasty and injection snoreplasty?
- Am I likely to benefit from lifestyle changes or other less invasive alternatives?
- Should I talk to my dentist about an oral appliance to control snoring?

### Lifestyle changes

Patients who snore only occasionally or who are light snorers may be helped by one or more of the following changes without undergoing surgery:

- Losing weight and getting adequate physical exercise.
- Avoiding tranquilizers, sleeping pills, antihistamines, or alcoholic beverages before bedtime.
- Quitting smoking.
- Sleeping on the side rather than the back. One do-it-yourself device that is sometimes recommended to keep the patient turned on his or her side is a tennis ball placed inside a sock and attached to the back of the pajamas or nightgown. This approach seems to work for some patients with simple snoring.
- Tilting the head of the bed upward about 4 in (10 cm).

### Complementary and alternative (CAM) approaches

There are three forms of alternative treatment that have been shown to be helpful in reducing primary snoring in patients with histories of nasal congestion or swollen tissues in the throat. The first is acupuncture. Treatments for snoring usually focus on acupuncture points on the stomach, arms, and legs associated with the production of excess mucus. Insertion of the acupuncture needles at these points is thought to stimulate the body to release the excess moisture or phlegm.

Homeopathy and aromatherapy also appear to benefit some patients whose snoring is related to colds, allergies, or sore throats. Homeopathic remedies for snoring are available as nose drops and throat sprays as well as the traditional pill formulations. Aromatherapy formulas for snoring typically contain marjoram oil, which may be used alone or combined with lavender and other herbs that clear the nasal passages. Some people find aromatherapy preparations helpful alongside

mainstream treatments because their fragrance is pleasant and relaxing.

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### ORGANIZATIONS

- American Academy of Medical Acupuncture, 4929 Wilshire Boulevard, Suite 428, Los Angeles, CA, 90010, (323) 937–5514, <http://www.medicalacupuncture.org>.
- American Academy of Otolaryngology Head and Neck Surgery, One Prince Street, Alexandria, VA, 22314 3357, (703) 836–4444, <http://www.entnet.org>.
- American Academy of Sleep Medicine, One Westbrook Corporate Center, Suite 920, Westchester, IL, 60154, (708) 492–0930, <http://www.aasmnet.org>.
- American Dental Association, 211 East Chicago Avenue, Chicago, IL, 60611, (312) 440–2500, <http://www.ada.org>.
- American Sleep Apnea Association, 1424 K Street NW, Suite 302, Washington, DC, 20005, (202) 293–3650, <http://www.sleepapnea.org>.



National Center on Sleep Disorders Research, Two Rockledge Centre, Suite 10038, 6701 Rockledge Drive, MSC 7920, Bethesda, MD, 20892 7920, (301) 435 0199, <http://www.nhlbi.nih.gov/about/ncsdr/index.htm>.

Rebecca Frey, Ph.D.

Sodium test see **Electrolyte tests**

Somnoplasty see **Snoring surgery**

## Sphygmomanometer

### Definition

A sphygmomanometer is a device for measuring blood pressure.

### Purpose

The sphygmomanometer is designed to monitor blood pressure by measuring the force of the blood in the heart where the pressure is greatest. This occurs during the contraction of the ventricles, when blood is pumped from the heart to the rest of the body (systolic pressure). The minimal force is also measured. This occurs during the period when the heart is relaxed between beats and pressure is lowest (diastolic pressure).

A sphygmomanometer is used to establish a baseline at a healthcare encounter and on admission to a hospital. Checking blood pressure is also performed to monitor the effectiveness of medication and other methods to control hypertension, and as a diagnostic aid to detect various diseases and abnormalities.

### Description

A sphygmomanometer consists of a hand bulb pump, a unit that displays the blood pressure reading, and an inflatable cuff that is usually wrapped around a person's upper arm. Care should be taken to ensure that the cuff size is appropriate for the person whose blood pressure is being taken. This improves the accuracy of the reading. Children and adults with smaller or larger than average-sized arms require special-sized cuffs appropriate for their needs. A **stethoscope** is also used in conjunction with the sphygmomanometer to hear the blood pressure sounds. Some devices have the stethoscope already built in.

A sphygmomanometer can be used or encountered in a variety of settings:

- home
- hospital

## KEY TERMS

**Aneroid monitor**—A monitor that works without fluids, i.e. without mercury.

**Blood pressure**—The tension of the blood in the arteries, measured in millimeters of mercury (mm Hg) by a sphygmomanometer or by an electronic device.

**Diastolic**—Minimum arterial blood pressure during ventricular relaxation or rest.

**Systolic**—Maximum arterial blood pressure during ventricular contraction.

- primary care clinic or professional office
- ambulance
- dental office
- pharmacy and other retail establishment

There are three types of equipment in common use for monitoring blood pressure.

- A mercury-based unit has a manually inflatable cuff attached by tubing to the unit that is calibrated in millimeters of mercury. During blood pressure measurement, the unit must be kept upright on a flat surface and the gauge read at eye level. Breakage of the unit may cause dangerous mercury contamination and would require specialist removal for disposal. Due to the hazards of mercury, the use of mercury-based sphygmomanometers has declined sharply since 2000.
- An aneroid unit is mercury free and consists of a cuff that can be applied with one hand for self-testing; a stethoscope that is built in or attached; and a valve that inflates and deflates automatically with the data displayed on an easy-to-read gauge that will function in any position. The unit is sensitive and if dropped may require recalibration.
- An automatic unit is also mercury free and is typically battery operated. It has a cuff that can be applied with one hand for self-testing, and a valve that automatically inflates and deflates. Units with manual inflation are also available. The reading is displayed digitally and a stethoscope is not required. This is useful for persons who are hearing impaired, for emergency situations when staff is limited, and for automatic input into instruments for storage or graphical display. A wrist monitor is also available for home testing. Some more expensive models also remember and print out recordings. The automatic units tend to be more portable than bulkier mercury devices.

### Operation

The flow, resistance, quality, and quantity of blood circulating through the heart and the condition of the arterial walls are all factors that influence blood pressure. If blood flow in the arteries is restricted, the reading will be higher.

Blood pressure should be routinely checked every one to two years. It can be checked at any time, but is best measured when a person has been resting for at least five minutes, so that exertion prior to the test will not unduly influence the outcome of the reading.

To record blood pressure, the person should be seated with one arm bent slightly, and the arm bare or with the sleeve loosely rolled up. With an aneroid or automatic unit, the cuff is placed level with the heart and wrapped around the upper arm, one inch above the elbow. Following the manufacturer's guidelines, the cuff is inflated and then deflated while an attendant records the reading.

If the blood pressure is monitored manually, a cuff is placed level with the heart and wrapped firmly but not tightly around the arm one inch (2–3 cm) above the elbow over the brachial artery. Wrinkles in the cuff should be smoothed out. Positioning a stethoscope over the brachial artery in front of the elbow with one hand and listening through the earpieces, the health professional inflates the cuff well above normal levels (to about 200 mm Hg), or until no sound is heard. Alternatively, the cuff should be inflated 10 mm Hg above the last sound heard. The valve in the pump is slowly opened. Air is allowed to escape no faster than 5 mm Hg per second to deflate the pressure in the cuff to the point where a clicking sound is heard over the brachial artery. The reading of the gauge at this point is recorded as the systolic pressure. The sounds continue as the pressure in the cuff is released and the flow of blood through the artery is no longer blocked. At this point, the noises are no longer heard. The reading of the gauge at this point is noted as the diastolic pressure. "Lub-dub" is the sound produced by the normal heart as it beats. Every time this sound is detected, it means that the heart is contracting once. The sounds are created when the heart valves click to close. When one hears "lub," the atrioventricular valves are closing. The "dub" sound is produced by the pulmonic and aortic valves.

With children, the clicking sound does not disappear but changes to a soft muffled sound. Because sounds continue to be heard as the cuff deflates to zero, the reading of the gauge at the point where the sounds change is recorded as the diastolic pressure.

Blood pressure readings are recorded with the systolic pressure first, then the diastolic pressure (e.g. 120/70).

### Interpretation

Blood pressure readings must be interpreted in relation to a person's age, physical condition, medical history, and medications being used.

### Maintenance

Devices should be checked and calibrated annually by a qualified technician to ensure accurate readings. This is especially important for automatic sphygmomanometers.

### Normal results

One elevated reading does not mean that hypertension is present. Repeated measurements may be required if hypertension is suspected. The **blood pressure measurement** is recorded and compared with normal ranges for an individual's age and medical condition, and a decision is made on whether any further medical intervention is required.

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**ORGANIZATIONS**

American Academy of Family Physicians. 11400 Tomahawk Creek Parkway, Leawood, KS 66211 2672. (913) 906 6000. Email: fp@aafp.org. <http://www.aafp.org>.

American Academy of Pediatrics. 141 Northwest Point Boulevard, Elk Grove Village, IL 60007 1098. (847) 434 4000. Fax: (847) 434 8000. Email: kidsdoc@aap.org. <http://www.aap.org/default.htm>.

American College of Physicians. 190 N. Independence Mall West, Philadelphia, PA 19106 1572. (800) 523 1546, x 2600 or (215) 351 2600. <http://www.acponline.org>.

American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464 5000. <http://www.ama-assn.org>.

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Sphygmomanometry see **Blood pressure measurement**

Spina bifida surgery see **Meningocele repair**

Spinal fluid analysis see **Cerebrospinal fluid (CSF) analysis**

## Spinal fusion

**Definition**

Spinal fusion is a procedure that promotes the fusing, or growing together, of two or more vertebrae in the spine.

**Purpose**

Spinal fusion is performed to:

- Straighten a spine deformed by scoliosis, neuromuscular disease, cerebral palsy, or other disorder.
- Prevent further deformation.
- Support a spine weakened by infection or tumor.
- Reduce or prevent pain from pinched or injured nerves.
- Compensate for injured vertebrae or disks.

The goal of spinal fusion is to unite two or more vertebrae to prevent them from moving independently of each other. This may be done to improve posture, increase ability to ventilate the lungs, prevent pain, or treat spinal instability and reduce the risk of nerve damage.

**Demographics**

According to the American Academy of Orthopaedic Surgeons, approximately a quarter-million spinal fusions are performed each year, half on the upper and half on the lower spine.

**Description****Spinal anatomy**

The spine is a series of individual bones, called vertebrae, separated by cartilaginous disks. The spine is composed of seven cervical (neck) vertebrae, 12 thoracic (chest) vertebrae, five lumbar (lower back) vertebrae, and the fused vertebrae in the sacrum and coccyx that help to form the hip region.

While the shapes of individual vertebrae differ among these regions, each is essentially a short hollow tube containing the bundle of nerves known as the spinal cord. Individual nerves, such as those carrying messages to the arms or legs, enter and exit the spinal cord through gaps between vertebrae.

The spinal disks act as shock absorbers, cushioning the spine, and preventing individual bones from contacting each other. Disks also help to hold the vertebrae together.

The weight of the upper body is transferred through the spine to the hips and the legs. The spine is held upright through the work of the back muscles, which are attached to the vertebrae.

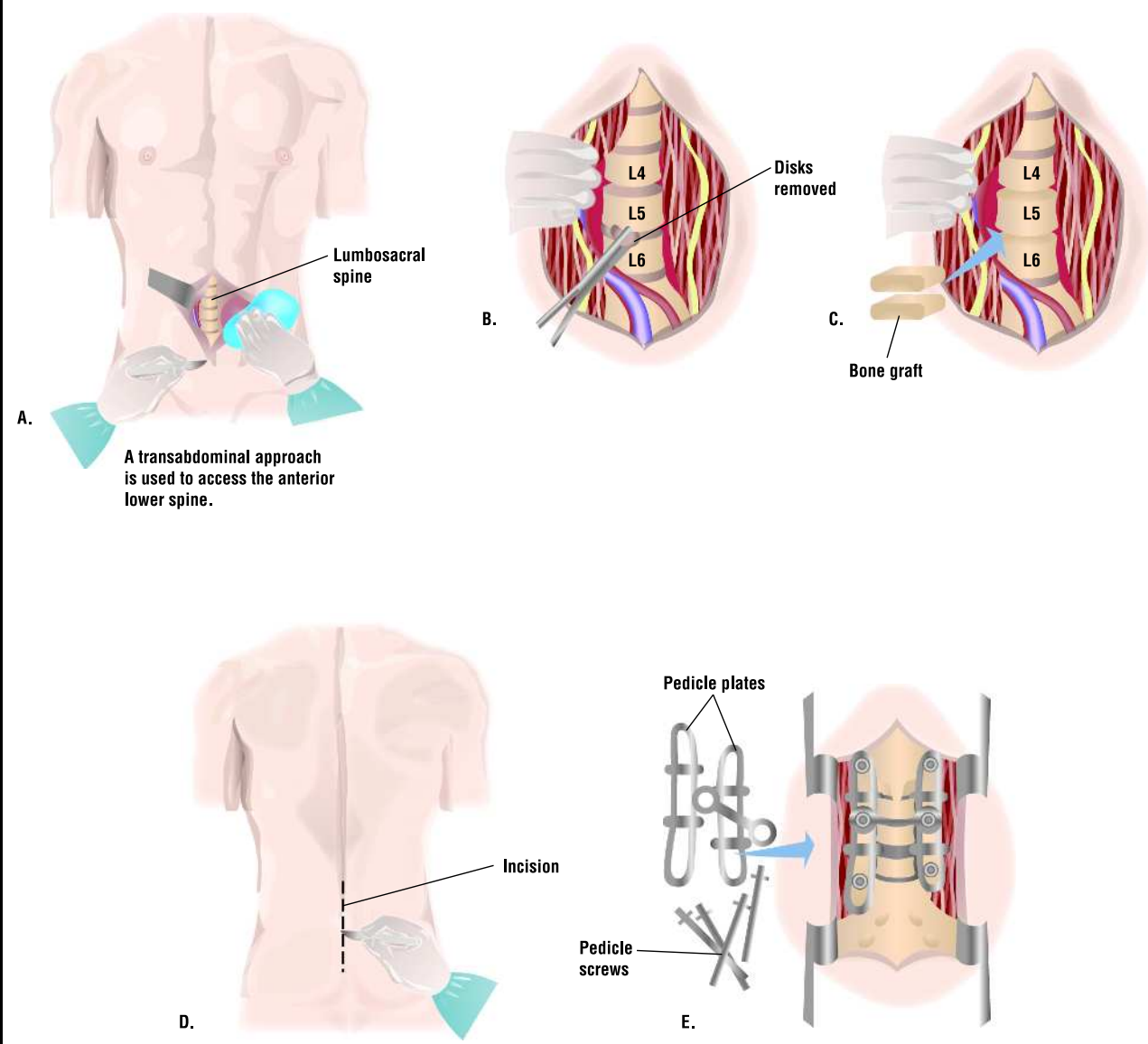
While the normal spine has no side-to-side curve, it does have a series of front-to-back curves, giving it a gentle “S” shape. The spine curves in at the lumbar region, back out at the thoracic region, and back in at the cervical region.

***Surgery for scoliosis, neuromuscular disease, and cerebral palsy***

Abnormal side-to-side curvature of the spine is termed scoliosis. An excessive lumbar curve is termed lordosis, and an excessive thoracic curve is kyphosis. “Idiopathic” scoliosis is the most common form of scoliosis; it has no known cause.

Scoliosis and other curves can be caused by neuromuscular disease, including Duchenne muscular dystrophy. Progressive and perhaps uneven weakening of the

## Spinal fusion



In this spinal fusion, the surgeon makes an incision in the lower abdomen to access the lumbar spine (A). The disks between the vertebrae are removed (B), and bone grafts are inserted into the spaces (C). Then another incision is made in the patient's back (D), and the vertebrae are exposed and fixed the pedicle plates and screws (E) (Illustration by GGS Information Services. Cengage Learning, Gale.)

spinal muscles leads to gradual inability to support the spine in an upright position. The weight of the upper body then begins to collapse the spine, inducing a curve. In addition to pain and disfigurement, severe scoliosis prevents adequate movement of air into and out of the lungs. Scoliosis also occurs in cerebral palsy, due to excess and imbalanced muscle activity pulling on the spine unevenly.

Idiopathic scoliosis, which occurs most often in adolescent girls, is usually managed with a brace that wraps the abdomen and chest, allowing the spine to develop straight. Spinal fusion is indicated in patients whose curves are more severe or are progressing rapidly. The indication for surgery in cerebral palsy is similar to that for idiopathic scoliosis.



## KEY TERMS

**Fusion**—A union, joining together; e.g., bone fusion.

**Herniated disk**—A blister-like bulging or protrusion of the contents of the disk out through the fibers that normally hold them in place. Also called ruptured disk, slipped disk, or displaced disk.

**Magnetic resonance imaging (MRI)**—A test that provides pictures of organs and structures inside the body by using a magnetic field and pulses of radio wave energy to detect tumors, infection, and other types of tissue disease or damage, or conditions affecting blood flow. The area of the body being studied is positioned inside a strong magnetic field.

**Vertebra**—One of the bones that make up the back bone (spine).

Spinal fusion in Duchenne muscular dystrophy is usually indicated earlier than in otherwise healthy adolescents. This is because these patients lose ventilatory function rapidly through adolescence, making the surgery more dangerous as time passes. Surgery should occur before excess ventilatory function is lost.

### *Surgery for herniated disks, disk degeneration, and pain*

As people age, their disks become less supple and more prone to damage. A herniated disk is one that has developed a bulge. The bulge can press against nerves located in the spinal cord or exiting from it, causing pain. Disks can also degenerate, losing mass and thickness, allowing vertebrae to contact each other. This can pinch nerves and cause pain. Disk-related pain is very common in the neck, which is subject to constant twisting forces, and the lower back, which experiences large compressive forces. In these cases, spinal fusion is employed to prevent the nerves from being damaged. The offending disk is removed at the same time. A fractured vertebra may also be treated with fusion to prevent it from causing future problems.

Sometimes, spinal fusion is used to treat back pain even when the anatomical source of the problem cannot be located. This is usually viewed as a last resort for intractable and disabling pain.

### *The spinal fusion operation*

Spinal fusion is performed under **general anesthesia**. During the procedure, the target vertebrae are exposed. Protective tissue layers next to the bone are

removed, and small chips of bone are placed next to the vertebrae. These bone chips can either be from the patient's hip or from a bone bank. The chips increase the rate of fusion. Using bone from the patient's hip (an autograft) is more successful than banked bone (an allograft), but it increases the stresses of surgery and loss of blood.

Fusion of the lumbar and thoracic vertebrae is done by approaching from the rear, with the patient lying face down. Cervical fusion is typically performed from the front, with the patient lying on his or her back.

Many spinal fusion patients also receive **spinal instrumentation**. During the fusion operation, a set of rods, wires, or screws will be attached to the spine. This instrumentation allows the spine to be held in place while the bones fuse. The alternative is an external brace applied after the operation.

An experimental treatment, called human recombinant bone morphogenetic protein-2, has shown promise for its ability to accelerate fusion rates without bone chips and instrumentation. This technique is only available through clinical trials at a few medical centers.

Spinal fusion surgery takes approximately four hours. The patient is intubated (tube placed in the trachea), and has an IV line and Foley (urinary) catheter in place. At the end of the operation, a drain is placed in the incision site to help withdraw fluids over the next several days. The fusion process is gradual and may not be completed for months after the operation.

## Diagnosis/Preparation

A potential candidate for spinal fusion undergoes a long series of medical tests. In patients with scoliosis, x rays are taken over many months or years to track progress of the curve. Patients with disk herniation or degeneration may receive x rays, MRI studies, or other tests to determine the location and extent of injury.

Patients in good health may donate several units of their own blood in preparation for surgery. This may be done between six weeks and one week prior to the operation. The patient will probably be advised to take iron supplements to help replace lost iron in the donated blood. Sunburn or sores on the back should be avoided prior to surgery because they increase the risk of infection.

A variety of medical tests will be done shortly before surgery to ensure that the patient is in good health and prepared for the rigors of surgery. Blood and urine tests, x rays, and possibly photographs documenting the curvature will be done. An electroencephalogram (EEG) may be performed to test nerve function along the spine.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Spinal fusion is performed by an orthopedic surgeon or neurosurgeon in a hospital setting.

The patient will be admitted to the hospital the evening before surgery. No food is allowed after midnight in order to clear the gastrointestinal tract, which will be immobilized by anesthesia.

### Aftercare

The patient will stay in the hospital for four to six days after the operation.

Post-operative pain is managed by intravenous pain medication. Many centers use **patient-controlled analgesia** (PCA) pumps, which allow patients to control the timing of pain medication.

For several days after the operation, the patient is unable to eat or drink because of the lasting effects of the anesthesia on the bowels. Fluids and nutrition are delivered via the IV line.

The nurse helps the patient sit up several times per day, and assists with other needs as well. Physical therapy begins several days after the operation.

Most activities are restricted for several weeks. Strenuous activities such as bike riding or running are usually resumed after six to eight months. The surgical incision should be protected from sunburn for approximately one year to promote healing of the scar.

### Risks

Spinal fusion carries a risk of nerve damage. Rarely, delayed paralysis can occur, probably from loss of oxygen to the spine during surgery. Infection may occur. Bone from the bone bank carries a small risk of infection with transmissible diseases from the bone donor. Anesthesia also poses risks. Unsuccessful fusion (pseudoarthrosis) may occur, leaving the patient with the same problem after the operation.

### Normal results

Spinal fusion for scoliosis is usually very successful in partially or completely correcting the deformity. Spinal fusion for pain is less uniformly successful because the cause of the pain cannot always be completely identified.

## QUESTIONS TO ASK THE DOCTOR

How long will hospitalization be necessary?

Will patient-controlled analgesia (PCA) be used for pain?

How soon can the normal regime of school or work be resumed?

What outcome is expected?

Is there an alternative to surgery?

### Morbidity and mortality rates

Unsuccessful fusion may occur in 5–25% of patients. Neurologic injury occurs in less than 1–5% of patients. Infection occurs in 1–8%. **Death** occurs in less than 1% of patients.

### Alternatives

Bracing and “watchful waiting” is the alternative to scoliosis surgery. Disk surgery without fusion is possible for some patients. Strengthening exercises and physical therapy may help some back pain patients avoid back surgery.

### Resources

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#### ORGANIZATIONS

National Scoliosis Foundation. (800) NSF MYBACK (673 6922). <http://www.scoliosis.org>.

Richard Robinson

## Spinal instrumentation

### Definition

Spinal instrumentation is a method of keeping the spine rigid after **spinal fusion** surgery by surgically attaching hooks, rods, and wire to the spine in a way that redistributes the stresses on the bones and keeps them in proper alignment while the bones of the spine fuse.

## Purpose

Spinal instrumentation is used to treat instability and deformity of the spine. Instability occurs when the spine no longer maintains its normal shape during movement. Such instability results in nerve damage, spinal deformities, and disabling pain. Scoliosis is a side-to-side spinal curvature. Kyphosis is a front-to-back curvature of the upper spine, while lordosis is an excessive curve of the lower spine. More than one type of curve may be present.

## Demographics

Spinal deformities may be caused by:

- birth defects
- fractures
- Marfan syndrome
- neurofibromatosis
- neuromuscular diseases
- severe injuries
- tumors
- idiopathic scoliosis (Idiopathic scoliosis is scoliosis of unknown origin. About 85% of cases occur in girls between the ages of 12 and 15 who are experiencing adolescent growth spurt.)

## Description

Spinal instrumentation provides a stable, rigid column that encourages bones to fuse after spinal fusion surgery. Its purpose is to aid fusion. Without fusion, the metal will eventually fatigue and break, and so instrumentation is not itself a treatment for spine deformity.

Different types of spinal instrumentation are used to treat different spinal problems. Although the details of the insertion of rods, wires, screws, and hooks vary, the purpose of all spinal instrumentation is the same—to correct and stabilize the backbone while the bones of the spine fuse. The various instruments are all made of stainless steel, titanium, or titanium alloy.

The oldest form of spinal instrumentation is the Harrington rod. While it was simple in design, it required a long period of brace wearing after the operation, and did not allow segmental adjustment of correction. The Luque rod was developed to avoid the long postoperative bracing period. This system threads wires into the space within each vertebra. The risk of injury to the nerves and spinal cord is higher than with some other forms of instrumentation. Cotrel-Dubousset instrumentation uses hooks and rods in a cross-linked pattern to realign the spine and redistribute the biomechanical stress. The main advantage of

## KEY TERMS

**Lumbar vertebrae**—The vertebrae of the lower back below the level of the ribs.

**Marfan syndrome**—A rare hereditary defect that affects the connective tissue.

**Neurofibromatosis**—A rare hereditary disease that involves the growth of lesions that may affect the spinal cord.

**Osteoporosis**—A bone disorder, usually seen in the elderly, in which the bones become increasingly less dense and more brittle.

**Spinal fusion**—An operation in which the bones of the spine are permanently joined together using a bone graft obtained usually from the hip.

**Thoracic vertebrae**—The vertebrae in the chest region to which the ribs attach.

Cotrel-Dubousset instrumentation is that because of the extensive cross-linking, the patient may not have to wear a cast or brace after surgery. The disadvantage is the complexity of the operation and the number of hooks and cross-links that may fail.

Several newer systems use screws that are embedded into the portion of the vertebra called the pedicle. Pedicle screws avoid the need for threading wires, but carry the risk of migrating out of the bone and contacting the spinal cord or the aorta (the major blood vessel exiting the heart). During the late 1990s, pedicle screws were the subject of several high-profile lawsuits. The controversies have since subsided, and pedicle screws remain an indispensable part of the spinal instrumentation. Many operations today are performed with a mix of techniques, such as Luque rods in the lower back and hooks and screws up higher. A physician chooses the proper type of instrumentation based on the type of disorder, the age and health of the patient, and the physician's experience.

The surgeon strips the tissue away from the area to be fused. The surface of the bone is peeled away. A piece of bone is removed from the hip and placed along side the area to be fused. The stripping of the bone helps the bone graft to fuse.

After the fusion site is prepared, the rods, hooks, screws, and wires are inserted. There is much variation in how this is done based on the spinal instrumentation chosen. Once the rods are in place, the incision is closed.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Spinal instrumentation is performed by a neurosurgical and/or orthopedic surgical team with special experience in spinal operations. The surgery is done in a hospital under general anesthesia. It is done at the same time as spinal fusion.

## Diagnosis/Preparation

Spinal fusion with spinal instrumentation is major surgery. The patient will undergo many tests to determine the nature and exact location of the back problem. These tests are likely to include

- x rays
- magnetic resonance imaging (MRI)
- computed tomography scans (CT scans)
- myelograms

In addition, the patient will undergo a battery of blood and urine tests, and possibly an **electrocardiogram** to provide the surgeon and anesthesiologist with information that will allow the operation to be performed safely. In Harrington rod instrumentation, the patient may be placed in **traction** or an upper body cast to stretch contracted muscles before surgery.

## Aftercare

After surgery, the patient will be confined to bed. A catheter is inserted so that the patient can urinate without getting up. **Vital signs** are monitored, and the patient's position is changed frequently so that **bedsores** do not develop.

Recovery from spinal instrumentation can be a long, arduous process. Movement is severely limited for a period of time. In certain types of instrumentation, the patient is put in a cast to allow the realigned bones to stay in position until healing takes place. This can be as long as six to eight months. Many patients will need to wear a brace after the cast is removed.

During the recovery period, the patient is taught respiratory exercises to help maintain respiratory function during the time of limited mobility. Physical therapists assist the patient in learning self-care and in performing strengthening and range-of-motion exercises. **Length of hospital stay** depends on the age and health of the patient, as well as the specific problem

## QUESTIONS TO ASK THE DOCTOR

- What types of instrumentation will I be receiving?
- Why is this the best choice for my condition?
- How long will I be immobilized?
- Should I receive physical therapy to help me regain lost strength and mobility?

that was corrected. The patient can expect to remain under a physician's care for many months.

## Risks

Spinal instrumentation carries a significant risk of nerve damage and paralysis. The skill of the surgeon can affect the outcome of the operation, so patients should look for a hospital and **surgical team** that has a lot of experience doing spinal procedures.

Since the hooks and rods of spinal instrumentation are anchored in the bones of the back, spinal instrumentation should not be performed on people with serious osteoporosis. To overcome this limitation, techniques are being explored that help anchor instrumentation in fragile bones.

After surgery there is a risk of infection or an inflammatory reaction due to the presence of the foreign material in the body. Serious infection of the membranes covering the spinal cord and brain can occur. In the long term, the instrumentation may move or break, causing nerve damage and requiring a second surgery. Some bone grafts do not heal well, lengthening the time the patient must spend in a cast or brace or necessitating additional surgery. Casting and wearing a brace may take an emotional toll, especially on young people. Patients who have had spinal instrumentation must avoid contact sports, and, for the rest of their lives, eliminate situations that will abnormally put stress on their spines.

## Normal results

Many young people with scoliosis heal with significantly improved alignment of the spine. Results of spinal instrumentation done for other conditions vary widely.

## Morbidity and mortality rates

Mortality rate for spinal fusion surgery is less than 1%. Neurologic injury may occur in 1–5% of cases. Delayed paralysis is possible but rare.



## Alternatives

Not all patients require instrumentation with their spinal fusion. For some patients, a rigid external brace can provide the required rigidity to allow the bones to fuse.

## Resources

### BOOKS

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Spinal tap see **Cerebrospinal fluid (CSF) analysis**

## Spirometry tests

### Definition

Spirometry is the measurement of air flow into and out of the lungs.

### Description

Spirometry requires that the nose is pinched off as the patient breathes through a mouthpiece attached to the spirometer. The patient is instructed on how to breathe during the procedure. Three breathing maneuvers are practiced before recording the procedure, and the highest of three trials is used for evaluation of breathing. This procedure measures air flow by electronic or mechanical displacement principles, and uses a microprocessor and recorder to calculate and plot air flow.

The test produces a recording of the patient's ventilation under conditions involving both normal and maximal effort. The recording, called a spirogram, shows the volume of air moved and the rate at which it travels into and out of the lungs. Spirometry measures several lung capacities. Accurate measurement is

dependent upon the patient performing the appropriate maneuver properly. The most common measurements are:

- **Vital capacity (VC).** This is the amount of air (in liters) moved out of the lung during normal breathing. The patient is instructed to breathe in and out normally to attain full expiration. Vital capacity is usually about 80% of the total lung capacity. Because of the elastic nature of the lungs and surrounding thorax, a small volume of air will remain in the lungs after full exhalation. This volume is called the residual volume (RV).
- **Forced vital capacity (FVC).** After breathing out normally to full expiration, the patient is instructed to breathe in with a maximal effort and then exhale as forcefully and rapidly as possible. The FVC is the volume of air that is expelled into the spirometer following a maximum inhalation effort.
- **Forced expiratory volume (FEV).** At the start of the FVC maneuver, the spirometer measures the volume of air delivered through the mouthpiece at timed intervals of 0.5, 1.0, 2.0, and 3.0 seconds. The sum of these measurements normally constitutes about 97% of the FVC measurement. The most commonly used FEV measurement is FEV-1, which is the volume of air exhaled into the mouthpiece in one second. The FEV-1 should be at least 70% of the FVC.
- **Forced expiratory flow 25–75% (FEF 25–75).** This is a calculation of the average flow rate over the center portion of the forced expiratory volume recording. It is determined from the time in seconds at which 25% and 75% of the vital capacity is reached. The volume of air exhaled in liters per second between these two times is the FEF 25–75. This value reflects the status of the medium and small sized airways.
- **Maximal voluntary ventilation (MVV).** This maneuver involves the patient breathing as deeply and as rapidly as possible for 15 seconds. The average air flow (liters per second) indicates the strength and endurance of the respiratory muscles.

Normal values for FVC, FEV, FEF, and MVV are dependent on the patient's age, gender, and height.

### Purpose

Spirometry is the most commonly performed pulmonary function test (PFT). The test can be performed at the bedside, in a physician's office, or in a pulmonary laboratory. It is often the first test performed when a problem with lung function is suspected. Spirometry may also be suggested by an abnormal x ray, arterial blood gas analysis, or other diagnostic pulmonary test result. The National Lung Health Education Program

## KEY TERMS

**Bronchodilator**—A drug, usually self-administered by inhalation, that dilates the airways.

**Forced expiratory volume (FEV)**—The volume of air exhaled from the beginning of expiration to a set time (usually 0.5, 1, 2, and 3 seconds).

**Forced vital capacity (FVC)**—The volume of air that can be exhaled forcefully after a maximal inspiration.

**Hemoptysis**—Spitting up of blood derived from the lungs or bronchial tubes as a result of pulmonary or bronchial hemorrhage.

**Thrombosis**—Formation or presence of a thrombus; clotting within a blood vessel that may cause infarction of tissues supplied by the vessel.

**Thrombotic**—Relating to, caused by, or characterized by thrombosis.

**Vital capacity (VC)**—The volume of air that can be exhaled following a full inspiration.

recommends that regular spirometry tests be performed on persons over 45 years old who have a history of smoking. Spirometry tests are also recommended for persons with a family history of lung disease, chronic respiratory ailments, and advanced age.

Spirometry measures ventilation, the movement of air into and out of the lungs. The spirogram will identify two different types of abnormal ventilation patterns, obstructive and restrictive.

Common causes of an obstructive pattern are cystic fibrosis, asthma, bronchiectasis, bronchitis, and emphysema. These conditions may be collectively referred to by using the acronym CABBE. Chronic bronchitis, emphysema, and asthma result in dyspnea (difficulty breathing) and ventilation deficiency, a condition known as chronic obstructive pulmonary disease (COPD). COPD is the fourth leading cause of **death** among Americans.

Common causes of a restrictive pattern are pneumonia, heart disease, pregnancy, lung fibrosis, pneumothorax (collapsed lung), and pleural effusion (compression caused by chest fluid).

Obstructive and restrictive patterns can be identified on spirographs using both a “y” and “x” axis. Volume (liters) is plotted on the y-axis versus time (seconds) on the x-axis. A restrictive pattern is characterized by a normal shape showing reduced volumes for all parameters. The reduction in volumes indicates the severity of the disease. An obstructive pattern

produces a spirogram with an abnormal shape. Inspiration volume is reduced. The volume of air expelled is normal but the air flow rate is slower, causing an elongated tail to the FVC.

A flow-volume loop spirogram is another way of displaying spirometry measurements. This requires the FVC maneuver followed by a forced inspiratory volume (FIV). Flow rate in liters per second is plotted on the y-axis and volume (liters) is plotted on the x-axis. The expiration phase is shown on top and the inspiration phase on the bottom. The flow-volume loop spirogram is helpful in diagnosing upper airway obstruction, and can differentiate some types of restrictive patterns.

Some conditions produce specific signs on the spirogram. Irregular inspirations with rapid frequency are caused by hyperventilation associated with stress. Diffuse fibrosis of the lung causes rapid breathing of reduced volume, which produces a repetitive pattern known as the penmanship sign. Serial reduction in the FVC peaks indicates air trapped inside the lung. A notch and reduced volume in the early segments of the FVC is consistent with airway collapse. A rise at the end of expiration is associated with airway resistance.

Spirometry is used to assess lung function over time, and often to evaluate the efficacy of bronchodilator inhalers such as albuterol. It is important for the patient to refrain from using a bronchodilator prior to the evaluation. Spirometry is performed before and after inhaling the bronchodilator. In general, a 12% or greater improvement in both FVC and FEV-1, or an increase in FVC by 0.2 liters, is considered a significant improvement for an adult patient.

## Precautions

The patient should inform the physician of any medications he or she is taking, or of any medical conditions that are present; these factors may affect the validity of the test. The patient’s smoking habits and history should be thoroughly documented. The patient must be able to understand and respond to instructions for the breathing maneuvers. Therefore, the test may not be appropriate for very young, unresponsive, or physically impaired persons.

Spirometry is contraindicated in patients whose condition will be aggravated by forced breathing, including:

- hemoptysis (spitting up blood from the lungs or bronchial tubes)
- pneumothorax (free air or gas in the pleural cavity)
- recent heart attack
- unstable angina
- aneurysm (cranial, thoracic, or abdominal)

- thrombotic condition (such as clotting within a blood vessel)
- recent thoracic or abdominal surgery
- nausea or vomiting

The test should be terminated if the patient shows signs of significant head, chest, or abdominal pain while the procedure is in progress.

Spirometry is dependent upon the patient's full compliance with breathing instructions, especially his or her willingness to extend a maximal effort at forced breathing. Therefore, the patient's emotional state must be considered.

### Preparation

The patient's age, gender, and race are recorded, and height and weight are measured before the procedure begins. The patient should not have eaten heavily within three hours of the test. He or she should be instructed to wear clothing that fits loosely over the chest and abdominal area. The respiratory therapist or other testing personnel should explain and demonstrate the breathing maneuvers to the patient. The patient should practice breathing into the mouthpiece until he or she is able to duplicate the maneuvers successfully on two consecutive attempts.

### Aftercare

In most cases, special care is not required following spirometry. Occasionally, a patient may become lightheaded or dizzy. Such patients should be asked to rest or lie down, and should not be discharged until after the symptoms subside. In rare cases, the patient may experience pneumothorax, intracranial hypertension, chest pain, or uncontrolled coughing. In such cases, additional care directed by a physician may be required.

### Normal results

The results of spirometry tests are compared to predicted values based on the patient's age, gender, and height. For example, a young adult in good health is expected to have the following FEV values:

- FEV-0.5—50-60% of FVC
- FEV-1—75-85% of FVC
- FEV-2—95% of FVC
- FEV-3—97% of FVC

In general, a normal result is 80-100% of the predicted value. Abnormal values are:

- mild lung dysfunction—60-79%
- moderate lung dysfunction—40-59%
- severe lung dysfunction—below 40%

## QUESTIONS TO ASK THE DOCTOR

What preparation is needed before the test?

What results are expected?

When will the results be available?

What are the risks of the test in this particular case?

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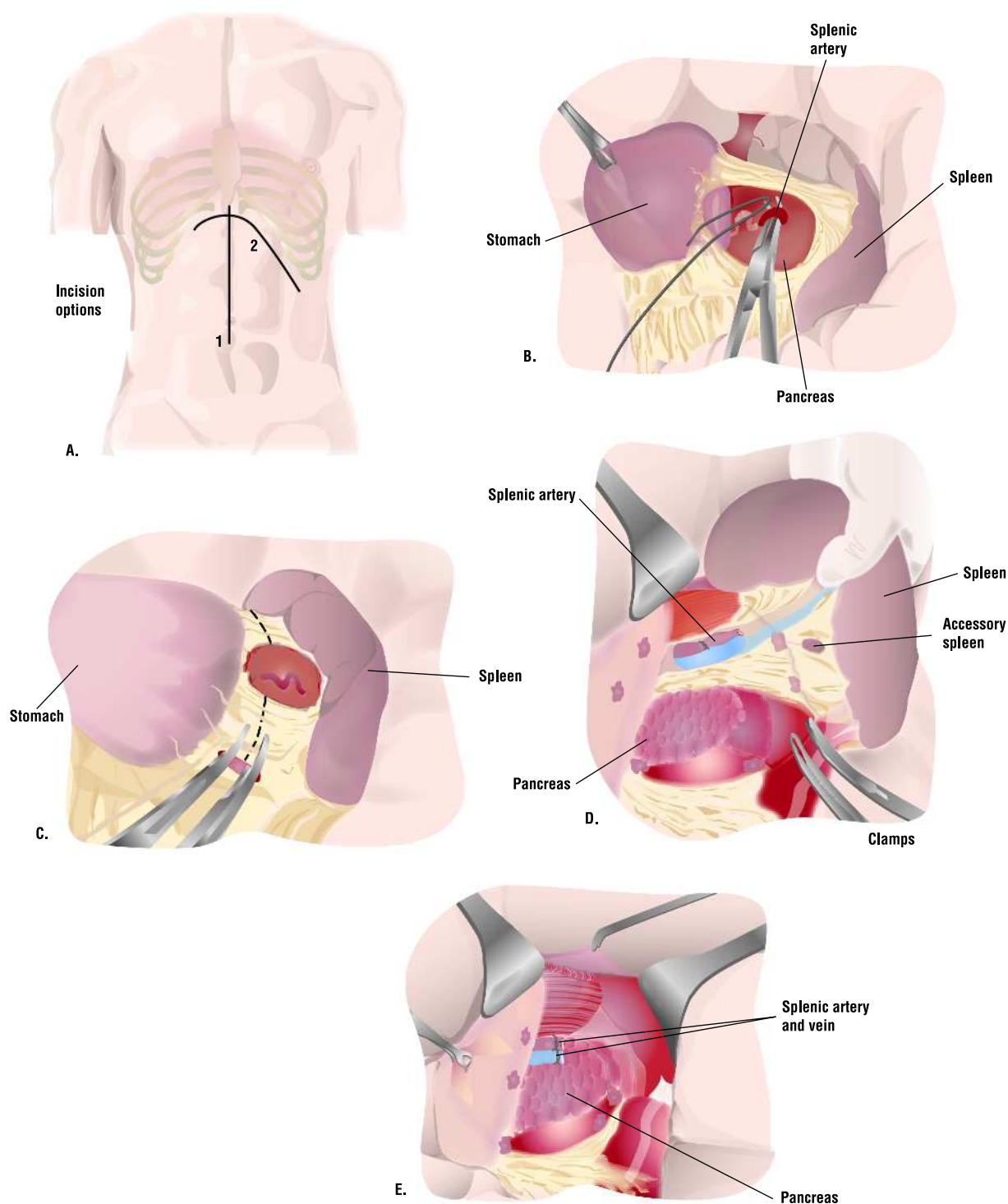
Spleen removal see **Splenectomy**

## Splenectomy

### Definition

A splenectomy is the total or partial surgical removal of the spleen, an organ that is part of the lymphatic system.

## Splenectomy



There are two options for accessing the spleen for a splenectomy (A, 1 and 2). After the abdomen is entered, the spleen is located, and the artery leading to it is tied off (B). The ligament connecting the stomach and spleen is cut (C), as is the ligament connecting the spleen and colon (D). This frees the spleen for removal (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)



## Purpose

The human spleen is a dark purple, bean-shaped organ located in the upper left side of the abdomen just behind the bottom of the rib cage. In adults, the spleen is about 4.8 X 2.8 X 1.6 in (12 X 7 X 4 cm) in size, and weighs about 4–5 oz (113–141 g). The spleen plays a role in the immune system of the body. It also filters foreign substances from the blood and removes worn-out blood cells. The spleen regulates blood flow to the liver and sometimes stores blood cells—a function known as sequestration. In healthy adults, about 30% of blood platelets are sequestered in the spleen.

Splenectomies are performed for a variety of different reasons and with different degrees of urgency. Most splenectomies are done after a patient has been diagnosed with hypersplenism. Hypersplenism is not a specific disease but a syndrome (group or cluster of symptoms) that may be associated with different disorders. Hypersplenism is characterized by enlargement of the spleen (splenomegaly), defects in the blood cells, and an abnormally high turnover of blood cells. It is almost always associated with such specific disorders as cirrhosis of the liver or certain cancers. The decision to perform a splenectomy depends on the severity and prognosis of the disease that is causing the hypersplenism.

### *Splenectomy always required*

There are two diseases for which a splenectomy is the only treatment—primary cancers of the spleen and a blood disorder called hereditary spherocytosis (HS). In HS, the absence of a specific protein in the red blood cell membrane leads to the formation of relatively fragile cells that are easily damaged when they pass through the spleen. The cell destruction does not occur elsewhere in the body and ends when the spleen is removed. HS can appear at any age, even in newborns, although doctors prefer to put off removing the spleen until the child is five to six years old.

### *Splenectomy usually required*

There are some disorders for which a splenectomy is usually recommended. They include:

- Immune (idiopathic) thrombocytopenic purpura (ITP). ITP is a disease in which platelets are destroyed by antibodies in the body's immune system. A splenectomy is the definitive treatment for this disease and is effective in about 70% of cases of chronic ITP.
- Trauma. The spleen can be ruptured by blunt as well as penetrating injuries to the chest or abdomen. Car accidents are the most common cause of blunt traumatic injury to the spleen.

- Abscesses. Abscesses of the spleen are relatively uncommon but have a high mortality rate.
- Rupture of the splenic artery. This artery sometimes ruptures as a complication of pregnancy.
- Hereditary elliptocytosis. This is a relatively rare disorder. It is similar to HS in that it is characterized by red blood cells with defective membranes that are destroyed by the spleen.

### *Splenectomy sometimes required*

Other disorders may or may not necessitate a splenectomy. These include:

- Hodgkin's disease, a serious form of cancer that causes the lymph nodes to enlarge. A splenectomy is often performed in order to find out how far the disease has progressed.
- Autoimmune hemolytic disorders. These disorders may appear in patients of any age but are most common in adults over 50. The red blood cells are destroyed by antibodies produced by the patient's own body (autoantibodies).
- Myelofibrosis. Myelofibrosis is a disorder in which bone marrow is replaced by fibrous tissue. It produces severe and painful splenomegaly. A splenectomy does not cure myelofibrosis but may be performed to relieve pain caused by the swelling of the spleen.
- Thalassemia. Thalassemia is a hereditary form of anemia that is most common in people of Mediterranean origin. A splenectomy is sometimes performed if the patient's spleen has become painfully enlarged.

## Demographics

In the United States, splenomegaly affects as many as 30% of full-term newborns and about 10% of healthy children. Approximately 3% of healthy first-year college students also have spleens that are large enough to be felt when a doctor palpates the abdomen. Some specific causes of splenomegaly are more common in certain racial or ethnic groups. For example, splenomegaly is a common complication of sickle cell disease in patients of African or Mediterranean ancestry. In other parts of the world, splenomegaly is frequently caused by malaria, schistosomiasis, and other infections in areas where these diseases are endemic.

Hereditary spherocytosis (HS) is a disorder is most common in people of northern European descent but has been found in all races. A family history of HS increases the risk of developing this disorder.

Immune thrombocytopenic purpura (ITP) is much more common in children, with male and female children being equally afflicted. Female predominance

## KEY TERMS

**Computed tomography (CT) scan**—An imaging technique that creates a series of pictures of areas inside the body, taken from different angles. The pictures are created by a computer linked to an x-ray machine.

**Embolization**—A treatment in which foam, silicone, or other substance is injected into a blood vessel in order to close it off.

**Endemic**—Present in a specific population or geographical area at all times. Some diseases that may affect the spleen are endemic to certain parts of Africa or Asia.

**Hereditary spherocytosis**—A hereditary disorder that leads to a chronic form of anemia (too few red blood cells) due to an abnormality in the red blood cell membrane.

**Idiopathic thrombocytopenia purpura (ITP)**—A rare autoimmune disorder characterised by an acute shortage of platelets with resultant bruising and spontaneous bleeding.

**Laparoscopy**—A procedure in which a laparoscope (a thin, lighted tube) is inserted through an incision in

the abdominal wall to evaluate the presence or spread of disease. Tissue samples may be removed for biopsy.

**Lymphatic system**—The tissues and organs that produce and store cells that fight infection, together with the network of vessels that carry lymph. The organs and tissues in the lymphatic system include the bone marrow, spleen, thymus gland, and lymph nodes.

**Palpate**—To examine by means of touch.

**Platelet**—A disk-shaped structure found in blood that binds to fibrinogen at the site of a wound to begin the clotting process.

**Sequestration**—A process in which the spleen withdraws blood cells from the circulation and stores them.

**Spleen**—An organ that produces lymphocytes, filters the blood, stores blood cells and destroys those that are aging. It is located on the left side of the abdomen near the stomach.

**Splenomegaly**—Enlargement of the spleen.

begins at puberty and continues in adult patients. Overall, 70% of patients with ITP are female; 72% of women diagnosed with ITP are over 40 years old.

## Description

### *Complete splenectomy*

**REMOVAL OF ENLARGED SPLEEN.** A splenectomy is performed under **general anesthesia**. The most common technique is used to remove greatly enlarged spleens. After the surgeon makes a cut (incision) in the abdomen, the artery to the spleen is tied to prevent blood loss and reduce the size of the spleen. Tying the splenic artery also keeps the spleen from further sequestration of blood cells. The surgeon detaches the ligaments holding the spleen in place and removes the organ. In many cases, tissue samples will be sent to a laboratory for analysis.

**REMOVAL OF RUPTURED SPLEEN.** When the spleen has been ruptured by trauma, the surgeon approaches the organ from its underside and ties the splenic artery before removing the ruptured organ.

### *Partial splenectomy*

In some cases, the surgeon removes only part of the spleen. This procedure is considered by some to be

a useful compromise that reduces pain caused by an enlarged spleen while leaving the patient less vulnerable to infection.

### *Laparoscopic splenectomy*

Laparoscopic splenectomy, or removal of the spleen through several small incisions, has been performed more frequently in recent years. Laparoscopic surgery, which is sometimes called keyhole surgery, is done with smaller **surgical instruments** inserted through very short incisions, with the assistance of a tiny camera and video monitor. Laparoscopic procedures reduce the **length of hospital stay**, the level of postoperative pain, and the risk of infection. They also leave smaller scars.

As of 2003, however, a laparoscopic procedure is contraindicated if the patient's spleen is greatly enlarged. Most surgeons will not remove a spleen longer than 20 cm (as measured by a CT scan) by this method.

## Diagnosis/Preparation

The most important part of a medical assessment in disorders of the spleen is the measurement of splenomegaly. The normal spleen cannot be felt when the doctor palpates the patient's abdomen. A spleen that

is large enough to be felt indicates splenomegaly. In some cases, the doctor will hear a dull sound when he or she thumps (percusses) the patient's abdomen near the ribs on the left side. Imaging studies that can be used to confirm splenomegaly include **ultrasound** tests, technetium-99m sulfur colloid imaging, and **CT scans**. The rate of platelet or red blood cell destruction by the spleen can also be measured by tagging blood cells with radioactive chromium or platelets with radioactive indium.

Preoperative preparation for a splenectomy procedure usually includes:

- Correction of abnormalities of blood clotting and the number of red blood cells.
- Treatment of any infections.
- Control of immune reactions. Patients are usually given protective vaccinations about a month before surgery. The most common vaccines used are Pneumovax or Pnu-Imune 23 (against pneumococcal infections) and Menomune-A/C/Y/W-135 (against meningococcal infections).

### Aftercare

Immediately following surgery, patients are given instructions for **incision care** and medications intended to prevent infection. Blood transfusions may be indicated for some patients to replace defective blood cells. The most important part of aftercare, however, is long-term caution regarding vulnerability to infection. Patients are asked to see their doctor at once if they have a fever or any other sign of infection, and to avoid travel to areas where exposure to malaria or similar diseases is likely. Children with splenectomies may be kept on antibiotic therapy until they are 16 years old. All patients can be given a booster dose of pneumococcal vaccine five to 10 years after undergoing a splenectomy.

### Risks

The main risk of a splenectomy procedure is overwhelming bacterial infection, or postsplenectomy sepsis. This condition results from the body's decreased ability to clear bacteria from the blood, and lowered levels of a protein in blood plasma that helps to fight viruses (immunoglobulin M). The risk of **dying** from infection after undergoing a splenectomy is highest in children, especially in the first two years after surgery. The risk of postsplenectomy sepsis can be reduced by vaccinations before the operation. Some doctors also recommend a two-year course of penicillin following splenectomy, or long-term treatment with ampicillin.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A splenectomy is performed by a surgeon trained in gastroenterology, the branch of medicine that deals with the diseases of the digestive tract. An anesthesiologist is responsible for administering anesthesia and the operation is performed in a hospital setting.

Other risks associated with the procedure include inflammation of the pancreas and collapse of the lungs. In some cases, a splenectomy does not address the underlying causes of splenomegaly or other conditions. Excessive bleeding after the operation is an additional possible complication, particularly for patients with ITP. Infection of the incision immediately following surgery may also occur.

### Normal results

Results depend on the reason for the operation. In blood disorders, the splenectomy will remove the cause of the blood cell destruction. Normal results for patients with an enlarged spleen are relief of pain and the complications of splenomegaly. It is not always possible, however, to predict which patients will respond well or to what degree.

Recovery from the operation itself is fairly rapid. Hospitalization is usually less than a week (one to two days for laparoscopic splenectomy), and complete healing usually occurs within four to six weeks. Patients are encouraged to return to such normal activities as showering, driving, climbing stairs, light lifting and work as soon as they feel comfortable. Some patients may return to work in a few days while others prefer to rest at home a little longer.

### Morbidity and mortality rates

The outcome of the procedure varies with the underlying disease or the extent of other injuries. Rates of complete recovery from the surgery itself are excellent, in the absence of other severe injuries or medical problems.

Splenectomy for HS patients is usually delayed in children until the age of five to prevent unnecessary infections; reported outcomes are very good.

Studies of patients with ITP show that 80%–90% of children achieve spontaneous and complete remission

## QUESTIONS TO ASK THE DOCTOR

- What happens on the day of surgery?
- What type of anesthesia will be used?
- How long will it take to recover from the surgery?
- When can I expect to return to work and resume normal activities?
- What are the risks associated with a splenectomy?
- How many splenectomies do you perform in a year?
- Will I have a large scar?

in two to eight weeks. A small percentage develop chronic or persistent ITP, but 61% show complete remission by 15 years. No deaths in patients older than 15 have been attributed to ITP.

### Alternatives

As of 2003 there are no medical alternatives to removing the spleen.

Splenic embolization is a surgical alternative to splenectomy that is used in some patients who are poor candidates for surgery. Embolization involves plugging or blocking the splenic artery with synthetic substances to shrink the size of the spleen. The substances that are injected during this procedure include polyvinyl alcohol foam, polystyrene, and silicone.

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- American College of Gastroenterology. 4900 B South 31st St., Arlington, VA 22206. (703) 820-7400.  
www.acg.gi.org
- American Gastroenterological Association (AGA). 4930 Del Ray Avenue, Bethesda, MD 20814. (301) 654-2055.  
www.gastro.org
- National Cancer Institute (NCI). NCI Public Inquiries Office, Suite 3036A, 6116 Executive Boulevard, MSC8322 Bethesda, MD 20892-8322. (800) 422-6237.  
www.cancer.gov

### OTHER

- The Body Homepage. *Spleen Cancer*. www.thebody.com/Forums/AIDS/Cancer/Archive/othertypes/Q141422.html.
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## Stapedectomy

### Definition

Stapedectomy is a surgical procedure in which the innermost bone (stapes) of the three bones (the stapes, the incus, and the malleus) of the middle ear is removed, and replaced with a small plastic tube surrounding a short length of stainless-steel wire (a prosthesis). The operation was first performed in the United States in 1956.

### Purpose

A stapedectomy is performed to improve the movement of sound to the inner ear. It is done to treat progressive hearing loss caused by otosclerosis, a condition in which spongy bone hardens around the base of the stapes. This condition fixes the stapes to the opening of the inner ear, so that the stapes no longer vibrates properly. Otosclerosis can also affect the malleus, the incus, and the bone that surrounds the inner ear. As a result, the transmission of sound to the inner ear is disrupted. Untreated otosclerosis eventually results in total deafness, usually in both ears.

### Demographics

Otosclerosis affects about 10% of the United States population. It is an autosomal dominant disorder with variable penetrance. These terms mean that a child having one parent with otosclerosis has



a 50% chance of inheriting the gene for the disorder, but that not everyone who has the gene will develop otosclerosis. In addition, some researchers think that the onset of the disorder is triggered when a person who has the gene for otosclerosis is infected with the measles virus. This hypothesis is supported by the finding that the incidence of otosclerosis has been steadily declining in countries with widespread measles vaccination.

Otosclerosis develops most frequently in people between the ages of 10 and 30. In most cases, both ears are affected; however, about 10–15% of patients diagnosed with otosclerosis have loss of hearing in only one ear. The disorder affects women more frequently than men by a ratio of two to one. Pregnancy is a risk factor for onset or worsening of otosclerosis.

With regard to race, Caucasian and Asian Americans are more likely to develop otosclerosis than African Americans.

### Description

A stapedectomy does not require any incisions on the outside of the body, as the entire procedure is performed through the ear canal. With the patient under local or **general anesthesia**, the surgeon opens the ear canal and folds the eardrum forward. Using an operating microscope, the surgeon is able to see the structures in detail, and evaluates the bones of hearing (ossicles) to confirm the diagnosis of otosclerosis.

Next, the surgeon separates the stapes from the incus; freed from the stapes, the incus and malleus bones can now move when pressed. A laser or small drill may be used to cut through the tendon and arch of the stapes bone, which is then removed from the middle ear.

The surgeon then opens the window that joins the middle ear to the inner ear and acts as the platform for the stapes bone. The surgeon directs the laser's beam at the window to make a tiny opening, and gently clips the prosthesis to the incus bone. A piece of tissue is taken from a small incision behind the ear lobe and used to help seal the hole in the window and around the prosthesis. The eardrum is then gently replaced and repaired, and held there by absorbable packing ointment or a gelatin sponge. The procedure usually takes about an hour and a half.

Good candidates for the surgery are those who have a fixed stapes from otosclerosis and a conductive hearing loss of at least 20 dB. Patients with a severe hearing loss might still benefit from a stapedectomy, if only to improve their hearing to the point where a

## KEY TERMS

**Audiologist**—A health care professional who performs diagnostic testing of impaired hearing.

**Cochlea**—The hearing part of the inner ear. This snail-shaped structure contains fluid and thousands of microscopic hair cells tuned to various frequencies, in addition to the organ of Corti (the receptor for hearing).

**Conductive hearing loss**—A type of medically treatable hearing loss in which the inner ear is usually normal, but there are specific problems in the middle or outer ears that prevent sound from getting to the inner ear in a normal way.

**Footplate**—A flat oval plate of bone that fits into the oval window on the wall of the inner ear; the base of the stapes.

**Incus**—The middle of the three bones of the middle ear. It is also known as the “anvil.”

**Malleus**—One of the three bones of the middle ear. It is also known as the “hammer.”

**Ossicles**—The three small bones of the middle ear: the malleus (hammer), the incus (anvil) and the stapes (stirrup). These bones help carry sound from the eardrum to the inner ear.

**Otology**—The branch of medicine that deals with the diagnosis and treatment of ear disorders.

**Otosclerosis**—Formation of spongy bone around the footplate of the stapes, resulting in conductive hearing loss.

**Stapedotomy**—A procedure in which a small hole is cut in the footplate of the stapes.

**Tinnitus**—A sensation of noise in the ears, usually a buzzing, ringing, clicking, or roaring sound.

**Vertigo**—A feeling of dizziness together with a sensation of movement and a feeling of rotating in space.

hearing aid can be of help. The procedure can improve hearing in more than 90% of cases.

### Diagnosis/Preparation

#### Diagnosis

Diagnosis of otosclerosis is based on a combination of the patient's family history, the patient's symptoms, and the results of hearing tests. Some patients notice only a gradual loss of hearing, but others experience dizziness, tinnitus (a sensation of buzzing,

ringing, or hissing in the ears), or balance problems. The hearing tests should be administered by an ear specialist (audiologist or otologist) rather than the patient's family doctor. The examiner will need to determine whether the patient's hearing loss is conductive (caused by a lesion or disorder in the ear canal or middle ear) or sensorineural (caused by a disorder of the inner ear or the eighth cranial nerve).

Two tests that are commonly used to distinguish conductive hearing loss from sensorineural are Rinne's test and Weber's test. In Rinne's test, the examiner holds the stem of a vibrating tuning fork first against the mastoid bone and then outside the ear canal. A person with normal hearing will hear the sound as louder when it is held near the outer ear; a person with conductive hearing loss will hear the tone as louder when the fork is touching the bone.

In Weber's test, the vibrating tuning fork is held on the midline of the forehead and the patient is asked to indicate the ear in which the sound seems louder. A person with conductive hearing loss on one side will hear the sound louder in the affected ear.

A computed tomography (CT) scan or x-ray study of the head may also be done to determine whether the patient's hearing loss is conductive or sensorineural.

### *Preparation*

Patients are asked to notify the surgeon if they develop a cold or sore throat within a week of the scheduled surgery. The procedure should be postponed in order to minimize the risk of infection being carried from the upper respiratory tract to the ear.

Some surgeons prefer to use general anesthesia when performing a stapedectomy, although an increasing number are using **local anesthesia**. A sedative injection is given to the patient before surgery.

### *Aftercare*

The patient is asked to have a friend or relative drive them home after the procedure. **Antibiotics** are given up to five days after surgery to prevent infection; packing and sutures are removed about a week after surgery.

It is important that the patient not put pressure on the ear for a few days after surgery. Blowing one's nose, lifting heavy objects, swimming underwater, descending rapidly in high-rise elevators, or taking an airplane flight should be avoided.

Right after surgery, the ear is usually quite sensitive, so the patient should avoid loud noises until the ear retrains itself to hear sounds properly.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Stapedectomies are usually done by otologists or otolaryngologists, who are surgeons with advanced training in treating ear disorders. A stapedectomy is usually performed as an outpatient procedure in an ambulatory surgery facility or same-day surgery clinic.

It is extremely important that the patient avoid getting the ear wet until it has completely healed. Water in the ear could cause an infection; most seriously, water could enter the middle ear and cause an infection within the inner ear, which could then lead to a complete hearing loss. When taking a shower, and washing the hair, the patient should plug the ear with a cotton ball or lamb's wool ball, soaked in Vaseline. The surgeon should give specific instructions about when and how this can be done.

Usually, the patient may return to work and normal activities about a week after leaving the hospital, although if the patient's job involves heavy lifting, three weeks of home rest is recommended. Three days after surgery, the patient may fly in pressurized aircraft.

### *Risks*

The most serious risk is an increased hearing loss, which occurs in about 1% of patients. Because of this risk, a stapedectomy is usually performed on only one ear at a time.

Less common complications include:

- temporary change in taste (due to nerve damage) or lack of taste
- perforated eardrum
- vertigo that may persist and require surgery
- damage to the chain of three small bones attached to the eardrum
- partial facial nerve paralysis
- ringing in the ears

Severe dizziness or vertigo may be a signal that there has been an incomplete seal between the fluids of the middle and inner ear. If this is the case, the patient needs immediate bed rest, an examination by the ear surgeon, and (rarely) an operation to reopen the eardrum to check the prosthesis.

## QUESTIONS TO ASK THE DOCTOR

- What is your opinion of medication treatments for otosclerosis?
- Am I a candidate for a stapedotomy without prosthesis?
- What are the chances of my hearing getting worse if I postpone surgery?
- How many stapedectomies have you performed?
- What are the possible complications I could expect following a stapedectomy?

### Normal results

Most patients are slightly dizzy for the first day or two after surgery, and may have a slight headache. Hearing improves once the swelling subsides, the slight bleeding behind the ear drum dries up, and the packing is absorbed or removed, usually within two weeks. Hearing continues to get better over the next three months.

About 90% of patients will have markedly improved hearing following the procedure, while 8% experience only minor improvement. About half the patients who had tinnitus before surgery will experience significant relief within six weeks after the procedure.

### Morbidity and mortality rates

Stapedectomy is a very safe procedure with a relatively low rate of complications. With regard to hearing, about 2% of patients may have additional hearing loss in the operated ear following a stapedectomy; fewer than 1% lose hearing completely in the operated ear. About 9% of patients experience disturbances in their sense of taste. Infection, damage to the eardrum, and facial nerve palsy are rare complications that occur in fewer than 0.1% of patients.

### Alternatives

Alternatives to a stapedectomy include:

- Watchful waiting. Some patients with only a mild degree of hearing loss may prefer to postpone surgery.
- Medications. Although there is no drug that can cure otosclerosis, some compounds containing fluoride or calcium are reported to be effective in preventing further hearing loss by slowing down abnormal bone growth. The medication most commonly recommended for the purpose is a combination of sodium fluoride and

calcium carbonate sold under the trade name Florical. The medication is taken twice a day over a two-year period, after which the patient's hearing is reevaluated. Florical should not be used during pregnancy, however.

- Hearing aids.
- Stapedotomy. A stapedotomy is a surgical procedure similar to a stapedectomy except that the surgeon uses the laser to cut a hole in the stapes in order to insert the prosthesis rather than removing the stapes. In addition, some ear surgeons use the laser to free the stapes bone without inserting a prosthesis. This variation, however, works best in patients with only mild otosclerosis.

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- American Academy of Audiology. 11730 Plaza America Drive, Suite 300, Reston, VA 20190. (703) 790-8466. <http://www.audiology.org>.

American Academy of Otolaryngology Head and Neck Surgery, Inc. One Prince St., Alexandria VA 22314 3357. (703) 836 4444. <http://www.entnet.org>

Better Hearing Institute. 515 King Street, Suite 420, Alexandria, VA 22314. (703) 684 3391.

National Institute on Deafness and Other Communication Disorders (NIDCD), National Institutes of Health. 31 Center Drive, MSC 2320. Bethesda, MD 20892 2320. <http://www.nidcd.nih.gov>.

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Carol A. Turkington  
Rebecca J. Frey, Ph.D.

Staples see **Stitches and staples**

Stem cell transplant see **Bone marrow transplantation**

Stents, biliary see **Biliary stenting**

Stents, coronary see **Coronary stenting**

Stents, ureteral see **Ureteral stenting**

## Stereotactic radiosurgery

### Definition

Stereotactic radiosurgery is the use of a precise beam of radiation to destroy tissue in the brain.

### Purpose

This procedure is used to treat brain tumors, arteriovenous malformations in the brain, and in some cases, benign eye tumors or other disorders within the brain.

### Demographics

Stereotactic radiosurgery is used to treat a variety of disorders with widely differing demographic profiles.

### Description

“Radiosurgery” refers to the use of a high-energy beam of radiation. “Stereotactic” refers to the three-dimensional targeting system used to deliver the beam to the precise location desired. Stereotactic radiosurgery

## KEY TERMS

**Angiography**—A technique for the diagnostic imaging of blood vessels that involves the injection of contrast material.

**Fractionated radiosurgery**—Radiosurgery in which the radiation is delivered in several smaller doses over a period of time rather than the full amount in a single treatment.

**Metastatic**—Referring to the spread of cancer from one organ in the body to another not directly connected to it.

**Radiosurgery**—Surgery that uses ionizing radiation to destroy tissue rather than a surgical incision.

**Simulation scan**—The process of making a mask for the patient and other images in order to plan the radiation treatment.

**Stereotactic**—Characterized by precise positioning in space. When applied to radiosurgery, stereotactic refers to a system of three-dimensional coordinates for locating the target site.

is primarily confined to the head and neck, because the patient must be kept completely still during the delivery of the radiation in order to prevent damage to surrounding tissue. The motion of the patient’s head and neck are restricted by a stereotactic frame that holds them in place. It is difficult to immobilize other body regions in this way.

The high energy of the radiation beam disrupts the DNA of the targeted cells, killing them. Multiple weak beams are focused on the target area, delivering maximum energy to it while keeping surrounding tissue safe. Since the radiation passes through the skull to its target, there is no need to cut open the skull to perform the surgery. The beam can be focused on any structure in the brain, allowing access to tumors or malformed blood vessels that cannot be reached by open-skull surgery.

Two major forms of stereotactic radiosurgery are in use as of 2003. The Gamma Knife® is a stationary machine that is most useful for small tumors, blood vessels, or similar targets. Because it does not move, it can deliver a small, highly localized and precise beam of radiation. Gamma knife treatment is done all at once in a single hospital stay. The second type of radiosurgery uses a movable linear accelerator-based machine that is preferred for larger tumors. This treatment is delivered in several small doses given over



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Stereotactic radiosurgery is performed by a radiosurgeon, who is a neurosurgeon with advanced training in the use of a gamma knife or linear accelerator-based machine. The radiosurgeon's dose plan is checked by a physicist before the treatment is administered to the patient. Stereotactic radiosurgery is done in a hospital that has the necessary specialized equipment.

several weeks. Radiosurgery that is performed with divided doses is known as fractionated radiosurgery. The total dose of radiation is higher with a linear accelerator-based machine than with gamma knife treatment.

Disorders treated by stereotactic radiosurgery include:

- benign brain tumors, including acoustic neuromas and meningiomas
- malignant brain tumors, including gliomas and astrocytomas
- metastatic brain tumors
- trigeminal neuralgia
- Parkinson's disease
- essential tremor
- arteriovenous malformations
- pituitary tumors

### Diagnosis/Preparation

A patient requiring radiosurgery has already been diagnosed with a specific disorder that affects the brain. As preparation for radiosurgery, he or she will undergo neuroimaging studies to determine the precise location of the target area in the brain. These studies may include **CT scans**, **MRI scans**, and others. Imaging of the blood vessels (**angiography**) or the brain's ventricles (ventriculography) may be done as well. These require the injection of either a harmless radioactive substance or a contrast dye.

Prior to the procedure, the patient will be fitted with a stereotactic frame or rigid mask to immobilize the head. This part of the treatment may be uncomfortable. The patient may receive a simulation scan to establish the precise relationship of the mask or frame to the head to help plan the treatment.

## QUESTIONS TO ASK THE DOCTOR

- What are the alternatives, if any, to radiosurgery for my specific condition?
- How many radiosurgical procedures have you performed?
- What is your success rate?
- What side effects have your patients reported?

The patient may be given a sedative and an anti-nausea agent prior to the simulation scan or treatment.

### Aftercare

Stereotactic radiosurgery does not produce some of the side effects commonly associated with radiation treatment, such as reddening of the skin or hair loss. Most patients can return to their usual daily activities following treatment without any special precautions.

### Risks

The risks of stereotactic radiosurgery include mild headache, tiredness, nausea and vomiting, and recurrence of the tumor. Questions have been raised as to whether radiosurgery can cause secondary tumors, but as of 2003, there is little detailed information about this potential risk.

### Normal results

Stereotactic radiosurgery does not cause pain; and because the skull is not opened, there is no long hospital stay or risk of infection. Recovery is very rapid; most patients go home the same day they are treated, although follow-up imaging and retreatment may be necessary in some cases. This form of surgery appears to be quite successful in extending the length of survival in cancer patients; one study found that gamma knife radiosurgery controlled tumor growth in 96% of patients with kidney cancer that had spread to the brain, and added an average of 15 months to the patients' survival.

### Morbidity and mortality rates

Stereotactic radiosurgery has a low reported rate of serious complications with minimal mortality. One German study reported a 4.8% rate of temporary morbidity in patients under treatment for brain tumors, with no permanent morbidity and no mortality. An American group of researchers found that less than

2% of patients who had eye tumors treated with radiosurgery suffered damage to the optic nerve from the dose of radiation.

Mild side effects following gamma knife radiosurgery are not uncommon, however. One group of British researchers found that 47 out of a group of 65 patients treated with gamma knife surgery had mild or moderate side effects within two weeks of treatment. Of these patients, more than half suffered headaches and a fifth reported unusual tiredness or nausea and vomiting.

## Alternatives

With certain types of brain tumors, whole-brain radiation treatment (WBRT) is an option; however, it has a number of severe side effects. Surgical removal of the tumor is another option, but it carries a higher risk of tumor recurrence. For other tumors, gamma knife radiosurgery is the only treatment available as of 2003.

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International Radiosurgery Support Association (IRSA). 3005 Hoffman Street, Harrisburg, PA 17110. (717) 260 9808. [www.irsas.org](http://www.irsas.org).

Johns Hopkins Radiosurgery. Weinberg 1469, 600 North Wolfe Street, Baltimore, MD 21287. (410) 614 2886. [www.hopkinsmedicine.org/radiosurgery/treatmentoptions/stereotacticradiosurgery.cfm](http://www.hopkinsmedicine.org/radiosurgery/treatmentoptions/stereotacticradiosurgery.cfm).

Richard Robinson

Sterilization, female see **Tubal ligation**

Sterilization, male see **Vasectomy**

# Stethoscope

## Definition

The stethoscope is an instrument used for auscultation, or listening to sounds produced by the body. It is used primarily to listen to the lungs, heart, and intestinal tract. It is also used to listen to blood flow in peripheral vessels and the heart sounds of developing fetuses in pregnant women.

## Purpose

A stethoscope is used to detect and study heart, lung, stomach, and other sounds in adult humans, human fetuses, and animals. Using a stethoscope, the listener can hear normal and abnormal respiratory, cardiac, pleural, arterial, venous, uterine, fetal and intestinal sounds.

## Demographics

All health care providers and students learn to use a stethoscope.

## Description

Stethoscopes vary in their design and material. Most are made of Y-shaped rubber tubing. This shape allows sounds to enter the device at one end, travel up

the tubes and through to the ear pieces. Many stethoscopes have a two-sided sound-detecting device or head that listeners can reverse, depending on whether they need to hear high or low frequencies. Some newer models have only one pressure-sensitive head. The various types of instruments include: binaural stethoscopes, designed for use with both ears; single stethoscopes, designed for use with one ear; differential stethoscopes, which allow listeners to compare sounds at two different body sites; and electronic stethoscopes, which electronically amplify tones. Some stethoscopes are designed specifically for hearing sounds in the esophagus or fetal heartbeats.

## Diagnosis/Preparation

### Training

Stethoscope users must learn to assess what they hear. When listening to the heart, one must listen to the left side of the chest, where the heart is located. Specifically, the heart lies between the fourth and sixth ribs, almost directly below the breast. The stethoscope must be moved around. A health care provider should listen for different sounds coming from different locations. The bell (one side of the head) of the instrument is generally used for listening to low-pitched sounds. The diaphragm (the other side of the head) of the instrument is used to listen to different areas of the heart. The sounds from each area will be different. “Lub-dub” is the sound produced by the normal heart as it beats. Every time this sound is detected, it means that the heart is contracting once. The noises are created when the heart valves click to close. When one hears “lub,” the atrioventricular valves are closing. The “dub” sound is produced by the pulmonic and aortic valves. Other heart sounds, such as a quiet “whoosh,” are produced by “murmurs.” These sounds are produced when there are irregularities in the path of blood flow through the heart. The sounds reflect turbulence in normal blood flow. If a valve remains closed rather than opening completely, turbulence is created and a murmur is produced. Murmurs are not uncommon; many people have them and are unaffected. They are frequently too faint to be heard and remain undetected.

The lungs and airways require different listening skills from those used to detect heart sounds. The stethoscope must be placed over the chest, and the person being examined must breathe in and out deeply and slowly. Using the bell, the listener should note different sounds in various areas of the chest. Then, the diaphragm should be used in the same way. There will be no wheezes or crackles in normal lung sounds.

## KEY TERMS

**Atrioventricular**—Referring to the valves regulating blood flow from the upper chambers of the heart (atria) to the lower chambers (ventricles). There are two such valves, one connecting the right atrium and ventricle and one connecting the left atrium and ventricle.

**Auscultation**—The act of listening to sounds produced by the body.

**Bell**—The cup-shaped portion of the head of a stethoscope, useful for detecting low-pitched sounds.

**Borborygmi**—Sounds created by the passage of food, gas or fecal material in the stomach or intestines.

**Diaphragm**—The flat-shaped portion of the head of a stethoscope, useful for detecting high-pitched sounds.

**Murmur**—The sound made as blood moves through the heart when there is turbulence in the flow of blood through a blood vessel, or if a valve does not completely close.

Crackles or wheezes are abnormal lung sounds. When the lung rubs against the chest wall, it creates friction and a rubbing sound. When there is fluid in the lungs, crackles are heard. A high-pitched whistling sound called a wheeze is often heard when the airways are constricted.

When the stethoscope is placed over the upper left portion of the abdomen, gurgling sounds produced by the stomach and small intestines can usually be heard just below the ribs. The large intestines, in the lower part of the abdomen, can also be heard. The noises they make are called borborygmi and are entirely normal. Borborygmi are produced by the movement of food, gas or fecal material.

### Operation

Some stethoscopes must be placed directly on the skin, while others can work effectively through clothing. For the stethoscopes with a two-part sound detecting device in the bell, listeners press the rim against the skin, using the bowl-shaped side, to hear low-pitched sounds. The other flat side, called the diaphragm, detects high-pitched sounds.

A stethoscope is used in conjunction with a device to measure blood pressure (**sphygmomanometer**). The stethoscope detects sounds of blood passing through an artery.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Any member of a health care team participating in a physical examination uses a stethoscope. It is used to detect and transmit sounds created within the body.

Examination with a stethoscope is noninvasive but very useful. It can assist members of the health care team in localizing problems related to the patient's complaints.

### Maintenance

Stethoscopes should be cleaned after each use in order to avoid the spread of infection. This precaution is especially important when they are placed directly onto bare skin.

### Aftercare

A stethoscope is a sensitive instrument. It should be handled with some care to avoid damage. It requires periodic cleaning.

### Risks

There are no risks to persons being examined with a stethoscope. Users of a stethoscope may be exposed to loud noise if the bell is accidentally dropped or struck against a hard surface while the earpieces are in the user's ears.

### Normal results

Stethoscopes produce important diagnostic information when used by a person with training and experience.

### Morbidity and mortality rates

Normal use of a stethoscope is not associated with injury to either an examiner or a person being examined.

### Alternatives

A tube formed by a roll of paper will function in the same manner as a stethoscope. This improvised instrument was the first form of the modern stethoscope invented by René Laënnec (1781-1826), a French physician. An inverted glass will also function as a stethoscope by placing the open portion on the

## QUESTIONS TO ASK THE DOCTOR

Are the sounds being heard normal or abnormal?

Have the sounds changed since the last examination?

Has a murmur, if present, changed in pitch or loudness?

surface to be listened to and the ear of the examiner on the bottom of the glass. Due to their shape, wine glasses with stems are more effective than flat-bottomed tumblers.

### Resources

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American Academy of Family Physicians. 11400 Tomahawk Creek Parkway, Leawood, KS 66211-2672. (913) 906-6000. E mail: fp@aafp.org. www.aafp.org.

American Academy of Pediatrics. 141 Northwest Point Boulevard, Elk Grove Village, IL 60007-1098. (847) 434-4000. Fax: (847) 434-8000. E mail: kidsdoc@aap.org. www.aap.org.

American College of Physicians. 190 N. Independence Mall West, Philadelphia, PA 19106-1572. (800) 523-1546, x2600 or (215) 351-2600. www.acponline.org.



American College of Surgeons. 633 North St. Clair Street, Chicago, IL 60611 3231. (312) 202 5000. Fax: (312) 202 5001. E mail: postmaster@facs.org. www.facs.org.

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L. Fleming Fallon, Jr., MD, DrPH

Stomach resection see **Gastrectomy**

Stomach stapling see **Vertical banded gastroplasty**

Stomach tube insertion see **Gastrostomy**

Strabismus repair see **Eye muscle surgery**

## Stress test

### Definition

A stress test is primarily used to identify coronary artery disease. It requires patients to **exercise** on a treadmill or exercise bicycle while their heart rate, blood pressure, **electrocardiogram** (ECG), and symptoms are monitored.

### Purpose

The body requires more oxygen during exercise than when it is at rest. To deliver more oxygen during exercise, the heart has to pump more oxygen-rich blood. Because of the increased stress on the heart, exercise can reveal coronary problems that are not apparent when the body is at rest. This is why the stress test, though not perfect, remains the best initial, noninvasive, practical coronary test.

The stress test is particularly useful for detecting ischemia (inadequate supply of blood to the heart muscle) caused by blocked coronary arteries. Less commonly, it is used to determine safe levels of exercise in people with existing coronary artery disease.

### Description

A technician affixes electrodes to the patient's chest, using adhesive patches with a special gel that

## KEY TERMS

**Angina**—Chest pain from a poor blood supply to the heart muscle due to stenosis (narrowing) of the coronary arteries.

**Cardiac arrhythmia**—An irregular heart rate (frequency of heartbeats) or rhythm (the pattern of heartbeats).

**Defibrillator**—A device that delivers an electric shock to the heart muscle through the chest wall in order to restore a normal heart rate.

**False negative**—Test results showing no problem when one exists.

**False positive**—Test results showing a problem when one does not exist.

**Hypertrophy**—The overgrowth of muscle.

**Ischemia**—Diminished supply of oxygen-rich blood to an organ or area of the body.

conducts electrical impulses. Typically, electrodes are placed under each collarbone and each bottom rib, and six electrodes are placed across the chest in a rough outline of the heart. Wires from the electrodes are connected to an ECG, which records the electrical activity picked up by the electrodes.

The technician runs resting ECG tests while the patient is lying down, then standing up, and then breathing heavily for half a minute. These baseline tests can later be compared with the ECG tests performed while the patient is exercising. The patient's blood pressure is taken and the blood pressure cuff is left in place so that blood pressure can be measured periodically throughout the test.

The patient begins riding a stationary bicycle or walking on a treadmill. Gradually the intensity of the exercise is increased. For example, if the patient is walking on a treadmill, then the speed of the treadmill increases and the treadmill is tilted upward to simulate an incline. If the patient is on an exercise bicycle, then the resistance or "drag" is gradually increased. The patient continues exercising at increasing intensity until reaching the target heart rate (generally set at a minimum of 85% of the maximal predicted heart rate based on the patient's age) or experiences severe fatigue, dizziness, or chest pain. During the test, the patient's heart rate, ECG, and blood pressure are monitored.

Sometimes other tests, such as **echocardiography** or thallium scanning, are used in conjunction with the exercise stress test. For instance, studies suggest that

women have a high rate of false negatives (results showing no problem when one exists) and false positives (results showing a problem when one does not exist) with the stress test. They may benefit from another test, such as exercise echocardiography. People who are unable to exercise may be injected with drugs, such as adenosine, which mimic the effects of exercise on the heart, and then given a thallium scan. The thallium scan or echocardiogram are particularly useful when the patient's resting ECG is abnormal. In such cases, interpretation of exercise-induced ECG abnormalities is difficult.

### Preparation

Patients are usually instructed not to eat or smoke for several hours before the test. They should be advised to inform the physician about any medications they are taking, and to wear comfortable sneakers and exercise clothing.

### Aftercare

After the test, the patient should rest until blood pressure and heart rate return to normal. If all goes well, and there are no signs of distress, the patient may return to his or her normal daily activities.

### Risks

There is a very slight risk of myocardial infarction (a heart attack) from the exercise, as well as cardiac arrhythmia (irregular heart beats), angina, or cardiac arrest (about one in 100,000). The exercise stress test carries a very slight risk (one in 100,000) of causing a heart attack. For this reason, exercise stress tests should be attended by health care professionals with immediate access to defibrillators and other emergency equipment.

Patients are cautioned to stop the test should they develop any of the following symptoms:

- unsteady gait;
- confusion;
- skin that is grayish or cold and clammy;
- dizziness or fainting;
- a drop in blood pressure;
- angina (chest pain); and
- cardiac arrhythmias (irregular heartbeat).

### Normal results

A normal result of an exercise stress test shows normal electrocardiogram tracings and heart rate,

blood pressure within the normal range, and no angina, unusual dizziness, or shortness of breath.

A number of abnormalities may appear on an exercise stress test. Examples of exercise-induced ECG abnormalities are ST segment depression or heart rhythm disturbances. These ECG abnormalities may indicate deprivation of blood to the heart muscle (ischemia) caused by narrowed or blocked coronary arteries. Stress test abnormalities generally require further diagnostic evaluation and therapy.

### Patient education

Patients must be well prepared for a stress test. They should not only know the purpose of the test, but also signs and symptoms that indicate the test should be stopped. Physicians, nurses, and ECG technicians can ensure patient safety by encouraging them to immediately communicate discomfort at any time during the stress test.

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American Heart Association, National Center 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242 8721, <http://www.americanheart.org>.

National Heart, Lung, and Blood Institute, Information Center P.O. Box 30105, Bethesda, MD, 20824 0105, (301) 592 8573, <http://www.nhlbi.nih.gov>.

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## Sulfonamides

### Definition

Sulfonamides are a group of anti-infective drugs that prevent the growth of bacteria in the body by interfering with their metabolism. Bacteria are one-celled disease-causing microorganisms that commonly multiply by cell division.

## Purpose

Sulfonamides are used to treat many kinds of infections caused by bacteria and certain other microorganisms. Physicians may prescribe these drugs to treat urinary tract infections, ear infections, frequent or long-lasting bronchitis, bacterial meningitis, certain eye infections, *Pneumocystis carinii* pneumonia (PCP), traveler's diarrhea, and a number of other infections. These drugs will, however, *not* work for colds, flu, and other infections caused by viruses.

## Description

Sulfonamides, which are also called sulfa medicines, are available only with a physician's prescription. They are sold in tablet and liquid forms. Some commonly used sulfonamides are sulfisoxazole (Gantrisin) and the combination drug sulfamethoxazole and trimethoprim (Bactrim, Cotrim, Septra).

Although the sulfonamides have been largely replaced by **antibiotics** for treatment of infections, some bacteria have developed resistance to antibiotics but can still be treated with sulfonamides because the bacteria have not been exposed to these drugs in the past.

Silver sulfadiazine, an ointment containing a sulfonamide, is valuable for the treatment of infections associated with severe burns. The combination drug trimethoprim/sulfamethoxazole (TMP-SMZ) remains in use for many infections, including those associated with HIV infection (AIDS). TMP-SMZ is particularly useful for prevention and treatment of *Pneumocystis carinii* pneumonia, which has been the most dangerous of the infections associated with HIV infection.

## Recommended dosage

The recommended dosage depends on the type of sulfonamide, the strength of the medication, and the medical problem for which it is being taken. Patients should check the correct dosage with the physician who prescribed the drug or the pharmacist who filled the prescription.

Patients should always take sulfonamides exactly as directed. To make sure the infection clears up completely, the full course of the medicine must be taken. Patients should not stop taking the drug just because their symptoms begin to improve, because the symptoms may return if the drug is stopped too soon.

Sulfonamides work best when they are at constant levels in the blood. To help keep blood levels constant, patients should take the medicine in doses spaced evenly through the day and night without missing any doses. For best results, sulfa medicines should be

## KEY TERMS

**Anemia**—A deficiency of hemoglobin in the blood. Hemoglobin is the compound in blood that carries oxygen from the lungs throughout the body.

**Anticoagulant**—A type of medication given to prevent blood from clotting. Anticoagulants are also known as blood thinners.

**Bronchitis**—Inflammation of the air passages of the lungs.

**Diuretic**—A type of medication given to increase urinary output.

**HIV infection**—An infectious disease that impairs the immune system. It is also known as acquired immune deficiency syndrome or AIDS.

**Inflammation**—A condition in which pain, redness, swelling, and warmth develop in a tissue or organ in response to injury or illness.

**Meningitis**—Inflammation of tissues that surround the brain and spinal cord.

***Pneumocystis carinii* pneumonia (PCP)**—A lung infection that affects people with weakened immune systems, such as patients with AIDS or people taking medicines that weaken the immune system.

**Porphyria**—A disorder in which porphyrins build up in the blood and urine.

**Porphyrin**—A dark red pigment, sensitive to light, that is found in chlorophyll as well as in a substance in hemoglobin known as heme.

**Stevens-Johnson syndrome**—A severe inflammatory reaction that is sometimes triggered by sulfa medications. It is characterized by blisters and eroded areas in the mouth, nose, eyes, and anus; it may also involve the lungs, heart, and digestive tract. Stevens-Johnson syndrome is also known as erythema multiforme.

**Urinary tract**—The passage through which urine flows from the kidneys out of the body.

taken with a full glass of water, and the patient should drink several more glasses of water every day. This precaution is necessary because sulfa drugs do not dissolve in tissue fluids as easily as some other anti-infective medications. Drinking plenty of water will help prevent some of the medicine's side effects.

## Precautions

Symptoms should begin to improve within a few days of beginning to take a sulfa drug. If they do not,

or if they get worse, the patient should consult the physician who prescribed the medicine.

Although major side effects are rare, some people have had severe and life-threatening reactions to sulfonamides. These include sudden and severe liver damage; serious blood problems; breakdown of the outer layer of the skin; and a condition called Stevens-Johnson syndrome (erythema multiforme), in which people get blisters around the mouth, eyes, or anus. The patient may be unable to eat and may develop ulcerated areas in the eyes or be unable to open the eyes. It is important to consult a dermatologist and an ophthalmologist as quickly as possible if a patient develops Stevens-Johnson syndrome, to prevent lasting damage to the patient's eyesight. In addition, the syndrome is sometimes fatal.

A physician should be called immediately if any of these signs of a dangerous reaction occur:

- skin rash or reddish or purplish spots on the skin;
- such other skin problems as blistering or peeling;
- fever;
- sore throat;
- cough;
- shortness of breath;
- joint pain;
- pale skin; or
- yellow skin or eyes.

Sulfa drugs may also cause dizziness. Anyone who takes sulfonamides should not drive, use machines or do anything else that might be dangerous until they have found out how these drugs affect them.

Sulfonamides may cause blood problems that can interfere with healing and lead to additional infections. Patients should try to avoid minor injuries while taking these medicines, and be especially careful not to injure the mouth when brushing or flossing the teeth or using a toothpick. They should not have dental work done until their blood is back to normal.

Sulfa medications may increase the skin's sensitivity to sunlight. Even brief exposure to sun can cause a severe sunburn or a rash. During treatment with these drugs, patients should avoid exposure to direct sunlight, especially high sun between 10 A.M. and 3 P.M.; wear a hat and tightly woven clothing that covers the arms and legs; use a sunscreen with a skin protection factor (SPF) of at least 15; protect the lips with a lip balm containing sun block; and avoid the use of tanning beds, tanning booths, or sunlamps.

Babies under two months should not be given sulfonamides unless their physician has specifically ordered these drugs.

Older people may be especially sensitive to the effects of sulfonamides, increasing the chance of such unwanted side effects as severe skin problems and blood disorders. Patients who are taking water pills (**diuretics**) at the same time as sulfonamides may also be more likely to have these problems.

### *Special conditions*

People with certain medical conditions or who are taking other medicines may have problems if they take sulfonamides. Before taking these drugs, the patient must inform the doctor about any of these conditions:

**ALLERGIES.** Anyone who has had unusual reactions to sulfonamides, diuretics, diabetes medicines, or glaucoma medications in the past should let his or her physician know before taking sulfonamides. The physician should also be told about any allergies to foods, dyes, preservatives, or other substances.

**PREGNANCY.** Some sulfonamides have been found to cause birth defects in studies of laboratory animals. The drugs' effects on human fetuses have not been studied. Pregnant women are advised not to use sulfa drugs around the time of labor and delivery, because they can cause side effects in the baby. Women who are pregnant or who may become pregnant should check with their physicians about the safety of using sulfonamides during pregnancy.

**LACTATION.** Sulfonamides pass into breast milk and may cause liver problems, anemia, and other problems in nursing babies whose mothers take the medicine. Because of those problems, women should not breast-feed their babies when they are under treatment with sulfa drugs. Women who are breast-feeding but require treatment with sulfonamides should check with their physicians to find out how long they should stop breast-feeding.

**OTHER MEDICAL CONDITIONS.** People with any of the following medical problems should make sure their physicians are aware of their conditions before they take sulfonamides:

- anemia or other blood problems;
- kidney disease;
- liver disease;
- asthma or severe allergies;
- alcohol abuse;
- poor nutrition;
- abnormal intestinal absorption;



- porphyria;
- folic acid deficiency; and
- deficiency of an enzyme known as glucose-6-phosphate dehydrogenase (G6PD).

### Side effects

The most common side effects are mild diarrhea, nausea, vomiting, dizziness, headache, loss of appetite, and tiredness. These problems usually go away as the body adjusts to the drug and do not require medical treatment.

More serious side effects are not common, but may occur. If any of the following side effects occur, the patient should check with a physician immediately:

- itching or skin rash;
- reddish or purplish spots on the skin;
- such other skin problems as redness, blistering, or peeling;
- severe, watery or bloody diarrhea;
- muscle or joint aches;
- fever;
- sore throat;
- cough;
- shortness of breath;
- unusual tiredness or weakness;
- unusual bleeding or bruising;
- pale skin;
- yellow eyes or skin; or
- swallowing problems.

Other rare side effects may occur. Anyone who has unusual symptoms while taking sulfonamides should get in touch with his or her physician.

### Interactions

Sulfonamides may interact with a large number of other medicines. When an interaction occurs, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes sulfonamides should give the physician a list of all other medicines that he or she is taking. Among the drugs that may interact with sulfonamides are:

- acetaminophen (Tylenol);
- medicines to treat an overactive thyroid gland;
- male hormones (androgens);
- female hormones (estrogens);
- other medicines used to treat infections;
- birth control pills;

- such medicines for diabetes as glyburide (Micronase);
- warfarin (Coumadin) and other anticoagulants;
- disulfiram (Antabuse), a drug used to treat alcohol abuse;
- amantadine (Symmetrel), used to treat influenza and also Parkinson's disease;
- hydrochlorothiazide (HCTZ, HydroDIURIL) and other diuretics;
- the anticancer drug methotrexate (Rheumatrex); and
- valproic acid (Depakote, Depakene) and other anti-seizure medications.

The list above does not include every drug that may interact with sulfonamides. Patients should be careful to check with a physician or pharmacist before combining sulfonamides with any other prescription or nonprescription (over-the-counter) medicine. This precaution includes herbal preparations. Some herbs, such as bearberry, parsley, dandelion leaf, and sarsaparilla, have a diuretic effect and should not be used while taking sulfa drugs. Basil, which is commonly used in cooking to flavor salad **dressings**, stews, and tomato recipes, is reported to affect the absorption of sulfonamides.

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- United States Food and Drug Administration, 5600 Fishers Lane, Rockville, MD, 20857 0001, (888) INFO FDA, <http://www.fda.gov>.

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Surgical debridement see **Debridement**

## Surgical instruments

### Definition

Surgical instruments are tools or devices that perform functions such as cutting, dissecting, grasping, holding, retracting, or suturing. Most surgical instruments are made from stainless steel. Other metals, such as titanium, chromium, vanadium, and molybdenum, are also used.

### Purpose

Surgical instruments facilitate a variety of procedures and operations. Specialized surgical packs contain the most common instruments needed for particular surgeries.

In the United States, surgical instruments are used in all hospitals, outpatient facilities, and most professional offices. Instrument users include surgeons, dentists, physicians, and many other health-care providers. Millions of new and replacement instruments are sold each year. Many modern surgical instruments have electronic or computerized components.

### Description

Basic categories of surgical instruments include specialized implements for the following functions:

- cutting, grinding, and dissecting;
- clamping;
- grasping and holding;
- probing;
- dilating or enlarging;
- retracting; and
- suctioning.

Scissors are an example of cutting instruments. Dissecting instruments are used to cut or separate tissue. Dissectors may be sharp or blunt. One example of a sharp dissector is a scalpel. Examples of blunt dissectors include the back of a knife handle, curettes, and elevators. Clamps, tenacula, and forceps are grasping and holding instruments. Probing instruments are used to enter natural openings, such as the common bile duct, or fistulas. Dilating instruments expand the size of an opening, such as the urethra or cervical os. Retractors assist in the visualization of the operative field while preventing trauma to other tissues. Suction devices remove blood and other fluids from a surgical or dental operative field.

Sharps and related items should be counted four times: prior to the start of the procedure, before closure of a cavity within a cavity, before wound closure

## KEY TERMS

**Autoclave**—A heavy vessel that uses pressurized steam for disinfecting and sterilizing surgical instruments.

**Curette**—A scoop-shaped surgical instrument for removing tissue from body cavities.

**Dilation**—The process of enlarging, usually applied to relatively circular openings.

**Forceps**—An instrument designed to grasp or hold. Forceps usually have a locking mechanism so that they continue to hold tissue when put down by an operator.

**Instruments**—Tools or devices that perform such functions as cutting, dissecting, grasping, holding, retracting, or suturing.

**Sharps**—Surgical implements with thin cutting edges or a fine point. Sharps include suture needles, scalpel blades, hypodermic needles, and safety pins.

**Sponges**—Pieces of absorbent material, usually cotton gauze, used to absorb fluids, protect tissue, or apply pressure and traction.

**Tenaculum (plural, tenacula)**—A small, sharp-pointed hook set in a handle, used to seize or pick up pieces of tissue during surgical operations.

begins, and at skin closure or the end of the procedure. In addition, a count should be taken any time surgical personnel are replaced before, during, or after a procedure. Instruments, sharps, and sponges should be counted during all procedures in which there is a possibility of leaving an item inside a patient.

The misuse of surgical instruments frequently causes alignment problems. Instruments should always be inspected before, during, and after surgical or dental procedures. Inspection is an ongoing process that must be carried out by all members of a **surgical team**.

Scissors must be sharp and smooth, and must cut easily. Their edges must be inspected for chips, nicks, or dents.

After a procedure, staff members responsible for cleaning and disinfecting the instruments should also inspect them. The instruments should be inspected again after cleaning and during packaging. Any instrument that is not in good working order should be sent for repair. Depending on use, surgical instruments can last for up to 10 years given proper care.

## Preparation

Instruction in the use and care of surgical instruments may range from the medical training required by physicians and dentists to on-the-job training for orderlies and aides.

Surgical instruments are prepared for use according to strict institutional and professional protocols. Instruments are maintained and sterilized prior to use.

Surgical instruments must be kept clean during a procedure. This is accomplished by carefully wiping them with a moist sponge and rinsing them frequently in sterile water. Periodic cleaning during the procedure prevents blood and other tissues from hardening and becoming trapped on the surface of an instrument.

Instruments must be promptly rinsed and thoroughly cleaned and sterilized after a procedure. Ultrasonic cleaning and automatic washing often follow the manual cleaning of instruments. Instruments may also be placed in an autoclave after manual cleaning. The manufacturer's instructions must be followed for each type of machine. Staff members responsible for cleaning instruments should wear protective gloves, waterproof aprons, and face shields to protect themselves and maintain instrument sterility.

## Aftercare

Observation of the patient after surgical or dental procedures provides the best indication that correct instrument handling and **aseptic technique** was followed during surgery. After an operation or dental procedure, individuals should show no evidence of the following:

- retained instruments or sponges; or
- infection at the site of the incision or operation.

## Risks

Risks associated with surgical instruments include improper use or technique by an operator, leaving an instrument inside a person after an operation, and transmitting infection or disease due to improper cleaning and sterilization techniques. Improperly cleaned or sterilized instruments may contribute to postoperative infections or mortality. Improper use of surgical instruments may contribute to postoperative complications.

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- American Board of Surgery, 1617 John F. Kennedy Boulevard, Suite 860, Philadelphia, PA, 19103, (215) 568 4000, (215) 563 5718, <http://www.absurgery.org>.
- American College of Surgeons, 633 North Saint Claire Street, Chicago, IL, 60611, (312) 202 5000, <http://www.facs.org/>.
- Association of Perioperative Registered Nurses, 2170 South Parker Road, Suite 300, Denver, CO, 80231, (800) 755 2676, (303) 750 3212, <http://www.aorn.org>.
- Association of Surgical Technologists, 6 West Dry Creek Circle, Suite 200, Littleton, CO, 80120 8031, (303) 694 9130, (303) 694 9169, <http://www.ast.org>.

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## Surgical mesh

### Definition

Surgical mesh is a sterile woven piece of netting that is used in surgical procedures to help repair sites of surgical incision, tissue herniation, or to provide support to internal parts of the body.

## Demographics

Surgical mesh is used in many different types of surgical procedures. Hernia repair is one of the most frequently performed general surgeries world wide, and usually involves the use of surgical mesh. Mesh is also used to assist in surgical correction of urinary incontinence, uterine suspension, vertebral reconstruction, tissue reconstruction, vaginal prolapse, and provides support for devices implanted to support the heart.

## Description

Surgical mesh can be used in many different surgical procedures to provide wound closure or support for internal body parts. Also known as a patch or screen, surgical mesh is implanted in the body for repair or reinforcement. Surgical mesh may be absorbable or non-absorbable. Some types of repair procedures using surgical mesh may also be called a “Lichtenstein Repair,” because of a surgeon named Irving Lichtenstein whose influence in the medical field increased the widespread use of surgical mesh. A Lichtenstein Repair is specifically a flat piece of surgical mesh used as a patch placed on top of a tissue defect.

Surgical mesh is usually a sterile, woven material made of a type of synthetic plastic. Surgical mesh can be made of various different types of synthetic material, such as Gore-Tex, polypropylene, or knitted polyester. Mesh is very sturdy and strong, yet extremely thin. It is soft and flexible to allow it to easily conform to the movement of the body. Surgical mesh is available in various measurements and can be cut to size for each surgical application. Depending on the type of repair that is needed, a patch of mesh is placed under, over, or within a defect in the body and sewn in place by a few sutures. The mesh acts as a type of scaffold for the body tissue that grows around and into the mesh. Mesh is also used like a sling to support internal body parts and hold them in place.

Once inserted, mesh is eventually incorporated into the surrounding tissue as if it is part of the body. For this reason, mesh is considered a tension-free type of repair, as opposed to sutures. Sutures hold flesh together through the tension they create by pulling tissues together to close a wound. Because sutures create tension in the tissue they repair, too much movement early on in the recovery period after surgery can re-open the repair site and cause internal bleeding. Mesh is different in that it does not rely on tension to hold tissue together. Rather the mesh itself fills the wound and allows tissue to grow into and around it. Patients in which surgical mesh has been used may resume activity much sooner after the surgical procedure than is usually seen with

tension repair techniques such as sutures. Surgical mesh may be used in the form of a patch that goes under or over a weakness in body tissues, or a plug that goes inside a hole in the tissue. The patient cannot feel the internal mesh, and is able to move freely.

## Mesh Used for Tissue Support

Surgical mesh may be used to help physically support body tissues that are weak or damaged in some way. One example of a procedure that may benefit from mesh in this way is uterine suspension. Uterine suspension is necessary when the uterus is tipped out of its normal position and causes medical complications. Uterine suspension is performed to put the uterus back into its normal position. Surgical mesh may be used as a sling to support the uterus and hold it in place. A second example of mesh used for tissue support is as a sling for the urethra in some types of urinary incontinence where the urethra has fallen out of its normal position. In surgery done for urinary incontinence, a sling is put in place to lift the urethra back into its normal position and create a type of pressure that helps prevent the incontinence. A mesh sling may be used and attached to the abdominal wall, where the body tissue will grow around and into it to provide strength and support.

## Mesh Used for Hernia Repair

Hernia repair is the most common use for surgical mesh. A hernia is a protrusion of body tissues through a defect in a muscle or other containing body parts. Mesh may be used to repair the defect that allowed the herniation of body tissue. Hernias used to be commonly repaired using sutures and other types of tension-based tissue closure techniques. However, sutures do not allow for free movement as soon after the surgery. Sutures also create a higher post-operative intra-abdominal pressure and consequent breathing problems than mesh. Sutures are associated with a higher rate of hernia recurrence than mesh. Mesh hernia repair also causes less pain after surgery than suture repair. Mesh hernia repair clearly has many advantages over hernia repair using sutures.

Almost all hernia repairs are performed today using tension-free surgical mesh. Polypropylene is one of the most commonly used synthetic meshes in hernia repair, with each type of mesh material having advantages and disadvantages for hernia repair. Some hernia repair techniques using mesh include the Lichtenstien Repair where mesh is placed over the defect in the tissue, the Kugel Method where mesh is placed behind the defect, and the Prolene Hernia System where two



## KEY TERMS

**Adhesions**—Scar tissue.

**Intra-abdominal Pressure**—The pressure present in the abdominal cavity that affects the pressure on the diaphragm and the ability to breathe easily.

**Prolapse**—A condition where the organs fall out of their normal location in the body.

**Sutures**—Stiches that are used in surgical procedures to bring two pieces of flesh together or close a wound.

**Urinary Incontinence**—Disorder where urination is uncontrolled and involuntary.

**Uterine Suspension**—Procedure that places a sling under the uterus and holds it in place.

**Vertebral Reconstruction**—Procedure for reconstruction and support of the vertebrae of the skeletal system.

layers of mesh are placed around the defect, one behind and one over the defect. Another method of mesh-based hernia repair is the Plug and Patch Method, where mesh is placed like a plug into the tissue defect and then covered over the top with another mesh patch. Hernia repairs using mesh may be done as same day surgery using only **local anesthesia**. Because surgical mesh is a type of tension-free repair, patients can resume normal physical activity much sooner after the operation.

### Risks Associated with Surgical Mesh

While the use of surgical mesh has many advantages over other techniques, it is also associated with risk of some medical complications. One of the greatest risks of the use of surgical mesh is mesh infection. Mesh infections tend to be resistant to **wound care** techniques and **antibiotics**, and are generally removed upon discovery. Removal of infected mesh necessitates a new surgical procedure and the replacement of the mesh with a new repair. Surgical mesh may also cause tissue inflammation, which can be painful. Mesh may also cause adhesions, or scar tissue. Adhesions sometimes cause medical problems in the surrounding area. For example, adhesions in the abdominal cavity may cause obstruction of the bowels, and adhesions in the pelvic region may contribute to infertility in females. All types of hernia repair are associated with the risk of hernia recurrence, the protrusion of tissue through the repaired defect from failure of the mesh or

suture repair. Mesh repairs have a lower risk of hernia recurrence than sutures.

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## Surgical oncology

### Definition

Surgical oncology is a specialized area of oncology that engages surgeons in the cure and management of cancer.

### Purpose

Cancer has become a medical specialty warranting its own surgical area because of advances in the biology, pathophysiology, diagnostics, and staging of malignant tumors. Surgeons have traditionally treated cancer patients with resection and radical surgeries of tumors, and left the management of the cancer and the patient to other specialists. Advances in the early diagnosis of cancer, the staging of tumors, microscopic analyses of cells, and increased understanding of cancer biology have broadened the range of nonsurgical cancer treatments. These treatments include systematic chemotherapy, hormonal therapy, and radiotherapy as alternatives or adjunctive therapy for patients with cancer.

Not all cancer tumors are manageable by surgery, nor does the removal of some tumors or metastases

## KEY TERMS

**Biopsy**—The surgical excision of tissue to diagnose the size, type, and extent of a cancerous growth.

**Cancer surgery**—Surgery in which the goal is to excise a tumor and its surrounding tissue found to be malignant.

**Resection**—Cutting out tissue to eliminate a cancerous tumor; usually refers to a section of the organ, (e.g., colon, intestine, lung, stomach) that must be cut to remove the tumor and its surrounding tissue.

**Tumor staging**—The method used by oncologists to determine the risk from a cancerous tumor. A number ranging from 1A–4B is assigned to predict the level of invasion by a tumor, and offer a prognosis for morbidity and mortality.

necessarily lead to a cure or longer life. The oncological surgeon looks for the relationship between tumor excision and the risk presented by the primary tumor. He or she is knowledgeable about patient management with more conservative procedures than the traditional excision or resection.

## Demographics

According to the American Cancer Society and the National Cancer Institute, about 559,650 people were projected to die of cancer in the year 2007. 66% of those diagnosed with cancer within the year 2007 are expected to survive for at least five years after diagnosis. The most common newly diagnosed cancers for males in the United States during 2007, with total of over 766,860 cases for all races, were:

- prostate—29%;
- lung—15%;
- colon and rectum—10%;
- bladder—7%; and
- non-Hodgkin's lymphoma—4%.

The most common newly diagnosed cancers for females in the United States during 2007, with total of over 678,060 cases for all races, were:

- breast—26%;
- lung—15%;
- colon and rectum—11%;
- uterine corpus—6%; and
- non-Hodgkin's lymphoma—4%.

## Description

Surgical oncology is guided by principles that govern the routine procedures related to the cancer patient's cure, palliative care, and quality of life. Surgical oncology performs its most efficacious work by local tumor excision, regional lymph node removal, the handling of cancer recurrence (local or widespread), and in rare cases, with surgical resection of metastases from the primary tumor. Each of these areas plays a different role in cancer management.

### Excision

Local excision has been the hallmark of surgical oncology. Excision refers to the removal of the cancer and its effects. Resection of a tumor in the colon can end the effects of obstruction, for instance, or removal of a breast carcinoma can stop the cancer. Resection of a primary tumor also stops the tumor from spreading throughout the body. The cancer's spread into other body systems, however, usually occurs before a local removal, giving resection little bearing upon cells that have already escaped the primary tumor. Advances in oncology through pathophysiology, staging, and biopsy offer a new diagnostic role to the surgeon using excision. These advances provide simple diagnostic information about size, grade, and extent of the tumor, as well as more sophisticated evaluations of the cancer's biochemical and hormonal features.

### Regional lymph node removal

Lymph node involvement provides surgical oncologists with major diagnostic information. The sentinel node biopsy is superior to any biological test in terms of prediction of cancer mortality rates. Nodal biopsy offers very precise information about the extent and type of invasive effects of the primary tumor. The removal of nodes, however, may present pain and other morbid conditions for the patient.

### Local and regional recurrence

Radical procedures in surgical oncology for local and regional occurrences of a primary tumor provide crucial information on the spread of cancer and prognostic outcomes; however, they do not contribute substantially to the outcome of the cancer. According to most surgical oncology literature, the ability to remove a local recurrence must be balanced by the patient's goals related to aesthetic and pain control concerns. Historically, more radical procedures have not improved the chances for survival.

### *Surgery for distant metastases*

In general, a cancer tumor that spreads further from its primary site is less likely to be controlled by surgery. According to research, except for a few instances where metastasis is confined, surgical removal of a distant metastasis is not warranted. Since the rapidity of discovering a distant metastasis has little bearing upon cancer survival, the usefulness of surgery is not time dependent. In the case of liver metastasis, for example, a cure is related to the pathophysiology of the original cancer and level of cancer antigen in the liver rather than the size or time of discovery. While surgery of metastatic cancer may not increase life, there may be indications for it such as pain relief, obstruction removal, control of bleeding, and resolution of infection.

### Diagnosis/Preparation

Surgery removes cancer cells and surrounding tissues. It is often combined with radiation therapy and chemotherapy. It is important for the patient to meet with the surgical oncologist to talk about the procedure and begin preparations for surgery. Oncological surgery may be performed to biopsy a suspicious site for malignant cells or tumor. It is also used for **tumor removal** from organs such as the tongue, throat, lung, stomach, intestines, colon, bladder, ovary, and prostate. Tumors of limbs, ligaments, and tendons may also be treated with surgery. In many cases, the biopsy and surgery to remove the cancer cells or tissues are done at the same time.

The impact of a surgical procedure depends upon the diagnosis and the area of the body that is to be treated by surgery. Many cancer surgeries involve major organs and require open abdominal surgery, which is the most extensive type of surgical procedure. This surgery requires medical tests and work-ups to judge the health of the patient prior to surgery, and to make decisions about adjunctive procedures like radiation or chemotherapy. Preparation for cancer surgery requires psychological readiness for a hospital stay, postoperative pain, sometimes slow recovery, and anticipation of complications from tumor excision or resection. It also may require consultation with stomal therapists if a section of the urinary tract or bowel is to be removed and replaced with an outside reservoir or conduit called an ostomy.

### Aftercare

After surgery, the type and duration of side effects and the elements of recovery depend on where in the body the surgery was performed and the patient's general health. Some surgeries may alter basic functions in

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A surgeon who specializes in cancer surgery or oncology performs oncology surgery in a general hospital or cancer research center.

the urinary or gastrointestinal systems. Recovering full use of function takes time and patience. Surgeries that remove conduits such as the colon, intestines, or urinary tract require appliances for urine and fecal waste and the help of a stomal therapist. Breast or prostate surgeries yield concerns about cosmetic appearance and intimate activities. For most cancer surgeries, basic functions like tasting, eating, drinking, breathing, moving, urinating, defecating, or neurological ability may be changed in the short-term. Resources to attend to deficits in daily activities need to be set up before surgery.

### Risks

The type of risks that cancer surgery presents depends almost entirely upon the part of the body being biopsied or excised. Risks of surgery can be great when major organs are involved, such as the gastrointestinal system or the brain. These risks are usually discussed explicitly when surgical decisions are made.

### Normal results

Most cancers are staged; that is, they are described by their likelihood of being contained, spreading at the original site, or recurring or invading other bodily systems. The prognosis after surgery depends upon the stage of the disease, and the pathology results on the type of cancer cell involved. General results of cancer surgery depend in large part on norms of success based upon the study of groups of patients with the same diagnosis. The results are often stated in percentages of the chance of cancer recurrence or its spread after surgery. After five disease-free years, patients are usually considered cured. This is because the recurrence rates decline drastically after five years. The benchmark is based upon the percentage of people known to reach the fifth year after surgery with no recurrence or spread of the primary tumor.

### Morbidity and mortality rates

Morbidity and mortality of oncological surgery are high if there is organ involvement or extensive

## QUESTIONS TO ASK THE DOCTOR

Who is recommended for a second opinion?

What are the alternatives to surgery for this cancer?

What is the likelihood that this surgery will entirely eliminate the cancer?

Is this a surgical procedure that is often performed in this hospital or surgical center?

excision of major parts of the body. Because there is an ongoing disease process and many patients may be very ill at the time of surgery, the complications of surgery may be quite complex. Each procedure is understood by the surgeon for its likely complications or risks, and these are discussed during the initial surgical consultations.

There are comprehensive surgical procedures for many cancers, and complications may be extensive due to the use of general anesthetic and the opening of body cavities. Open surgery has general risks associated with it that are not related to the type of procedure. These risks include possibility of blood clots and cardiac events.

There is an extensive body of literature about the complication and morbidity rates of surgery performed by high-volume treatment centers. Data show that in general, large volumes of surgery affect the quality outcomes of surgery, with smaller hospitals having lower rates of procedural success and higher operative and postoperative complications than larger facilities. It is not known whether the surgeon's experience or the advantages of institutional resources in operative or **postoperative care** contributes to these statistics.

### Alternatives

Alternatives to cancer surgery exist for almost every cancer treated in the United States. Research into alternatives has been very successful for some—but not all—cancers. There are many alternatives to surgery, and chemotherapy and radiation after surgery. Most organizations dealing with cancer patients suggest alternative treatments. Physicians and surgeons expect to be asked about alternatives to surgery, and are usually quite knowledgeable about their use as cancer treatments or as adjuncts to surgery.

## Resources

### BOOKS

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Wein, A. J., L. R. Kavoussi, A. C. Novick, A. W. Partin, and C. A. Peters. *Campbell Walsh Urology*, 9th ed. Philadelphia: Saunders, 2006.

### OTHER

*Cancer Trends Progress Report 2007 Update*. National Cancer Institute. December 2007. <http://progressreport.cancer.gov/> (April 7, 2008).

### ORGANIZATIONS

American Cancer Society, 1875 Connecticut Avenue, NW, Suite 730, Washington, DC, 20009, (800) ACS 2345, <http://www.cancer.org>.

National Breast Cancer Coalition, 1101 17th Street, NW, Suite 1300, Washington, DC, 20036, (800) 622 2838, (202) 265 6854, <http://www.stopbreastcancer.org/>.

Office of Cancer Complementary and Alternative Medicine, National Cancer Institute, 6116 Executive Boulevard, Suite 609, MSC 8339, Bethesda, MD, 20892, (800) 422 6237, <http://www.cancer.gov/cam/>.

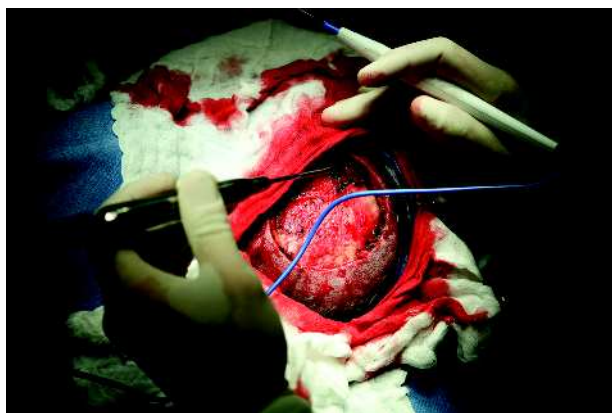
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## Surgical risk

### Definition

Surgical risk is the set of potential adverse medical circumstances that may arise from having surgery, or the dangers and harm that may occur. Risk is determined by surgical risk factors, which are any set of circumstances that increase the risk of surgical complications. Surgical complications are any negative medical results that deviate from the normal expected outcomes of surgery, or the expected recovery scenario.





Surgeon using electrocautery to stop bleeding. (PHOTOTAKE Inc. / Alamy)

### Demographics

Specific subsets of the population are at higher risk for serious complications after surgery. People who are more vulnerable to surgical complications and therefore have a higher risk include the elderly, the obese, people who are in very poor physical condition from disease, lack of **exercise**, or malnourishment, people who have a compromised immune system such as AIDS patients, people with certain heart conditions, and smokers.

### Benefits and Risk

By nature, surgery is a risky business. However, those risks have been greatly minimized by modern technology and the high standard of physician **surgical training**. Surgeons usually undergo the rigors of nearly a decade of intensive training and education before they perform surgeries on their own. Experience is key to becoming a qualified surgeon, and so is included even in the early training stages of a surgeon's career. A qualified surgeon is a highly trained and skilled professional who can serve certain patients to improve or even save their lives. It can be overwhelming to read the long list of potential complications that may arise from having surgery. However, it is important to note that most of these complications are anticipated and measures are taken to avoid harm to the patient. Surgery saves many lives each year, and should be viewed in light of considering the potential benefits as well as the potential risks.

### Description

The degree of surgical risk varies between different surgical procedures, as well as with the individual medical aspects associated with each patient. The risk

a patient takes when having a surgical procedure is a combination of the risks associated with the procedure itself as well as risks associated with specific patient-based factors regarding surgery. Patient-based risk factors are an important part of surgical risk, and help determine the likelihood of a surgical complication occurring. The decision to perform any surgical procedure is based on whether or not potential benefits outweigh the sum of the potential risks.

#### *Procedure-Based Risk*

Any patient undergoing surgery is at risk for medical complications that arise from the procedure itself. The specific factors that may potentially cause these complications are called procedure-based risk factors. The surgical procedures associated with the highest level of risk include cardiac surgery, lung surgery, prostate removal, and some major orthopedic surgeries such as **hip replacement**.

#### *Patient-Based Risk*

Many patient-based factors increase the risk of having complications during or after a surgical procedure. Patient-based factors that generally increase risk include advanced age, obesity, poor physical condition, smoking, a compromised immune system, recent heart attack or unstable heart conditions, and malnourishment. Some specific types of surgical procedures may have their own specific types of patient-based risk factors. Specific complications are also associated with certain patient-based risk factors. For example, obesity increases the risk for wound and pulmonary complications after surgery. **Smoking cessation** for six weeks before surgery decreases the incidence of pulmonary complications.

#### *Risk of Excessive Bleeding*

Excessive bleeding is risk factor of undergoing surgery. During any surgical procedure, there may be accidental damage to a major blood vessel. If that damage is not effectively repaired, it may result in excessive blood loss. If procedural damage is done to smaller blood vessels as an expected part of the surgery but is not properly controlled, there may be excessive blood loss. Even without surgical damage to blood vessels, if a patient undergoes too much physical activity soon after having a surgical procedure, they may accidentally open some of the internal or external surgical sites and cause bleeding. Excessive bleeding may result in the patient becoming anemic. Anemia, and the resulting fatigue associated with anemia, is a risk of surgical procedures. If a very large amount of blood is lost, it can lead to complications much more

serious than anemia. A very large loss of blood risks the patient going into a state of shock.

Disorders of blood clotting predispose a surgical patient to bleeding complications. If the patient's blood has a defective ability to clot, the body cannot properly close small wounds in a normal manner. Instead, even small cuts that are part of the surgical procedure can result in excessive or prolonged bleeding that may be life threatening. If surgery is a necessity in this type of patient, physicians can appropriately manage these conditions prior to the procedure to minimize the risk for bleeding complications.

### *Risk of Seroma Formation*

A seroma is an internal collection of bodily fluids at a surgical site. Seromas may result from improper wound closure or as a complication of the specific procedure. For example, breast surgery is associated with a high risk of seroma formation, even when performed properly. The presence of a seroma may delay wound healing and also increases the risk of developing an infection. Seromas are more likely to form in obese individuals, or individuals whose body forms an excessive volume of fluids that need to be drained from the surgical site during the recovery period.

### *Risk of Infection*

Hospitals may contain types of bacteria that the average person in the United States is not normally exposed to, or mutated strains of common bacteria. Having surgery and staying in the hospital may increase the risk of being exposed to these types of bacteria. Additionally, the emergence of antibiotic resistant strains of bacteria complicates the risk of infection after surgery. Infections with mutated strains of bacteria that are resistant to available **antibiotics** are especially difficult to prevent, treat, or control.

Risk of infection is associated with any type of surgical procedure. To minimize the chance of a patient contracting a bacterial infection, some surgical procedures involve prophylactic application of antibiotics. Surgical procedures that may involve **antibiotic prophylaxis** include bowel surgery, procedures that include insertion of prosthetic material, surgeries on patients with impaired immune systems, **neurosurgery**, cardiac surgery, and ophthalmic surgery. In addition to antibiotics, proper surgical technique in an appropriately clean **operating room** setting also minimizes risk of infection. Surgeons "scrub in" to surgery, meaning that they follow specific protocols of hand washing and dressing in surgical gowns that minimize risk of infection. The surgical site on the patient's body also needs to

be effectively disinfected before the procedure can be performed. However, even with proper protective measures taken, there is risk of contracting a bacterial infection at surgical sites after having a procedure.

Bacterial infections after surgery may also occur in the urinary tract when a urinary catheter is used, in the respiratory tract if the patient needs to be on a respirator after the procedure, or may be systemic infections that lead to sepsis. Patients with compromised immune systems are at especially high risk of contracting bacterial infections that healthier individuals are usually able to resist. Other patient-based risk factors for post-surgery infection include a pre-existing infection before surgery, low levels of certain non-immune blood components, advanced age, obesity, smoking, diagnosis of diabetes, certain cardiovascular diseases, a physiological state of shock, excessive physical trauma, and requiring a blood **transfusion**. The organism most often associated with infection of surgical sites in the hospital is *Staphylococcus aureus*, which may be resistant to many current antibiotics such as methicillin.

### *Risk of Neurological Damage*

Surgical procedures may involve risk of neurological damage, or damage to the nervous system. Depending on the type of surgery, nerve damage may be a result of direct injury to the brain, spinal cord, or peripheral nerves. Nerve damage from a surgical procedure may also occur secondary to the administration of spinal, epidural, or regional anesthesia, or from a temporary reduction of oxygen flow to a specific part of the body. Depending on the part of the nervous system that sustains damage, the results may be mild to severe, temporary or permanent. For example, head and neck surgery is associated with risk of injury to numerous delicate nerves, some of which may result in a permanent state of Bell's palsy if damage occurs.

### *Risk of Postoperative Delirium*

Although most patients experience a temporary state of confusion when they come out of anesthesia, having a surgical procedure may carry the risk of postoperative delirium. Delirium is a severe state of mental confusion, disorientation, agitation, and general incoherence. Delirium may also include hallucinations. Postoperative delirium is a temporary state of delirium that may be caused by multiple factors relating to the surgical procedure. A postoperative temporary state of delirium may occur if the patient experiences a lack of oxygen, hypotension, or sepsis as a result of the surgical procedure. Patient-based risk factors for postoperative delirium include advanced age, pre-existing

dementia, chronic drug or alcohol abuse, certain metabolic disorders, side effects of certain medications such as meperidine, and sleep deprivation. Because individuals of advanced age are at higher risk for postoperative delirium, the mental status of elderly patients is frequently assessed in postoperative recovery. If delirium occurs, the patient's oxygen levels are checked, and all non-essential drugs are temporarily discontinued. With proper treatment, post-operative delirium usually goes away within 72 hours.

### *Risk of Anesthesia Complications*

A patient undergoing **general anesthesia** for a surgical procedure runs the risk of a temporary, minor disturbance in mental function after the procedure. Patients may experience slight confusion, disorientation, and decreased general mental acuity after having anesthesia for a surgical procedure. This mental state may take up to a week to fully dissipate, and may affect the patient's ability to work or operate an automobile. Patient-based factors that increase the likelihood of anesthesia complications include advanced age, obesity, and kidney or liver insufficiencies resulting in poor metabolism of the anesthetic agent.

### *Risk of Cardiac Complications*

Cardiac complications are another surgical risk factor. Certain types of anesthesia such as halothane may cause a cardiac arrhythmia during the induction of anesthesia. Additionally there are other factors that may contribute to cardiac complications after surgery. Certain drugs, excessive pain, certain acid-base imbalances, and problems with oxygen delivery during surgery may lead to arrhythmias. Post-operative hypertension may also occur as a result of poor **pain management** after a surgical procedure. Patient-based risk factors for post-operative hypertension include advanced age, congestive heart failure, and angina.

There is a slight risk of heart attack associated with non-cardiac surgeries, and a greater risk associated with cardiac or vascular surgeries. Risk factors for heart attack associated with surgery are pre-existing congestive heart failure, angina, atherosclerosis, pre-existing anemia, hypotension or anemia as a result of blood loss during surgery, defective oxygen delivery during surgery, and advanced patient age.

### *Risk of Other Organ-Based Complications*

Any surgical procedure performed on or around an organ system has some risk of damage to that system. The following are examples of organ-based surgical risk factors. Pancreatitis (inflammation of the pancreas) is a

rare complication as a result of surgery. However, within the cases of pancreatitis that do exist, approximately 10% are related to injury during surgical procedures. When a surgical procedure is performed in the physical vicinity of the pancreas, approximately 1-3% of patients may develop pancreatitis. If the surgical procedure involves maneuvering the actual biliary tract, the incidence of pancreatitis rises. Patient surgical risk factors that predispose to pancreatitis include previous history of pancreatitis, parathyroid surgery which alters blood levels of calcium very quickly and in a short period of time, cardiopulmonary bypass, and renal transplantation.

Surgeries involving the contents of the abdomen have risk for temporarily disrupting the normal movement of the intestines, a condition known as postoperative intestinal ileus. If the intestines are handled too much or are damaged, or certain types of postoperative pain medications are overused, the normal propulsive movements of the bowels may cease completely. While this condition is temporary and treatable, the patient cannot eat or drink until normal intestinal movement is restored. Postoperative ileus may cause abdominal distention, pain, constipation, and vomiting; require a prolonged hospital stay; or contribute to a regional bacterial infection.

### *Risk of Vascular Complications*

Several vascular complications may result from a surgical procedure. If a procedure involves the placement of a central line, air may be introduced into the body cavity outside of the lung, and then collapse the lung. If a catheter is left open air may enter the blood stream, travel to, and affect the proper functioning of the heart.

Deep Venous Thrombosis (DVT) is a condition where a blood clot (thrombus) forms in a blood vessel. DVT occurs in approximately 40% of postoperative patients. Clots usually form in the lower extremities. To prevent DVT, support hose and compression devices are used during surgical procedures. DVT is dangerous because if a clot becomes an embolus (clot that detaches from the vessel wall and travels through the bloodstream) and goes into the pulmonary system (pulmonary embolus) it can be life threatening. It is one of the most common causes of sudden **death** in hospitalized patients and is a risk factor if a surgical procedure requires a long period of bed rest during recovery.

Pulmonary emboli may be caused by multiple types of clots in addition to DVT, and are a type of surgical risk. For example pulmonary emboli may also be caused fat droplets entering the bloodstream during

joint replacement surgery. Patient-based risk factors for a pulmonary embolus during surgery include advanced age, heart disease, obesity, and varicose veins.

### *Risk Associated with Blood Transfusions*

Patients undergoing some surgical procedures carry the risk of needing a blood transfusion. Blood transfusions may cause a dangerous immune system reaction against the blood type or other blood components of the transfusion. These reactions can make the patient very sick or may even become anaphylactic and life threatening. To prevent the likelihood of an immune reaction, blood is carefully matched to the patient in a way that minimizes risk. Although the blood used for blood transfusions is screened for known viruses, transmission of an unknown virus is a possibility.

### *Risk of Pulmonary Complications*

Pulmonary complications are a main cause of postoperative illness. Pulmonary complications may be caused by patient-based risk factors or surgical procedure-based risk factors. Many pulmonary complications after surgery involve part of the respiratory system partially collapsing, usually within 48 hours of a surgical procedure. Other potential respiratory/pulmonary complications involve lung infections, difficulty breathing, or aspirating (breathing in) regurgitated gastric secretions while under general anesthesia. While under anesthesia the parts of the body that normally protect the respiratory system from taking in food or fluids (the epiglottis and esophageal sphincter) are relaxed. Therefore safeguards have to be set in place for protection. Endotracheal tubes are tubes placed in the throat to minimize the risk of breathing regurgitated stomach contents down into the respiratory tract. If food or fluids from the stomach enter the respiratory tract, it may result in pulmonary complications associated with high mortality rates. In order to avoid these complications patients are asked to fast from food before surgical procedures requiring general anesthesia, are positioned carefully for surgery, and carefully fitted with an endotracheal tube.

Patient-based risk factors associated with different types of pulmonary complications include advanced age, obesity, pre-existing chronic lung disease, and smoking history. Surgical procedure-based risk factors include procedures requiring a long duration of anesthesia, prolonged **mechanical ventilation**, thoracic or upper abdomen surgery, abdominal distention, inadequate pain control that results in the patient not coughing effectively after the procedure, oversedation due to administration of too much anesthesia, excessive

## QUESTIONS TO ASK YOUR DOCTOR

- Why do I need a surgical procedure?
- What are alternative options to surgery?
- What are the potential benefits of this procedure?
- What are the potential risks of this procedure?
- What outcomes are anticipated if I do not have the surgical procedure?
- Who would perform the procedure?
- How many times has my surgeon performed this procedure before?
- Are there any patient-based risk factors that could be altered to minimize risk?
- Will any of my medications, over-the-counter medicines, and nutritional or herbal supplements affect my recovery from this procedure?
- How long should recovery be expected to take?
- Will I have to stay in the hospital after the procedure?

postsurgical pain killer use, or an endotracheal tube that is not positioned correctly.

### *Tool-Based Risk*

The tools used during surgery pose a risk for damage to organs, nerves, or blood vessels. Scalpels, cauterizers, needles, and clamps may be mishandled and accidentally cut, burn, pierce, or cause blunt trauma to the body. Even minimal access surgeries such as a **laparoscopy** involve tool-based surgical risk. Tool-based risks of laparoscopies include the use of **trocars**, a tool used to make the first incision or entry into the abdominal cavity. If a classic trocars is used in the first “blind jab” into the abdomen, before a camera can be inserted, the physician may push too hard on the trocars and damage blood vessels or internal organs. Any surgical tool poses a risk for damage, and is only as safe as the skill of the surgeon wielding it.

## Hospital Screening Tests to Minimize Surgical Risk

Hospitals may perform laboratory tests before admitting a patient for surgery in order to catch patient-based risk factors that predispose for surgical complications and treat them. Pre-surgery tests such as **urinalysis**, chest x-rays, or complete blood counts may identify potential risk factors that could lead to complications. Commonly performed pre-surgery tests include:



## KEY TERMS

**Acquired Immunodeficiency Syndrome (AIDS)**—A disease syndrome in which the patient's immune cells are destroyed by HIV virus, leaving the patient open to opportunistic infections that a healthy immune system could keep at bay.

**Anaphylactic**—A serious allergic reaction to a foreign protein or other material.

**Anemia**—A physiological state in which the number of red blood cells or amount of hemoglobin in the blood is abnormally low, leading to a decrease in the capacity of the blood to carry oxygen to the tissues.

**Angina**—Disease involving decreased oxygen flow to the heart and often constricting chest pain.

**Aspiration**—The act of inspiring or sucking foreign fluid or vomit into the airways.

**Atherosclerosis**—Disease involving irregularly deposited fat within the arteries that results in medical complications.

**Bell Palsy**—One-sided paralysis of the face that may be due to damage to the facial nerve.

**Cardiac Arrhythmia**—An irregular heartbeat.

**Cardiac Pulmonary Bypass**—A procedure where heart blood is diverted into an inserted pump in order to maintain appropriate blood flow.

**Catheter**—A flexible tube inserted into the body to allow passage of fluids in or out.

**Central Line**—A catheter passed through a vein into large blood vessels of the chest or the heart; used in various medical procedures.

**Deep Venous Thrombosis (DVT)**—Blood clot that usually forms in the lower extremities after prolonged inactivity.

**Delirium**—An altered state of consciousness that includes confusion, disorientation, incoherence, agitation, and defective perception (such as hallucinations).

**Electrocardiogram (ECG)**—A medical tool used to monitor the electrical impulses released by the beating heart. The results are drawn out in graphical fashion to visualize the function of the heart.

**Embolus**—A plug of blood cell components, bacteria, or foreign body that travels through the bloodstream, lodges, and occludes a blood vessel.

**Endotracheal Tube**—Tube inserted in the throat during general anesthesia to prevent aspiration of gastric contents into the respiratory tract.

**Epidural Anesthesia**—Regional anesthesia produced by injecting the anesthetic agent into an area near the spinal cord.

- Chest x-rays for patients with shortness of breath, chest pain, or a cough
- Electrocardiogram (ECG) for patients with chest pain or abnormal heart signs
- Urinalysis for patients with urinary problems, side pain, kidney disease, or diabetes
- White blood cell count for patients with a suspected infection, or on medications known to affect white blood cell counts
- Platelet count for patients with excessive blood loss, alcoholism, or on medications known to affect platelet count
- Glucose levels for patients with excessive sweating, tremors, diabetes, cystic fibrosis, an altered mental status, or alcoholism
- Potassium levels for patients with congestive heart failure, kidney failure, muscle weakness, diabetes, or on medications known to affect potassium levels
- Sodium levels for patients with pulmonary disease, central nervous system disease, congestive heart failure, or some types of liver disease

## Resources

## BOOKS

*The Merck Manual of Diagnosis and Therapy* Eighteenth Edition. 2006.

*General Surgery Board Review Series*. Lippincott Williams & Wilkins. 2000.

*The Merck Manual Home Edition* 2004.

## PERIODICALS

Cheadle, W. G. "Risk Factors for Surgical Site Infection." *Surgical Infections* 7, no. 1 (2006).

Weinstein, Robert A. "Nosocomial Infection Update." *Emerging Infectious Diseases, Special Issue* 4, no. 3 (July September 1998; updated April 3, 2008). <http://www.cdc.gov/ncidod/eid/vol4no3/weinstein.htm> [accessed April 3, 2008].

## ORGANIZATIONS

American Association for the Surgery of Trauma, 633 N Saint Clair St, Suite 2400, Chicago, Illinois, 60611, (312)202 5252, (800)789 4006, (312)202 5013, <http://www.aast.org/index.aspx>.

American Academy of Orthopaedic Surgery, 6300 North River Road, Rosemont, Illinois, 60018 4262, (847)823 7186, (847)823 8125, <http://www.aaos.org>.

**Epiglottis**—A leaf-shaped piece of cartilage lying at the root of the tongue that protects the respiratory tract from aspiration during the swallowing reflex.

**Esophageal Sphincter**—Muscle at the opening to the stomach that keeps the stomach contents from traveling into the esophagus.

**Glucose**—A form of sugar used by the body for energy.

**Hypotension**—Low blood pressure.

**Hypovolemia**—An abnormally low amount of blood in the body.

**Intestinal Ileus**—Mechanical or dynamic obstruction of the bowel causing pain, abdominal distention, vomiting, and often fever.

**Laparoscopy**—Minimally invasive surgical procedure in which small incisions are made in the abdominal or pelvic cavity and surgical tools are used with a miniature camera for guidance.

**Merperidine**—A type of narcotic pain killer that may be used after surgical procedures.

**Methicillin-resistant *Staphylococcus aureus* (MRSA)**—A strain of Staph. bacteria that is resistant to methicillin and hence poses a greater health threat because it is difficult to control or kill.

**Pancreatitis**—Inflammation of the pancreas.

**Parathyroid Gland**—An endocrine gland that modulates calcium in the body.

**Platelet**—A blood component responsible for normal clotting mechanisms that seal small wounds.

**Prophylaxis**—The prevention of disease or infection, or of a process that can lead to disease or infection.

**Sepsis**—A dangerous physiological state of extensive, systemic bacterial infection.

**Seroma**—A seroma is an internal collection of fluid at a surgical site.

**Spinal Anesthesia**—Regional anesthesia produced by injecting the anesthetic agent into an area directly around the spinal cord.

**Thrombus**—A blood clot attached to a blood vessel wall.

**Trocars**—A surgical tool shaped as a hollow cylinder that is sometimes used to make an initial incision into a body cavity and through which other surgical tools are then passed.

**White Blood Cell**—A component of the blood involved in the immune response.

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Maria Basile, PhD

## Surgical team

### Definition

The surgical team is a unit providing the continuum of care beginning with **preoperative care**, and extending through perioperative (during the surgery) procedures, and postoperative recovery. Each specialist on the team, whether surgeon, anesthesiologist or nurse, has advanced training for his or her role before, during, and after surgery.

### Purpose

Surgery, whether elective, required, or emergency, is done for a variety of conditions that include:

- cosmetic procedures
- diagnostic and exploratory procedures
- treatment of acute, chronic, and infectious diseases of tissue or organs
- transplantation of organs
- reposition and enhancement of bone, ligaments, tendons, or organ conduits
- replacement or implantation of artificial or electronic devices

The crucial elements of surgery—surgical and operative procedures, pain control, patient safety, and blood and wound control—require individual expertise and high levels of concentration and coordination. Through a team effort, the patient is treated and monitored as he or she undergoes significant acts of bodily invasion and pain control that make up the

surgical experience, whether they be the most benign and superficial operations, or the most intense.

### Demographics

According to the Centers for Disease Control (CDC) and Prevention and the National Center for Health Statistics, 45 million inpatient surgical procedures were performed in the United States in 2005, followed closely by 31.5 million outpatient surgeries. Leading surgeries included:

- digestive system surgeries: 12 million
- musculoskeletal system surgeries: 7.4 million
- cardiovascular system surgeries: 6.8 million
- eye surgeries: 5.4 million

### Description

The components of the surgical team depend on the type of surgery, the precise procedures, and the location and the type of anesthesia utilized. The team may include surgeons, anesthesiologists, and nursing and technical staff who are trained in **general surgery** or in a particular surgical specialty. Intense surgeries require larger teams and more comprehensive recovery care. Even though minimally invasive procedures (e.g., **laparoscopy** or endoscopy) are conducted with small instruments and a video camera probe, they require specialized expertise and high technology knowledge. These procedures utilize smaller teams, create less extensive wounds, and yield quicker healing, but often require more operating time and may result in operative injuries.

### Types of surgery

Many surgeries are categorized as general surgery, and are associated primarily with accidents, emergencies, and trauma care. Hospitals have general surgeons that staff their emergency rooms or trauma centers. As surgical technology and knowledge have advanced, other surgical specialties have developed for each function and organ of the body. They involve special surgical techniques and anesthesiology requirements, and sometimes require subspecialists with in-depth knowledge of organ function, operative techniques, complex anesthesiology procedures, and specialized nursing care.

The basic surgical specialties include:

- **General surgery.** General surgeons manage a broad spectrum of surgical conditions that involve almost any part of the body. They confirm the diagnoses provided by primary care or emergency physicians

## KEY TERMS

**Anesthesiologist**—A physician with advanced training in anesthesia (and sometimes other medical specialties) who administers or oversees the administration of anesthesia to the patient and monitors care after surgery.

**Anesthetist**—A nurse trained in anesthesiology who, working as an assistant to an anesthesiologist, administers the anesthesia in surgery and monitors the patient after surgery.

**Minimally invasive surgery**—Surgical techniques, especially the use of small instruments and tiny video cameras, that allow surgery to take place without a full operative wound.

**Operative nurse**—A nurse specially trained to assist the surgeon and work in all areas of the surgical event to care for the patient.

and radiologists, and perform procedures necessary to correct or alleviate the problem.

- **Cardiothoracic surgery.** A major surgical specialty with very high demands, The cardiothoracic surgical team oversees the preoperative, operative, and critical care of patients with pathologic conditions within the chest, including the heart and its valves, cancers of the lung, esophagus, and chest wall, and chest vessels.
- **Neurosurgery.** Neurosurgical teams specialize in surgery of the nervous system, including the brain, spine, and peripheral nervous system, and their supporting structures.
- **Oral and maxillofacial surgery.** Head and neck surgical teams provide treatment for problems of the ears, sinuses, mouth, pharynx, jaw, and other structures of the head and neck.
- **Reconstructive and plastic surgery.** Reconstructive surgery is performed on abnormal structures of the body due to injury, birth defects, infection, tumors, or disease. Cosmetic surgery is performed to improve a patient's appearance.
- **Transplantation.** Transplant surgical teams specialize in specific organ transplant techniques, such as heart and heart-lung transplants, liver transplants, and kidney/pancreas transplants. These highly intricate surgeries require very advanced training and technological support.
- **Urology and renal transplantation.** Also known as gastrointestinal surgery, the team specializes in problems of the digestive tract (stomach, bowels, liver,

and gallbladder) with intensive use of or coordination with transplant team members.

- **Vascular surgery.** Vascular surgery offers diagnosis and treatment of arterial and venous disorders such as aneurysms, lower extremity revascularization, and other problems.
- **Pediatric surgery.** Pediatric surgical teams are specially trained to treat a broad range of conditions affecting infants and children. They work closely with specially trained anesthesiologists, and are experts in childhood diseases of the head, neck, chest, and abdomen, with training in birth defects and injuries. Many pediatric surgeons work to increase the use of minimally invasive techniques with children.

### *Surgical techniques*

Open surgeries requiring invasive procedures within the abdominal cavity, brain, or extensive limb areas require a hospital stay overnight or up to two weeks. Hospitalization allows the clinical staff to monitor patient recovery (and provide medical attention in the case of a complication), while allowing patients to regain organ functions.

Surgery has been revolutionized by new technology. Ambulatory or outpatient surgeries account for an increasing percentage of surgeries in the United States. Imagery with miniature videoscopes that pass into the patient via tiny incisions is an example of how minimally invasive procedures are replacing open surgeries. Minimally invasive surgeries reduce recovery time and increase the speed of healing. Outpatient or ambulatory surgery environments often allow patients to recover and go home the same day. In specialty surgery centers, such as those designed for ophthalmology, surgery is performed as part of a physician's office practice. These centers contain their own operating rooms and recovery areas.

Minimally invasive procedures that involve the use of a video scope as an exploratory as well as viewing instrument, include the following:

- **Arthroscopy** allows viewing of the interior of joints, especially the knee joint.
- **Cystoscopy** is used to examine the urethra and bladder.
- **Endoscopy** uses an endoscope in gastrointestinal surgeries of the esophagus, stomach, and colon.
- **Laparoscopy** uses an illuminated tube with a video camera inserted in small incisions in the abdomen.
- **Sigmoidoscopy** is used for examining the rectum and sigmoid colon.

### *Types of anesthesia*

Surgical procedures and the surgical setting may be associated with different types of anesthesia:

- **General anesthesia** renders the patient unconscious during surgery. The anesthesia is either inhaled or given intravenously. A breathing tube may be inserted into the windpipe (trachea) to facilitate breathing. The patient is carefully monitored and wakes up in the recovery room.
- **Regional anesthesia** numbs the surgical section of the body. This is usually accomplished via injection through the spinal canal (spinal anesthesia) or through a catheter to the lower part of the back (epidural). Regional anesthetics numb the area of the nerves that provide feeling to the designated part of the body.
- **Local anesthesia** medicates only the direct operative site, and is administered through injection. The patient remains conscious during the operation.

### *Surgical team*

The basic surgical team consists of experts in operative procedure, **pain management**, and overall or specific patient care. Team members include the surgeon, anesthesiologist, and **operating room nurse**. In teaching hospitals attached to medical schools, the team may be added to by those in training, such as interns, residents, and nursing students.

**SURGEON.** The surgeon performs the operation, and leads the surgical team. Surgeons have medical degrees, specialized **surgical training** of up to seven years, and, in most cases, have passed national board certification exams. Board certification means that the surgeon has passed written and oral examinations of academic competence. The American Board of Surgery, a professional organization that strives to improve the quality of care for patients, is the certifying board for surgeons. As a peer review organization, the College has advanced standards to certify surgical competence by allowing examined surgeons to become a fellow of the organization. Fellows of the American College of Surgeons (FACS) are the elite members of the profession. An FACS designation after a physician's name and degree denotes attainment of the profession's highest training and expertise. Surgeons' credentials may be explored through the Official American Board of Medical Specialties, available at libraries or online.

**ANESTHESIOLOGIST.** Anesthesiologists are physicians with at least four years of advanced training in anesthesia. They may attain further specialization in surgical procedures, such as **neurosurgery** or **pediatric surgery**. They are directly or indirectly involved in all three stages of surgery, preoperative, operative, and



postoperative, due to their focus on pain management and patient safety.

**CERTIFIED REGISTERED NURSE ANESTHETIST (CRNA).** The certified nurse anesthetist supports the anesthesiologists and, in an increasing number of hospitals, takes full control of the anesthesia for the operation. Registered nurses must graduate from an approved nursing program and pass a licensing examination. They may be licensed in more than one state. While states determine the training and certification requirements of nurses, the work setting determines their daily responsibilities. Certified registered nurse anesthetists must have advanced education and clinical practice experience in anesthesiology.

**OPERATING NURSE.** The general nursing staff is a critical feature of the surgical team. The nursing staff performs comprehensive care, assistance, and pain management during each surgical phase. He or she is usually the team member providing the most continuity between the stages of care. The operating nurse is the general assistant to the surgeon during the actual operation phase, and usually has advanced training.

### Preparation

The surgical team admits the patient to the hospital or surgery center. Many surgeons and anesthesiologists have privileges at more than one hospital and may admit the patient to a center of the patient's choosing. Surgical preparation is the preoperative phase of surgery, and involves special team activities that include monitoring **vital signs**, and administering medications and tests needed immediately before the procedure. In preparation for surgery, the patient meets with the surgeon, anesthesiologist, and surgical nurse. Each team member discusses his or her role in the surgery, and obtains from the patient pertinent information.

### Aftercare

After the surgical procedure has been performed, the patient is brought to a **recovery room** where post-anesthesia staff take over from the surgical team under the guidance of the surgeon and anesthesiologist. The staff carefully monitors the patient by checking vital signs, the surgical wound and its **dressings**, IV medications, swallowing ability, level of consciousness, and any tubes or drains. Clinical staff also manages the patient's pain and body positioning.

### Risks

Because of its risks, surgery should be the option chosen when the benefit includes the removal of life-

threatening conditions or improvement in quality of daily life. Radical surgeries for some types of cancer may offer less than a 20% chance of cure, and the operation may pose the same percentage of mortality risk. A failed operation may shorten time with loved ones and friends, or a successful operation may lead to major positive changes in daily life.

Surgery often brings quicker relief from many conditions than other medical treatment. The risks of surgery depend upon a number of factors, including the experience of the surgical team. In a *New England Journal of Medicine* article, researchers found that mortality decreased as patient volume in a surgical setting increased. The study's messages were that patients should choose surgical centers where a large number of the type of surgery they need is performed, and that physicians working in low-volume hospitals should find ways to increase volume and reduce their morbidity and mortality rates.

Mortality rates are lower and the care more extensive in teaching hospitals with a house staff made up of interns and residents in training.

Healthcare facilities keep records of the procedures they perform. By contacting the Joint Commission on Accreditation of Healthcare Organizations (JCAHO), a center's success with surgical care, mortality and morbidity rates, and surgical complications can be determined.

The Institute of Medicine estimates that today's anesthesia care is nearly 50 times safer than it was 20 years ago, with one anesthesia-related **death** per 200,000–300,000 cases. Despite this record of progress, many questions remain about anesthetic safety. Certified registered nurse anesthetists administer over 65% of anesthesia in the United States, and are often the primary anesthetists for rural communities and delivery rooms.

Independent of surgical team expertise and experience, patient status, and the level of technological advancement in surgical procedures, cardiac events, blood clots, and infection pose surgical risks. These risks accompany all surgeries and, while great progress has been achieved, they remain factors that are part of any surgical invasion and any use of anesthesia.

### Alternatives

Alternatives to surgery should be investigated with the referring physician or primary care physician. Many medical conditions benefit from changes in lifestyle, such as losing weight, increasing **exercise**, and undergoing physical rehabilitation. This is especially true for chronic conditions of the gastrointestinal tract, cardiovascular system, urologic system, and bone and joint

issues. Research and other resources offer alternatives to surgery including pharmaceutical and medical remedies.

Patients should obtain a **second opinion** before undergoing most major surgeries. It is very important that patients understand that a second opinion offers them the ability to obtain a confirming or differing diagnosis as well as new treatment options. A study of New York City employees and retirees who sought second opinions found that 30% of the second opinions differed from the first. Many health plans have mandatory second opinion clauses. Second opinions should involve physicians in other facilities or even other cities. A change in surgeon will mean a change in the surgical team.

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## Surgical training

### Definition

Surgical training encompasses the acquisition of knowledge and skills required for a physician to operate on people in a safe and therapeutically successful manner.

### Purpose

The purpose of surgical training is to prepare a physician to specialize in surgery.

An individual's first formal exposure to surgery occurs during the third year of medical school. Every medical student spends 12 weeks in a surgical clerkship. During this period, students are exposed to patients with conditions that can be addressed using surgery. Medical students accompany surgeons. Initially, they observe. Gradually, they are allowed to assist with simple activities such as changing **bandages** or wound **dressings** or holding instruments. Under constant direct supervision, they may be allowed to close wounds by placing sutures. During this period, students read about surgery and are taught and quizzed by the surgeons that they are accompanying.

The next phase surgical training occurs after a physician has graduated from medical school. This phase is called residency training and lasts for five years. The first year of residency training is often referred to as an internship year. During this time, surgical residents receive intensive training in the medical management of patients. Their surgical duties include additional observation of surgical procedures. As their skills improve and knowledge base grows, they are allowed to perform simple surgical procedures such as establishing a surgical field, making initial incisions, placing drains in wounds and closing wounds when surgical procedures have been completed.

During the second through fifth years, surgical residents continue to read, acquire additional skills and manage patients. Throughout the five years of surgical training, residents are constantly observed and evaluated. In the fifth year, each trainee serves as a Chief Resident. In this capacity, residents learn about leadership. They are responsible for assigning cases (patients) to other surgical residents, instructing other surgical residents and teaching medical students.

After completing the five years of resident training, trainees must pass an examination. The testing involves a written component that covers medical and surgical knowledge and an oral component that covers surgical skills and patient management. When they



Surgeons at medical school. (BSIP / Phototake. Reproduced by permission.)

pass this examination, they receive Fellowship status in the American College of Surgeons. With this, they are entitled to call themselves surgeons and use the letters FACS after their names. At this point, surgeons are also board certified.

Some surgeons begin regular work in a surgical practice or as employees in a hospital or other similar organization. Some surgeons opt for obtaining additional specialized training and enter fellowships. (This is not to be confused with their Fellowship status in the American College of Surgeons.) Fellowship training is focused on a particular aspect of surgery. Fellowship training lasts from one to two years. At the completion of fellowship training, surgeons take another round of examinations. When they successfully complete the written and oral components, they receive an additional board certification as specialists.

Examples of surgical fellowship training include cardiac surgery (specialize on the heart), **thoracic surgery** (specialize on the lungs), **plastic surgery** (specialize on reconstructive and **cosmetic surgery**), **orthopedic surgery** (specialize on bones and joints), trauma surgery (specialize on hands or other body parts), gynecological

surgery (specialize on the female reproductive system), ophthalmic surgery (specialize on the eye), and **transplant surgery** (specialize on the kidneys, pancreas, liver and lungs), and **neurosurgery** (specialize on the brain and nervous system).

### Demographics

As of 2008, there were 61,516 Fellows in the American College of Surgeons.

More males than females enter surgical training. This is a long-standing pattern. As a result, the great majority of surgeons in the United States are males.

### Description

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## QUESTIONS TO ASK YOUR SURGEON

- Are you board certified?
- When did you complete your surgical training?
- What is your complication rate?
- How many times have you completed the surgical procedure that you are recommending for me?

on reconstructive and cosmetic surgery), orthopedic surgery (specialize on bones and joints), trauma surgery (specialize on hands or other body parts), gynecological surgery (specialize on the female reproductive system), ophthalmic surgery (specialize on the eye), and transplant surgery (specialize on the kidneys, pancreas, liver and lungs), and neurosurgery (specialize on the brain and nervous system).

## Diagnosis/Preparation

Prior to entering medical school, individuals interested in becoming surgeons usually complete four years of undergraduate training in a college or university. During their premedical education, future physicians complete a core curriculum that includes a minimum of one year of biology, one year of physics, one year of mathematics (including a semester of calculus), and two years of chemistry (including a year of inorganic chemistry and a year of organic chemistry). So-called pre-meds often complete a bachelor degree in biology or chemistry although this is not now required. Medical schools seek persons that can think in a logical manner. Thus, persons with degrees in any undergraduate major are welcomed as long as they have completed the ten courses of a core curriculum already described.

Candidates must take and submit scores from the Medical College Admission Test (MCAT).

## Risks

Risks associated with surgical training include disappointment for candidates that are unsuccessful in gaining admission to medical school. Risks associated with surgical training from medical school through fellowship training include fatigue and occupational injuries. Occupational injuries associated with surgery include accidental needle sticks, accidental cuts from scalpels or other instruments and exposure to pathogens acquired from patients. Risks associated with surgical training include fatigue, occupational injuries and malpractice suits.



## KEY TERMS

**Fellowship training**—Additional specialty training that follows completion of residency training; fellowships are one to two years in length.

**Internship**—The first year of residency training

**Residency training**—A five-year period of additional training that follows completion of medical school.

**Surgeon**—A physician that has completed surgical residency training, passed all examinations and is a Fellow of the American College of Surgeons.

## Normal results

The normal result of surgical training is successfully mastering the knowledge presented in medical school and residency, learning the techniques of surgery, and becoming a productive surgeon.

## Morbidity and mortality rates

Morbidity for surgeons includes occupational injuries on the job. They experience the same risks of life as do all individuals. In 2008, mortality from on-the-job related events includes exposure to AIDS through an accidental needle-stick or cut by a contaminated instrument.

## Alternatives

To become a surgeon, there are no alternatives to receiving surgical training.

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American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464 5000. <http://www.ama-assn.org>.

American Society for Aesthetic Plastic Surgery. 11081 Winners Circle, Los Alamitos, CA 90720. (800) 364 2147 or (562) 799 2356. <http://www.surgery.org>.

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L. Fleming Fallon, Jr, MD, DrPH

## Surgical triage

### Definition

Triage (from the French verb *trier* "to sort") is the assessment of medical condition performed by health care providers to screen for the most critically ill patients out of a group of people. Surgical triage focuses on establishing priority with respect to which

surgeries are most critical in a time-sensitive manner. Triage is a necessary process when health care resources are limited and not every patient can be treated at once.

### Purpose

Triage is performed to prioritize medical treatment so that the most endangered patients are treated first, while the number of lives saved is maximized. Triage is especially important in emergency situations where the amount of resources are limited and so have to be distributed in a selective manner. For example, a patient with a chest wound requiring immediate surgery to maintain life will take priority over a patient who needs surgery for a benign tumor.

### Demographic

Surgical triage is performed on any patient presenting with a condition that may be amenable to surgical repair. Surgical triage is performed, when medically necessary, regardless of age, gender, or race.

### Description

Triage is a system of screening, evaluating, and classifying the sick or wounded. It may be done during war, disaster situations, or in the emergency room of a hospital. Regardless of where it is performed, triage for any medical treatment is dependent on available medical resources. Medical resources include medications, **operating room** space, hospital space, **bandages** or other materials, as well as a physician's time. Medical resources are all limiting factors to the medical treatment available for patients. Surgical triage takes both the acuity (severity) of the patient's medical condition, as well as available medical resources into account.

### *Emergency Surgical Triage*

There are multiple grading systems or standards for triaging patients in an emergency setting. In emergency situations, each patient is evaluated (including obtaining a brief history when possible) and given a rapid physical exam specifically geared toward **vital signs** and areas of critical injury or illness. The components of the initial triage history include a specific set of information that is important: allergies to specific medications; current medications need to be established in case new medications are indicated; when the patient last ate is pertinent due to the risk of vomiting and breathing in the vomit during **general anesthesia** and the surgical procedure. Establishing an airway and taking basic life support measures is a

priority. Other priority items include stopping any arterial bleeding before the patient goes into shock. **Emergency surgery** procedures apply the general principles of emergency triage in addition to information about the specific medical condition involved in order to determine which surgeries need to be performed first.

Emergency surgical procedures may be necessary due to trauma (with the patient being critically injured) or a critical phase of a disease state (such as immediately life-threatening heart failure that is caused by a condition amenable to surgical repair). It is essential that triage be performed rapidly and accurately, because in emergency situations a single minute could make the difference between survival and **death**. The rationale of surgical triage is to first treat patients that are in the most critical need of care in order to preserve life. Topics that factor into the order in which patients are triaged includes vital signs, clinical history, mechanism of injury or pre-hospital course of disease, age, co-morbid conditions, and whether they have open airways through which to breathe. A patient may be given priority if their vital signs are unstable, they have a clinical history of cardiac or pulmonary disease, have serious injuries, closed airways, are very young or very old, have lost consciousness, or are showing signs of neurological injuries.

An initial assessment of the patient involves running a primary survey, during which the airway, breathing, circulation/hemorrhage, and mental disability are evaluated. The purpose of the primary survey is for the initial management of life-threatening conditions. If the airway is obstructed, the patient may immediately go into an emergency surgery procedure to remove the obstruction. Next the patient's ability to breathe independently is evaluated. If the patient cannot breathe due to a surgically amenable condition such as internal bleeding into the chest cavity they may be triaged into emergency surgery. If the patient has obstructed circulation, such as in cardiac tamponade where the heart sac is filled with blood and the heart cannot pump properly, emergency surgery would be required. Mental disability in the context of a primary survey refers to the current mental status of the patient. If the patient has serious neurological disability due to a head or spinal cord injury, **neurosurgery** may be necessary.

If the patient has not been triaged in the primary survey as having an immediately life-threatening condition, a secondary survey is performed. The secondary survey is a more thorough **physical examination** covering the entire body of the patient. Blood tests may be run to check the basic functioning of the

patient's bodily systems. At this point, triage is performed and the patients are prioritized for surgery.

Trauma patients being triaged for surgery may need diagnostic tests such as a Computed Tomography (CT) scan to help diagnose what is wrong with them and initiate appropriate surgery. However, if a patient has initially been brought to a smaller hospital without an appropriate surgeon present, this aspect of surgical triage may be temporarily put aside. Diagnostic tools such as **CT scans** take time and may delay the transfer of the patient to an appropriate trauma facility.

### *Non-emergency Surgical Triage*

Triage also takes place in non-emergency department situations when scheduling operations in the hospital. While non-emergent procedures are generally scheduled on a first-come first-serve basis, if a patient is identified who medically requires a procedure in a time-sensitive manner, it may take precedence over a previously scheduled surgery. For example, if a current patient is identified during a routine examination with an aggressive tumor that requires surgery, a non-emergent procedure may be rescheduled to make room for the tumor patient. Hence, initial triage decisions may take place outside of the emergency department of the hospital.

### **Who Performs the Triage Procedure**

An initial triage officer is a health care professional who performs triage on a patient arriving at the hospital. In the emergency department, the initial triage officer is often a triage nurse, who identifies the critically ill and sends them for further evaluation by a physician. Sometimes the triage officer is a resident, a full medical doctor who is in training for their specialty. For surgical triage, it is often a surgical resident that first determines whether a new patient requires surgery immediately.

Once a patient has undergone a surgical procedure, the triage process continues in the Surgical **Intensive Care Unit (SICU)**. The SICU is a special hospital unit dedicated to patients undergoing surgery until they are deemed well enough to be transferred to other parts of the hospital or discharged. The surgical specialties of each hospital support the SICU, and may include the specialties of trauma surgery, neurosurgery, cardiothoracic surgery, **transplant surgery**, **orthopedic surgery**, ear nose and **throat surgery**, **plastic surgery**, **vascular surgery**, **general surgery**, and obstetrics and gynecological surgery. While the SICU is run by numerous types of health care providers, some systems utilize a Surgical Intensivist to triage which patients

need to stay in the SICU and which may leave. A Surgical Intensivist is an MD who is both a general surgeon and has special training in intensive care practices.

In addition to the triage needs of each individual patient, the Surgical Intensivist must also manage a balance between the supply and demand of factors such as operating room time, post-anesthesia care unit availability, and bed space. It is a challenge for the Surgical Intensivist to properly assess which patients require SICU admission and which ones can be either denied admission or discharged safely for home. Patients who are inappropriately judged ready for discharge have been associated with a higher level or mortality, so triage on this level has a critical impact on healthcare. The Surgical Intensivist's triage decisions may be supported by the surgeons on the patient's primary surgical care team.

### **Triage Systems**

Triage systems of classification may have from two to five categories into which to place patients. Many hospitals in the U.S. use three level systems with the categories of Emergency, Urgent, and Non-Urgent. However, studies have shown that five level systems are the most effective. Five level systems include the categories of Resuscitation (when breathing or pulse is not detected), Emergent, Urgent, Non-urgent, and Referred (minimal medical resources are required). One well-known five level triage system that is employed by emergency departments of the United States is the Emergency Severity Index (ESI). The ESI categorizes patients presenting to the emergency department by both health threat acuity and the resources available. The ESI scale ranges from one to five, with a lower number indicating greater severity. A triage nurse is usually the one who initiates the ESI when a patient presents to the emergency department. The acuity of a patient's medical condition is determined by the stability of the patient's vital signs and the potential for threat to life, limbs, or organs. If the patient meets high acuity level criteria (level 1 or 2), they need immediate treatment possibly including surgery. If the patient does not meet high acuity level criteria, the triage nurse then proceeds to evaluate the expected resources needed for treatment to help determine a triage level (level 3, 4, or 5). The ESI is a method for emergency departments to triage patients in a validated manner. It is one of the only triage systems that specifically categorizes based on resources available. A general triage system such as the ESI is only one factor in the process of surgical triage. Patients with high acuity levels and conditions amenable to

surgery are then given over to more specific surgical triage done by the appropriate surgical specialty.

### Surgical Triage after Trauma

Triage decisions are based on many factors, and may include a patient's trauma score. These scores are an approximate way to aid assessment of how critical a patient's medical condition is after physical trauma. There are many different trauma-scoring systems that may assist in the process of triage. The Revised Trauma Score (RTS) is one commonly used system to aid triage decisions. The RTS is based on physiological parameters, including vital signs. Blood pressure, respiratory rate, and level of consciousness all contribute to the RTS. Each parameter is worth a certain number of points, with higher points being better. An RTS score lower than 11 requires admission of the patient to a trauma center. Other types of trauma scoring systems may be geared toward different types of injuries: The Injury Severity Score (ISS), Penetrating Abdominal Trauma Index (PATI), Systemic Inflammatory Response Syndrome (SIRS), and ICD-based Injury Severity Score (ICISS) are all examples. The Abbreviated Injury Score (AIS) is often used to assist in triage for trauma surgery. The AIS is an anatomically based system of grading injuries from one to six, with one being minor injury and six being lethal injury. For trauma conditions that are amenable to surgery, an appropriate trauma-scoring system may greatly influence who is brought to the trauma center and surgical triage decisions.

### Triage Coding in Disasters

Triage officers in mass casualty situations may utilize the Simple Triage and Rapid Treatment (START) system. The START system is a very simple four category triage system that groups medical conditions as severe, urgent, minor, and beyond medical assistance. In advanced systems, patients triaged in emergency or mass casualty situations are often given a color-coded tag to help identify their status to other health care workers. Triage tag systems vary from country to country. In general, there are five categories each assigned to a color: immediate care required with possible positive outcome anticipated, urgent care required but may be briefly delayed, care required but may be extensively delayed, and immediate care required but the patient is realistically beyond saving.

Red is the color tag used for the group of patients requiring immediate care without which they would not survive. The red triage tag indicates that the patient is in an immediate medical crisis, and may be realistically

saved given the medical facilities available. Red-tagged triage patients are given top priority over other colored tags. In surgical triage a red-tagged patient would generally be one who requires immediate surgery to save their life. If the medical facilities are substantial enough, some types of crippling injuries that are not life threatening may be given a red triage tag. For example, amputations may be triaged as red because surgical reattachment of severed or partially severed limbs must take place within minutes of the injury, in order to be salvaged.

Yellow is the color tag used for patients who require medical care urgently but who are not in immediate danger of losing their life. Yellow triage groups may be able to wait hours for medical treatment, but not days. Yellow is the group known as delayed priority. In surgical triage, yellow-tagged patients may require surgery within a specific time frame in order to maintain life. While yellow-tagged patients may be stable for the moment, triage is a dynamic process and medical conditions may deteriorate rapidly. A patient in the yellow triage category needs to be monitored while awaiting treatment and re-triaged if necessary.

Green is the color tag used for patients for whom medical care is a minor priority, and who may wait a number of days before treatment without risking life. An example of a green triage condition is a broken bone without compound fracture, which needs to be treated but will not endanger a patient's life. The green category is sometimes referred to as the "walking wounded". White is the color tag used for patients who have such minor injuries that a doctor's care is not required. These patients are dismissed and would not be placed in a surgical triage situation.

Black is the triage color category that causes the most difficult ethical dilemma. The black triage tag is given to patients who are in immediate danger of losing their lives from injury or disease, but for whom medical treatment is unlikely to be successful. This category of triage is often given lowest priority when medical resources are scarce. The purpose of triage is to maintain the health of the greatest number of people. Resources devoted to black-tagged patients are often considered resources taken away from patients who may have benefited from them. For surgical triage, black-tagged patients are patients for whom surgery is unlikely to salvage. Potential examples of black-tagged surgical triage would be patients with extremely extensive burns or crush injuries.

### Ethical Considerations of Triage

Triage systems have been developed to ensure the greatest number of people requiring medical care



## KEY TERMS

**Cardiac Disease**—Any disease involving the heart.

**Cardiac Tamponade**—A condition in which the sac around the heart is filled with blood and keeps the heart from functioning properly.

**Cardiothoracic Surgery**—Surgery involving the chest body cavity known as the thoracic cavity.

**Co-morbid Conditions**—Diseases or disorders that exist simultaneously in one patient.

**Computed Tomography (CT scan)**—A computer uses x-rays across many different directions on a given cross section of the body, and combines all the cross sections to create one image. CT scans can be used to visualize bodily organs including the brain, blood vessels, bones, and the spinal cord. Contrast dye is sometimes administered to the patient to help visualize structures.

**Hemorrhage**—Excessive blood loss through blood vessel walls.

**Mental Disability**—The inability to mentally function due to injury, illness, or toxicity.

**Neurological**—Pertaining to the nervous system: peripheral nervous system, brain, and spinal cord.

**Neurosurgery**—Surgery involving the nervous system: peripheral nervous system, brain, and spinal cord.

**Obstetrics and Gynecological Surgery**—Surgery involving the reproductive organs or pregnancy.

**Orthopedic Surgery**—Surgery involving the musculoskeletal system, which includes muscles, tendons, joints, and bones.

**Physiological**—Pertaining to the normal vital life functions of a living organism.

**Pulmonary Disease**—Any disease involving the lungs.

**Trauma Surgery**—Surgery performed as a result of injury.

**Vascular Surgery**—Surgery involving blood vessels.

**Vital Signs**—The physiological aspects of body function basic to life. They are temperature, pulse, breathing rate, and blood pressure.

survive disease or injury. Unfortunately, medical resources are often limited, and not enough to give each and every patient ideal medical care. For black-tagged triage patients who are unlikely to survive despite medical care, this dilemma is especially poignant. Physicians are

generally trained to see any patient under their care as one to whom the physician demonstrates fidelity by acting in the best interests of the patient over the interests of others. However in emergency triage situations it is necessary for triage officers to assign priority based on established guidelines. Any care given to black-tagged triage patients is considered care taken away from other patients who might have survived or suffered less severe disability if the resources had been used on them. In essence, physicians may greatly desire to treat any patient that requires help. However, in emergency situations they may need to put certain patients aside so as to use the available medical resources to save the lives of others. Since a physician's time is considered a limited medical resource, especially in emergency or mass casualty situations, a patient may even be coded as black-tagged for triage if the amount of time necessary to save them is very long. With limited time to save as many as possible, a twenty-four hour procedure for one person may mean losing five others that could have been treated in the same time period. Triage is essentially designed to do the greatest good for the greatest number of patients in any given situation. However, accomplishing this goal often puts physicians in difficult ethical situations and an emotionally painful decision-making process.

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Sweat test see **Electrolyte tests**

## Sympathectomy

### Definition

Sympathectomy is a surgical procedure that destroys nerves in the sympathetic nervous system. The procedure is performed to increase blood flow and decrease long-term pain in certain diseases that cause narrowed blood vessels. It can also be used to decrease excessive sweating. This surgical procedure cuts or destroys the sympathetic ganglia, which are collections of nerve cell bodies in clusters along the thoracic or lumbar spinal cord.

### Purpose

The autonomic nervous system controls involuntary body functions such as breathing, sweating, and blood pressure. It is subdivided into two components, the sympathetic and the parasympathetic nervous systems.

The sympathetic nervous system speeds the heart rate, narrows (constricts) blood vessels, and raises blood pressure. Blood pressure is controlled by means of nerve cells that run through sheaths around the arteries. The sympathetic nervous system can be described as the “fight or flight” system because it allows humans to respond to danger by fighting off an attacker or running away. When danger threatens, the sympathetic nervous system increases heart and respiratory rates and blood flow to muscles, and decreases blood flow to other areas such as skin, digestive tract, and limb veins. The net effect is an increase in blood pressure.

Sympathectomy is performed to relieve intermittent constricting of blood vessels (ischemia) when the fingers, toes, ears, or nose are exposed to cold (Raynaud’s phenomenon). In Raynaud’s phenomenon, the affected extremities turn white, then blue, and red as the blood supply is cut off. The color changes are accompanied by numbness, tingling, burning, and pain. Normal color and feeling are restored when heat is applied. The condition sometimes occurs without direct cause but is more often caused by an underlying medical condition, such as rheumatoid arthritis. Sympathectomy is usually less effective when Raynaud’s syndrome is caused by an

## KEY TERMS

**Causalgia**—A severe burning sensation sometimes accompanied by redness and inflammation of the skin. Causalgia is caused by injury to a nerve outside the spinal cord.

**Claudication**—Cramping or pain in a leg caused by poor blood circulation, frequently caused by hardening of the arteries (atherosclerosis). Intermittent claudication occurs only at certain times, usually after exercise, and is relieved by rest.

**Fiberoptics**—In medicine, fiberoptics uses glass or plastic fibers to transmit light through a specially designed tube inserted into organs or body cavities where it transmits a magnified image of the internal body structures.

**Hyperhidrosis**—Excessive sweating. Hyperhidrosis can be caused by heat, overactive thyroid glands, strong emotion, menopause, or infection.

**Parasympathetic nervous system**—The division of the autonomic (involuntary) nervous system that slows heart rate, increases digestive and glandular activity, and relaxes the sphincter muscles that close off body organs.

**Percutaneous**—Performed through the skin. It is derived from two Latin words, *per* (through) and *cutis* (skin).

**Pneumothorax**—A collection of air or gas in the chest cavity that causes a lung to collapse. Pneumothorax may be caused by an open chest wound that admits air.

underlying medical condition. Narrowed blood vessels in the legs that cause painful cramping (claudication) are also treated with sympathectomy.

Sympathectomy may be helpful in treating reflex sympathetic dystrophy (RSD), a condition that sometimes develops after injury. In RSD, the affected limb is painful (causalgia) and swollen. The color, temperature, and texture of the skin changes. These symptoms are related to prolonged and excessive sympathetic nervous system activity.

Sympathectomy is also effective in treating excessive sweating (hyperhidrosis) of the palms, armpits, or face.

### Demographics

Experts estimate that 10,000–20,000 sympathectomy procedures are performed each year in the United States.

## Description

Sympathectomy for hyperhidrosis is accomplished by making a small incision under the armpit and introducing air into the chest cavity. The surgeon inserts a fiberoptic tube (endoscope) that projects an image of the operation on a video screen. The ganglia are cut with fine scissors attached to the endoscope. Laser beams may also be used to destroy the ganglia.

If only one arm or leg is affected, it may be treated with a percutaneous radiofrequency technique. In this technique, the surgeon locates the ganglia by a combination of x-ray and electrical stimulation. The ganglia are destroyed by applying radio waves through electrodes on the skin.

## Diagnosis/Preparation

A reversible block of the affected nerve cell (ganglion) determines if sympathectomy is needed. This procedure interrupts nerve impulses by injecting the ganglion with a steroid and anesthetic. If the block has a positive effect on pain and blood flow in the affected area, the sympathectomy will probably be helpful. The surgical procedure should be performed only if conservative treatment has not been effective. Conservative treatment includes avoiding exposure to stress and cold, and the use of physical therapy and medications.

Sympathectomy is most likely to be effective in relieving reflex sympathetic dystrophy if it is performed soon after the injury occurs. The increased benefit of early surgery must be balanced against the time needed to promote spontaneous recovery and responses to more conservative treatments.

Patients should discuss expected results and possible risks with their surgeons. They should inform their surgeons of all medications they are taking, and provide a complete medical history. Candidates for surgery should have good general health. To improve general health, a surgical candidate may be asked to lose weight, give up smoking or alcohol, and get the proper amount of sleep and **exercise**. Immediately before the surgery, patients will not be permitted to eat or drink, and the surgical site will be cleaned and scrubbed.

## Aftercare

The surgeon informs the patient about specific aftercare needed for the technique used. Doppler ultrasonography, a test using sound waves to measure blood flow, can help to determine whether sympathectomy has had a positive result.

The operative site must be kept clean until the incision closes.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A sympathectomy is usually performed by a general surgeon, neurosurgeon, or surgeon with specialty training in head and neck surgery.

Sympathectomy was traditionally performed on an inpatient under general anesthesia. An incision was made on the mid-back, exposing the ganglia to be cut. Recent techniques are less invasive. As a result, the procedure may be performed under local anesthesia in an outpatient surgical facility.

## Risks

Side effects of sympathectomy may include decreased blood pressure while standing, which may cause fainting. After sympathectomy in men, semen is sometimes ejaculated into the bladder, possibly impairing fertility. After a sympathectomy is performed by inserting an endoscope in the chest cavity, some persons may experience chest pain with deep breathing. This problem usually disappears within two weeks. They may also experience pneumothorax (air in the chest cavity).

## Normal results

Studies show that sympathectomy relieves hyperhidrosis in more than 90% of cases and causalgia in up to 75% of cases. The less invasive procedures cause very little scarring. Most persons stay in the hospital for less than one day and return to work within a week.

## Morbidity and mortality rates

In 30% of cases, surgery for hyperhidrosis may cause increased sweating on the chest. In 2% of cases, the surgery may cause increased sweating in other areas, including increased facial sweating while eating. Less frequent complications include Horner's syndrome, a condition of the nervous system that causes the pupil of the eye to close, the eyelid to droop, and sweating to decrease on one side of the face. Other rare complications are nasal blockage and pain to the nerves supplying the skin between the ribs. Mortality is extremely rare, and usually attributable to low blood pressure.

## Alternatives

Nonsurgical treatments include physical therapy, medications, and avoidance of stress and cold.

## QUESTIONS TO ASK THE DOCTOR

How will a sympathectomy affect daily activities after recovery?

Is the surgeon board certified?

What alternative procedures are available?

How many sympathectomy procedures has the surgeon performed?

What is the surgeon's complication rate?

These measures reduce or remove the likelihood of triggering a problem mediated by the sympathetic nervous system.

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American College of Surgeons. 633 North St. Clair Street, Chicago, IL 60611 32311. (312) 02 5000. Fax: (312) 202 5001. E mail: [postmaster@facs.org](mailto:postmaster@facs.org). <http://www.facs.org/>.

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Syndactyly surgery see **Webbed finger or toe repair**

## Syringe and needle

### Definition

Syringes and needles are sterile devices used to inject solutions into or withdraw secretions from the body. A syringe is a calibrated glass or plastic cylinder with a plunger at one and an opening that attaches to a needle. The needle is a hollow metal tube with a pointed tip.

### Purpose

A syringe and needle assembly is used to administer drugs when a small amount of fluid is to be injected; when a person cannot take the drug by mouth; or when the drug would be destroyed by digestive secretions. A syringe and needle may also be used to withdraw various types of body fluids, most commonly tissue fluid from swollen joints or blood from veins.

### Description

The modern hypodermic needle was invented in 1853 by Alexander Wood, a Scottish physician, and independently in the same year by Charles Pravaz, a French surgeon. As of 2003, there are many different



types and sizes of syringes used for a variety of purposes. Syringe sizes may vary from 0.25 mL to 450 mL, and can be made from glass or assorted plastics. Latex-free syringes eliminate the exposure of health care professionals and patients to allergens to which they may be sensitive. The most common type of syringe is the piston syringe. Pen, cartridge, and dispensing syringes are also extensively used.

One common type of syringe consists of a hollow barrel with a piston at one end and a nozzle at the other end that connects to a needle. Other syringes have a needle already attached. These devices are often used for subcutaneous injections of insulin and are single-use (i.e., disposable). Syringes have markings etched or printed on their sides, showing the graduations (i.e., in milliliters) for accurate dispensing of drugs or removal of body fluids. Cartridge syringes are intended for multiple uses, and are often sold in kits containing a pre-filled drug cartridge with a needle inserted into the piston syringe. Syringes may also have anti-needlestick features, as well as positive stops that prevent accidental pullouts.

There are three types of nozzles:

- Luer-lock, which locks the needle onto the nozzle of the syringe.
- Slip tip, which secures the needle by compressing the slightly tapered hub onto the syringe nozzle.
- Eccentric, which secures with a connection that is almost flush with the side of the syringe.

A hypodermic needle is a hollow metal tube, usually made of stainless steel and sharpened at one end. It has a female connection at one end that fits into the male connection of a syringe or intravascular administration set. The size of the diameter of the needle ranges from the largest gauge (13) to the smallest (27). The length of the needle ranges from 3.5 inches (8 cm) for the 13-gauge to 0.25 inch (0.6 cm) for the 27-gauge. The needle consists of a hub with a female connection at one end that attaches to the syringe. The bevel, which is a slanted opening on one side of the needle tip, is located at the other end.

Needles are almost always disposable. Reusable needle assemblies are available for home use.

### *Operation*

Syringes and needles are used for injecting or withdrawing fluids from a person. The most common procedure for removing fluids is venipuncture or drawing blood from a vein. In this procedure, the syringe and a needle of the proper size are used with a vacutainer. A vacutainer is a tube with a rubber top

## KEY TERMS

**Aseptic**—Free from infection or diseased material; sterile.

**Bevel**—The slanted opening on one side of the tip of a needle.

**Hypodermic**—Applied or administered beneath the skin. The modern hypodermic needle was invented to deliver medications below the skin surface.

**Piston**—The plunger that slides up and down inside the barrel of a syringe.

**Sharps**—A general term for needles, lancets, scalpel blades, and other medical devices with points or sharp edges requiring special disposal precautions.

**Sterile**—Free from living microorganisms.

**Subcutaneous**—Beneath the skin.

**Vacutainer**—A tube with a rubber top from which air has been removed.

**Z-track injection**—A special technique for injecting a drug into muscle tissue so that the drug does not leak (track) into the layers of tissue just beneath the skin.

from which air has been removed. Fluids enter the container without pressure applied by the person withdrawing the blood. A vacutainer is used to collect blood as it is drawn. The syringe and needle can be left in place while the health care provider changes the vacutainer, allowing for multiple samples to be drawn during a single procedure.

Fluids can be injected by intradermal injection, subcutaneous injection, intramuscular injection, or Z-track injection. For all types of injections, the size of syringe should be chosen based on the amount of fluid being delivered; the gauge and length of needle should be chosen based on the size of the patient and type of medication. A needle with a larger gauge may be chosen for drawing up the medication into the syringe, and a smaller-gauge needle used to replace the larger one for administering the injection. Proper procedures for infection control should be strictly followed for all injections.

### *Maintenance*

Syringes and needles are normally sterile products and should be stored in appropriate containers. Care should be taken prior to using them. The care provider should ensure that the needles have not been blunted and that the packaging is not torn, as poor handling or

storage exposes the contents to air and allows contamination by microorganisms.

### Safety

All health care personnel must be offered vaccines against such bloodborne infections as hepatitis B and C.

Used syringes and needles should be discarded quickly in appropriate containers. If a needlestick injury occurs, it must be reported immediately and proper treatment administered to the injured person.

### Training

Health care instructors should ensure that staff members are skilled in up-to-date methods of **aseptic technique** as well as the correct handling and use of syringes and needles. All persons administering injections should be aware of current methods of infection prevention.

Teaching the correct use of syringes and needles, as well as their disposal, is important to protect medical staff and people receiving injections from needlestick injuries and contamination from bloodborne infections. As of 2003, some of the more serious infections are human immunodeficiency virus (HIV), hepatitis B (HBV), and hepatitis C (HCV).

Needles are defined as “sharps” for purposes of public health regulation, and must be broken or otherwise “rendered unrecognizable” before being placed in a puncture-proof container labeled with the universal biohazard symbol. This precaution is intended to prevent drug addicts from reusing the needles as well as to protect the hospital environment from contamination by medical waste.

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- American Academy of Pediatrics. 141 Northwest Point Boulevard, Elk Grove Village, IL 60007 1098. (847) 434 4000. Fax: (847) 434 8000. E mail: kidsdoc@aap.org. www.aap.org.
- American College of Physicians. 190 N. Independence Mall West, Philadelphia, PA 19106 1572. (800) 523 1546, x2600 or (215) 351 2600. www.acponline.org.
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# T

T-PA see **Thrombolytic therapy**

## Talking to the doctor

### Definition

Talking to the doctor is a fundamental requirement for an accurate exchange of information between patient and healthcare provider. It includes communicating private or potentially sensitive information, and requires a climate of trust. Without trust and accurate information, treatment and healing are difficult at best and impossible at worst.

### Purpose

The purpose of talking to a doctor is to exchange information and obtain a cure or relief from pain and suffering. This outcome can only occur in an atmosphere of openness and mutual confidence.

### Description

Talking is a basic human mode of communication. Talking to a doctor should be easy, but for many people, this is not the case. Barriers to straightforward communication include inhibition (shyness), fear, and guilt. These barriers may be present whether the patient is an adult who can speak for him- or herself or a child or elderly person whose history and symptoms must be described by another family member.

### Inhibition

People often hold physicians in high regard. The stated reason for this feeling is a difference in educational level. Doctors have more educational credentials than most people in the general population. This differential tends to make patients self-conscious and hesitant to offer information.

Inhibition is further fueled by the sense of hurry and urgency that many health professionals project. Patients feel uncomfortable when they sense that they are being rushed by their doctor. As a result, they are reluctant to speak freely.

### *Fear*

Apart from vaccinations or routine physical checkups, people in the United States do not ordinarily visit a doctor when they are well. The norm is to make an appointment when something hurts or does not function or feel right. It is natural for people to feel anxious in these circumstances—they are afraid of receiving bad news.

### *Guilt*

Many patients' health complaints are often the direct consequences of their own behavior. Obesity often results from a combination of overeating and inadequate **exercise**. The leading cause of lung cancer is smoking tobacco. Casual sex can lead to unwanted pregnancies and sexually transmitted diseases. Having to accept responsibility for choices that lead to undesirable consequences is painful. Having to tell a person who is an authority figure as well as a trusted confidant often arouses guilt feelings.

### *Establishing trust*

Trust requires time to develop, but it is also a two-way interaction. People seeking the advice of a doctor may reveal only a portion of their symptoms at first. While it is the doctor's task to elicit relevant information, the patient who is answering the questions must be open.

Doctors often assume that patients do not give completely honest answers. Women typically understate their body weight, while men overstate their strength. Smokers rarely admit to the true number of cigarettes that they smoke per day. Drinkers underestimate the amount of alcohol that they consume.



## Preparation

Important elements of any doctor-patient conversation are honesty and openness. Some people may have to make a conscious decision to be open with their doctors. To avoid wasting time and feeling pressured, people should decide to be completely frank before they enter a doctor's office. In addition, inaccurate or incomplete information may lead the doctor to make an incorrect diagnosis or treatment decision.

Bringing records from visits to other healthcare providers is very useful to a doctor. People who have known their doctors for long periods of time are a steadily shrinking minority. Providing a new doctor with copies of one's medical history saves time and usually improves diagnostic accuracy. For example, old photographs are especially invaluable when evaluating skin problems.

## Results

The passage of time, repeated positive interactions, and good outcomes from the information provided by the patient help to establish mutual trust. Trust then enhances the therapeutic interaction. The result may well be better health for the patient.

Preventive care should be part of the interaction between doctor and patient. A frank exchange of information is one form of prevention. If a conversation with one's doctor accomplishes nothing else, it will reduce inhibition, fear and guilt.

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## Tarsorrhaphy

### Definition

Tarsorrhaphy is a rare procedure in which the eyelids are partially sewn together to narrow the opening.

## KEY TERMS

**Cornea**—The clear part of the front of the eye through which vision occurs.

**Enophthalmos**—A condition in which the eye falls back into the socket and inhibits proper eyelid function.

**Exophthalmos**—A condition in which the eyes bulge out of their sockets and inhibit proper eyelid function.

**Palpebral fissure**—Eyelid opening.

**Sjögren's syndrome**—A connective tissue disease that hinders the production of tears and other body fluids.

## Purpose

The eye needs the lid for protection. It also needs tears and periodic blinking to cleanse it and keep it moist. There are many conditions that impair these functions and threaten the eye, specifically the cornea, with drying. Sewing the eyelids partially together helps protect the eye until the underlying condition can be corrected.

A partial list of the conditions that can require tarsorrhaphy includes:

- Paralysis or weakness of the eyelids so that they cannot close or blink adequately. Bell's palsy is a nerve condition that weakens the muscles of the face, including the eyelids. It is usually temporary. Myasthenia gravis also weakens facial muscles, but it is usually treatable. A stroke can also weaken eyelids so that they do not close.
- Exophthalmos (eyes bulging out of their sockets) occurs with Graves' disease of the thyroid, and with tumors behind the eyes. If the eyes bulge out too far, the lids cannot close over them.
- Enophthalmos is a condition in which the eye falls back into the socket, making the eyelid ineffective.
- Several eye and corneal diseases cause swelling of the cornea, and require temporary added protection until the condition resolves.
- Sjögren's syndrome reduces tear flow to the point where it can endanger the cornea.
- Dendritic ulcers of the cornea caused by viruses may need to be covered with the eyelid while they heal.

## Demographics

People of all ages can suffer from paralysis or corneal diseases that may benefit from tarsorrhaphy.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Ophthalmologists perform the procedure on an outpatient basis in a hospital, or sometimes in their offices.

For that reason, physicians can perform tarsorrhaphy on patients of any age. However, it is viewed as a last alternative for many patients, and is not indicated until after other treatments (e.g., patching and eye ointments) have been attempted.

## Description

**Stitches** are carefully placed at the corners of the eyelid opening (palpebral fissure) to narrow it. This provides the eye with improved lubrication and less air exposure. Eyeball motion can help bathe the cornea in tears when it rolls up under the lid. The outpatient procedure is done under local anesthetic.

## Diagnosis/Preparation

The use of eye drops and contact lenses to moisten and protect the eyes must be considered before tarsorrhaphy is performed. Tarsorrhaphy is a minor procedure done under **local anesthesia**. Special preparation is not necessary.

## Aftercare

Patients should avoid rubbing the eye and refrain from wearing make-up until given permission from the physician. Driving should be restricted until approval from the ophthalmologist.

Pathways in the home should be cleared of obstacles, and patients should be aware of peripheral vision loss. They will need to compensate by turning their head fully when looking at an object.

An analgesic may be used to ease pain, but severe pain is not normal, and the physician must be alerted. Sutures will be removed in two weeks.

Eye drops or ointment may still be needed to preserve the cornea or treat accompanying disease.

## Risks

Tarsorrhaphy carries few risks. Complications may include minor eyelid swelling and superficial infection.

## QUESTIONS TO ASK THE DOCTOR

How long will the eyes be closed with sutures?  
 Will it be painful?  
 Will the condition be remedied after the procedure?

### Normal results

The procedure succeeds in protecting the eye and returning moisture to dry eyes.

### Morbidity and mortality rates

This is a safe procedure. Only superficial infections have been reported.

### Alternatives

Eye drops and contact lenses are widely used to treat conditions that once warranted tarsorrhaphy. The procedure is now considered a last option for treatment.

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## Telesurgery

### Definition

Telesurgery, also called remote surgery, is performed by a surgeon at a site removed from the patient. Surgical tasks are directly performed by a robotic system controlled by the surgeon at the remote site. The word

telesurgery is derived from the Greek words *tele*, meaning “far off,” and *cheirurgia*, meaning “working by hand.”

### Description

In the early 2000s, several projects investigating the possibility and practicality of telesurgery were successful in performing complete surgical procedures on human patients from remote locations.

### Preceding technologies

Telesurgery became a possibility with the advent of laparoscopic surgery in the late 1980s. **Laparoscopy** (also called minimally invasive surgery) is a surgical procedure in which a laparoscope (a thin, lighted tube) and other instruments are inserted into the abdomen through small incisions. The internal operating field may then be visualized on a video monitor connected to the scope. In certain cases, the technique may be used in place of more invasive surgical procedures that require more extensive incisions and longer recovery times.

Computer-assisted surgery premiered in the mid-1990s; it was the next step toward the goal of remote surgery. The ZEUS Surgical System, developed in 1995 by Computer Motion, Inc., was approved by the Federal Drug Administration (FDA) in 2002 for use in general and laparoscopic surgeries with the patient and surgeon in the same room. ZEUS comprises three table-mounted robotic arms—one holding the AESOP endoscope positioner, which provides a view of the internal operating field, the others holding **surgical instruments**. The robotic arms are controlled by the surgeon, who sits at a console several meters away. Visualization of the operating field is controlled by voice activation, while the robotic arms are controlled by movements of the surgeon’s hands and wrists.

Computer-assisted surgery, which is generally called telerobotic surgery as of 2007, has a number of advantages over traditional laparoscopic surgery. The computer interface provides a method for filtering out the normal hand tremors of the surgeon. Two- and three-dimensional visualization of the operating field is possible. The surgeon can perform a maneuver on the console, review it to be sure of its safety and efficacy, then instruct the remote device to perform the task. The surgeon is also seated in an ergonomic position with arms supported by arm rests for the duration of the operation. One limitation on telerobotic surgery as of the early 2000s is the cost of the robots; the Da Vinci surgical robot, a new model with four arms, costs \$2.2 million.

### *Operation Lindbergh*

While the concept of telesurgery seems like a logical technological progression, there is a major constraint that could lead to disastrous results during surgery, namely time delay. In the case of computer-assisted surgery, the computer console and remote surgical device are directly connected by several feet (meters) of cable; there is therefore virtually no delay in the transmission of data from the console to the surgical device back to the console. The surgeon views his or her movements on the computer interface as they are happening. If the surgical system were removed to a more distant site, however, it would introduce a time delay. Visualization of the operating field could be milliseconds or even seconds behind the real-time manipulations of the surgeon. Studies showed that a delay of more than 150–200 milliseconds would be dangerous; satellite transmission, for example, would introduce a delay of more than 600 milliseconds.

In order to make telesurgery a reality, expert surgeons would need to work with the telecommunication industry to develop secure, reliable, high-speed transmission of data over large distances with imperceptible delays. In January 2000, such a project, labeled Operation Lindbergh, began under the direction of Dr. Jacques Marescaux, director of the European Institute of Telesurgery; Moji Ghodoussi, project manager at Computer Motions, Inc.; and communication experts from France Télécom. Testing began on a prototype remote system (a modified version of the ZEUS Surgical System called ZEUS TS) in September 2000, with data being relayed between Paris and Strasbourg, France—a distance of approximately 625 mi (1,000 km). Once an acceptable length of time delay was established, trials began in July 2001 between New York City and Strasbourg.

On September 7, 2001, Operation Lindbergh culminated in the first complete remote surgery on a human patient (a 68-year-old female), performed over a distance of 4,300 mi (7,000 km). The patient and surgical system were located in an **operating room** in Strasbourg, while the surgeon and remote console were situated in a high-rise building in downtown New York. A team of surgeons remained at the patient's side to step in if need arose. The procedure performed was a laparoscopic **cholecystectomy** (gall bladder removal), considered the standard of care in minimally invasive surgery. The established time delay during the surgery was 135 ms—remarkable considering that the data traveled a distance of more than 8,600 mi (14,000 km) from the surgeon's console to the surgical system and back to the console. The patient left the hospital

within 48 hours—a typical stay following laparoscopic cholecystectomy—and had an uneventful recovery.

Limitations that still need to be overcome in order to make telesurgery more widely available include the establishment of international compatibility of equipment and training to overcome linguistic difficulties. Another concern is the need for a backup human surgeon at the remote location in case the robot malfunctions or there is an interruption in telecommunications.

### *Applications*

Operation Lindbergh has paved the way for wide-ranging applications of telesurgery technology. On February 28, 2003, the first hospital-to-hospital telerobotic-assisted surgery took place in Ontario, Canada, over a distance of 250 mi (400 km). Two surgeons worked together to perform a Nissen fundoplication (surgery to treat chronic acid reflux), with one situated at the patient's side and the other controlling a robotic surgical system from a remote hospital site. Such a scenario may eventually allow surgeons in rural areas to receive expert assistance during minimally invasive procedures. Since the first telesurgery in Canada, Dr. Mehran Anvari, the founder of the Centre for Minimal Access Surgery (CMAS) in Ontario, has performed a number of remote surgeries between St. Joseph's Hospital in Hamilton, Ontario, and a community hospital in North Bay, about 250 miles from Hamilton. Dr. Anvari uses a virtual private network (VPN) over a non-dedicated fiber-optic connection that shares bandwidth with regular telecommunications data.

Other applications of telesurgery include:

- Training new surgeons. CMAS has developed a program in advanced minimal access surgery for Canadian surgeons, which combines lectures, laboratory sessions, and live surgery. As of 2007, about 160 surgeons have completed the program.
- Assisting and training surgeons in developing countries.
- Treating injured soldiers on or near the battlefield.
- The expanded use of telerobotic surgery. Telerobotic surgery offers the advantages of allowing surgery to be performed during an epidemic (such as the SARS outbreak of 2002–2003) without having to bring patients from remote and uninfected communities into cities affected by the epidemic.
- Performing surgical procedures in space or underwater. CMAS joined forces in 2006 with the National Aeronautics and Space Administration (NASA), the U.S. Army Telemedicine and Advanced Technology Research Center (TATRC), and the National Space



Biomedical Research Institute (NSBRI) to work on NASA's Extreme Environment Mission Operation 9, or NEEMO 9. Dr. Anvari at CMAS tested remote surgery with a next-generation surgical robot and a patient simulator in the Aquarius Undersea Habitat, an underwater laboratory operated by the National Undersea Research Center at the University of North Carolina at Wilmington (UNCW) for the National Oceanic and Atmospheric Administration (NOAA). The laboratory is located on the ocean floor off Key Largo in the Florida Keys, 70 feet beneath the surface. The mission lasted 18 days. A two-second time delay was built into the telecommunications system to simulate the time delay that would be present in a manned lunar exploration mission.

- Collaborating and mentoring during surgery by surgeons around the globe. Telementoring has been used in Canada since 2004 with financial assistance from a government partnership program. Telementoring involves an experienced surgeon in an advanced treatment facility in a major city using a two-way telecommunications link to guide the remote surgeon during an operation.

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## Temperature measurement

### Definition

Temperature measurement is the quantification of a person's **body temperature**, which is an important indicator of a person's physiological state. Temperature measurement is done to assess whether body temperature is within a narrow, safe range. An abnormally high temperature is a fever, a sign that the body is mounting an immune response.

### Description of Body Temperature

Normal body temperature varies from person to person. Gender, age, recent physical activity, having a meal, and the menstrual cycle all affect body temperature within the normal range. Body temperature measurement also varies based on which part of the body it is taken from. The average normal body temperature is 98.6°F (37°C) when taken orally. However, body temperature may vary slightly more than one degree higher or lower and still be in the normal range. Normal body temperature can range from 97

to 100°F (36.1 to 37.8°C). A temperature higher than normal is considered a fever (hyperthermia). A temperature lower than 96°F is considered a state of hypothermia. Temperature varies with the age of a person. Younger people tend to have higher body temperatures. Temperature also varies by the time of day it is taken. Body temperature is usually lowest in the morning and highest in the evening. Temperature can also be elevated by **exercise**, stress or strong emotions, eating food, heavy clothing, certain medications, or high room temperature. All of these factors need to be taken into account when temperature is measured because they affect the interpretation of temperature-measurement results.

### Locations for Body Temperature Measurement

#### *Oral*

Temperature is often measured orally by placing a **thermometer** in the heat pocket under the tongue in the back of the mouth. The mouth is closed and the patient breathes through their nose for several minutes until the temperature is measured. Oral temperatures that are 1 to 1.5°F above a patient's normal body temperature are considered a fever.

#### *Rectal*

The most accurate method of assessing body temperature is rectally using a glass or electronic digital thermometer. A lubricated electronic probe is inserted about 1 to 1.5 inches into the anal canal. Normal rectal temperature is usually 0.5 to 1.0°F higher than oral temperature. A rectal body temperature above 100.5°F is considered a fever in adults. In infants and children, a normal rectal temperature may approach 101°F. Rectal temperature measurement is a convenient alternative for patients who are unable to hold an oral thermometer in a closed mouth due to illness or being unconscious. It is also used for infants or very young children who cannot safely hold a thermometer in their mouth.

#### *Armpit*

Another temperature measurement method sometimes employed by pediatricians is placing a thermometer in the armpit. While less invasive than rectal temperature measurement, this location is the least accurate and takes the longest time to measure. Normal temperature in the armpit tends to be 0.5 to 1.0°F lower than oral temperature.

#### *Ear*

Thermometers made for the ear can be used to assess the body's core temperature, which approximates the temperature of the internal organs. Ear thermometers may measure the temperature of the eardrum or the ear canal. Normal ear temperature tends to be about 1.4°F higher than oral temperature.

### Why Temperature is Measured in the Hospital

Temperature measurement is done to monitor a person's body temperature. Body temperature, heart rate, breathing rate, and blood pressure are all considered **vital signs**. If body temperature is abnormal, it is an important indicator of the physiological state of the body. A fever is the body mounting an immune defense against a foreign invader to help fight infection or disease. A fever can be a critical sign that the body is fighting a battle, such as a post-surgical bacterial infection or cancer. It can also be used to assess whether a treatment is working, such as in antibiotic treatment of infections. The extent of a fever does not necessarily correlate with the severity of the illness. However, temperature measurement is still an important tool used in the hospital to monitor a patient's health.

Measuring and monitoring body temperature can be done at specific time points in the process of diagnosing and treating illness. Physicians sometimes use repeated temperature measurements to follow patterns in body temperature such as how frequently a fever occurs and how long it lasts. These measurements may provide diagnostic insights into body processes during illness. Temperature measurement is especially important for the management of a critically ill patient, where trends in body temperature are significant. Careful temperature measurement is also essential in the health management of elderly people. Because the elderly may have difficulty mounting a high fever as an immune response against infection, a low-grade fever is often the only early sign that something is wrong. Elderly people are also more prone to hypothermia than younger individuals.

### How Temperature is Measured

#### *Mercury Thermometers*

Traditionally temperature was measured orally with a graded glass thermometer containing mercury. The level to which the mercury would rise on the graded scale was an indication of temperature. According to the Environmental Protection Agency (EPA), mercury is a toxic substance that is poisonous to both

humans and the environment. The dangers associated with mercury if the thermometer breaks in a patient's body and the cost of disposing of mercury led to the development of modern mercury-free thermometers that do not pose such health risks.

### *Electronic Digital Thermometers*

Digital thermometers with an electronic probe are far more accurate at measuring body temperature than the old mercury thermometers. They are usually a lightweight plastic and shaped like a broad pencil, with the electronic temperature probe at the tip. A digital temperature display window at the other end measures temperature down to a tenth of a decimal point. Electronic thermometers are designed for use in the mouth, rectum, or armpit. Rectal thermometers may have a colored probe to help distinguish them from silver-tipped oral thermometers. They are accurate and easy to use in the hospital. In addition to antiseptic, disposable protective guards are often used to cover the probe to help prevent the spread of infection between patients.

### *Infrared Ear Thermometers*

Digital ear thermometers use infrared energy to measure body temperature instead of an electronic probe. They are made in different shapes. One design has a small cone-shaped end that is placed within the ear. An infrared beam is then aimed at the eardrum. Ear thermometers only take seconds to measure body temperature, whereas other types of thermometers require minutes for accurate temperature measurement.

### *Disposable Thermometers*

Hospitals often use disposable thermometers to decrease risk of transmitting infection from patient to patient. Disposable thermometers are thin pieces of plastic with a colored grid of dots representing temperature on one end. The color change displayed in the grid is how temperature measurement is visualized. Disposable thermometers are accurate and safe since they contain no glass or mercury. One thermometer can be reused on the same patient until it is no longer needed. Disposable thermometers are designed for use in the mouth, armpit, or rectum. A disposable thermometer in patch form has been designed for use on infants whose temperature needs to be monitored for long periods of time.

## **When Temperature is Measured**

In the hospital routine temperature measurement takes place twice a day. The first measurement is

usually done in the morning between 7 and 10 am. The second measurement takes place in the afternoon around 2 pm. If a patient is suspected to have an illness causing fever or is critically ill, temperature measurement may be performed up to four times an hour to closely monitor the situation. Interpretation of temperature measurement is influenced by when the measurement is taken. In the early morning, normal adult body temperature may be as low as 96.4°F (35.8°C). In the evening normal temperature may be as high as 99.1°F (37.3°C).

## **What Abnormal Results of Temperature Measurement Mean**

An abnormally high body temperature means that the patient has a fever. Fever is not an illness itself but rather a defense mechanism of the body to fight disease or infection. Higher body temperatures are less hospitable for most bacteria and viruses, and also allow the body's immune system to mobilize against disease more readily. However, if the body temperature is raised too high for a prolonged period of time, then fever may pose a threat to the body. In infants and children, a very high fever may occur even in response to minor infections.

### **Abnormally High Body Temperature Potential Causes**

- Infection by Bacteria, Viruses, or Parasites
- Medications
- Response to Surgical Procedures without having an Infection
- Drugs used during Surgery
- Metabolic Disorders such as Hyperthyroidism
- Heat Stroke
- Extreme Dehydration
- Cancer
- Inflammatory Conditions and Autoimmune Disorders
- Physical Trauma
- Certain Blood Disorders

### **Abnormally Low Body Temperature Potential Causes**

- Hypothermia from Cold Exposure
- Medications
- Metabolic Disorders such as Hypothyroidism
- Excessive Alcohol Intake
- Starvation

## KEY TERMS

**Autoimmune Disorders**—Disorder in which the immune system mounts a response against some aspect of its own body.

**Hypothermia**—State of abnormally low body temperature that can be fatal if left untreated.

**Hyperthyroidism**—Disease of the thyroid gland involving overproduction of thyroid hormones. Hyperthyroidism affects body temperature.

**Hypothyroidism**—Disease of the thyroid gland involving underproduction of thyroid hormones. Hypothyroidism affects body temperature.

**Immune Response**—Any response of the immune system against something identified by the immune system as being foreign.

**Infrared**—A type of energy wave given off as heat.

**Physiological State**—The status of the normal vital life functions of a living organism.

**Vital Signs**—The physiological aspects of body function basic to life. They are temperature, pulse, breathing rate, and blood pressure.

## Resources

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Maria Basile, PhD

## Tendon repair

### Definition

Tendon repair refers to the surgical repair of damaged or torn tendons, which are cord-like structures made of strong fibrous connective tissue that connect muscles to bones. The shoulder, elbow, knee, and ankle are the joints most commonly affected by tendon injuries.

### Purpose

The goal of tendon repair is to restore the normal function of joints or their surrounding tissues following a tendon laceration.

### Demographics

Tendon injuries are widespread in the general adult population. They are more common among people whose occupations or recreational athletic activities require repetitive motion of the shoulder, knee, elbow, or ankle joints. Injuries to the tendons in the shoulder often occur among baseball players, window washers, violinists, dancers, carpenters, and some assembly line workers. Rowers are at increased risk for injuries to the forearm tendons. The repetitive stresses of classical ballet, running, and jogging may damage the Achilles tendon at the back of the heel. So-called tennis elbow, which occurs in many construction workers, highway crews, maintenance workers, and baggage handlers as well as professional golfers and tennis players, is thought to affect 5% of American adults over the age of 30.

Women in all age brackets are at greater risk than men for injuries to the tendons in the elbow and knee joints. It is thought that injuries in these areas are related to the slightly greater looseness of women's joints compared to those in men.

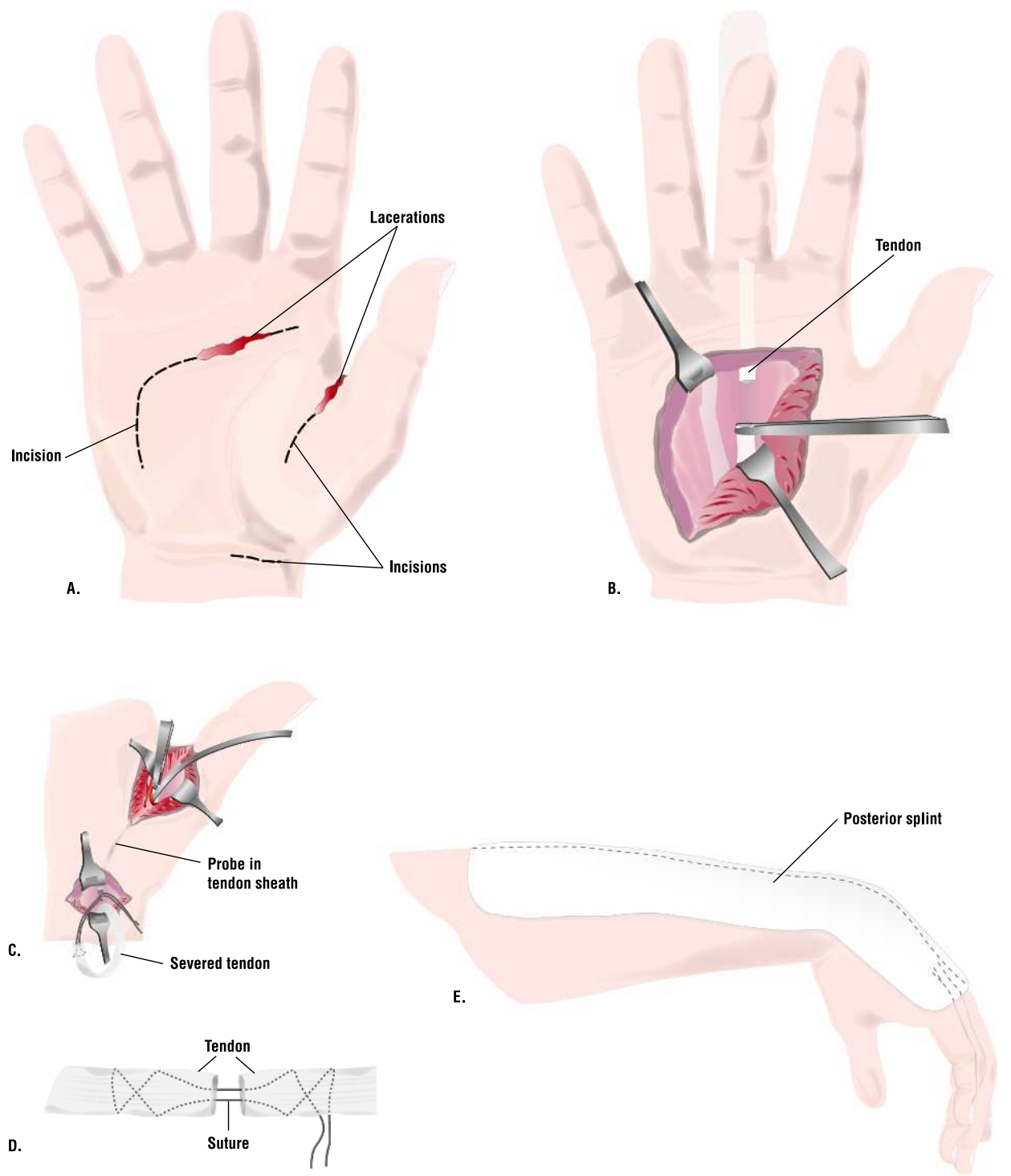
### Description

Local, regional or **general anesthesia** is administered to the patient depending on the extent and location of tendon damage. With a general anesthetic, the patient is asleep during surgery. With a regional anesthetic, a specific region of nerves is anesthetized; with a local anesthetic, the patient remains alert during the surgery, and only the incision location is anesthetized.

After the overlying skin has been cleansed with an antiseptic solution and covered with a sterile drape, the surgeon makes an incision over the injured tendon. When the tendon has been located and identified, the surgeon sutures the damaged or torn ends of the tendon together. If the tendon has been severely injured, a tendon graft may be required. This is a procedure in which a piece of tendon is taken from the foot or other part of the body and used to repair the damaged tendon. If required, tendons are reattached to the surrounding connective tissue. The surgeon inspects the area for injuries to nerves and blood vessels, and closes the incision.



## Tendon repair



To repair a torn tendon, incisions are made to expose the area for repair (A). Some tendon can be reattached through one incision (B), while others require two to access the severed point and the remaining tendon (C). A special splint that minimizes stretching the tendons may be worn after surgery (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Anesthesia**—Loss of normal sensation or feeling induced by anesthetic drugs.

**Collagen**—Any of a group of about 14 proteins found outside cells. Collagens are a major component of connective tissue, providing its characteristic strength and flexibility.

**Contracture**—A condition of high resistance to the passive stretching of a muscle, resulting from the formation of fibrous tissue in a joint or from a disorder of the muscle tissue itself.

**Fibroblast**—A type of cell found in connective tissue involved in collagen production as well as tendon formation and healing.

**Laceration**—A physical injury that results in a jagged tearing or mangle of the skin.

**Meniscus (plural, menisci)**—One of two crescent-shaped pieces of cartilage attached to the upper surface of the tibia. The menisci act as shock absorbers within the knee joint.

**Prolotherapy**—A technique for stimulating collagen growth in injured tissues by the injection of glycerin or dextrose.

**Tendon**—A fibrous cord of strong connective tissue that connects muscle to bone.

## Diagnosis/Preparation

Diagnosis of a tendon injury is usually made when the patient consults a doctor about pain in the injured area. The doctor will usually order radiographs and other imaging studies of the affected joint as well as taking a history and performing an external **physical examination** in the office. In some cases, fluid will be aspirated (withdrawn through a needle) from the joint to check for signs of infection, bleeding, or arthritis.

In the hours prior to surgery, the patient is asked not to eat or drink anything, even water. A few days before the operation, patients are also instructed to stop taking such over-the-counter (OTC) pain medications as **aspirin** or ibuprofen. If the patient has a splint or cast, it is removed before surgery.

To prepare for surgery, the patient typically reports to a preoperative nursing unit. Next, the patient is taken to a preoperative holding area, where an anesthesiologist administers an intravenous sedative. The patient is then taken to the **operating room**.

## Aftercare

Healing may take as long as six weeks, during which the injured part may be immobilized in a splint or cast. Patients are asked not to use the injured tendon until the physician gives permission. The physician will decide how long to rest the tendon. It should not be used for lifting heavy objects or walking. Patients are also asked to avoid driving until the physician gives the go-ahead. To reduce swelling and pain, they should keep the injured limb lifted above the level of the heart as much as possible for the first few days after surgery.

Splints or **bandages** should be left in place until the next checkup. Patients are advised to keep bandages clean and dry. If patients have a cast, they are asked not to get it wet. Fiberglass casts that get wet may be dried with a hair dryer. Patients are also instructed not to push or lean on the cast to avoid breaking it. If patients have a splint that is held in place with an Ace bandage, they are instructed to ensure that the bandage is not too tight. They are also asked to ensure that splints remain in exactly the same place. Medications prescribed by the doctor should be taken exactly as directed. Patients who have been given **antibiotics** should take the complete course even if they feel well; this precaution is needed to minimize the risk of drug resistance developing in the disease organism. If patients are taking medicine that makes them feel drowsy, they are advised against driving or using heavy equipment.

Aftercare may also include physical therapy for the affected joint. There are a variety of exercises, wraps, splints, braces, bandages, ice packs, massages, and other treatments that physical therapists may recommend or use in helping a patient recover from tendon surgery.

## Risks

Tendon repair surgery includes the risks associated with any procedure requiring anesthesia, such as reactions to medications and breathing difficulties. Risks associated with any surgery are also present, such as bleeding and infection. Additional risks specific to tendon repair include formation of scar tissue that may prevent smooth movements (adequate tendon gliding), nerve damage, and partial loss of function in the involved joint.

## Normal results

Tendon injuries represent a difficult and frustrating problem. Conservative treatment has little if any

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Tendon repairs are usually performed in an outpatient setting. Hospital stays, if any, are short no longer than a day. Tendon repairs are performed by orthopedic surgeons. Orthopedics is the medical specialty that focuses on the diagnosis, care and treatment of patients with disorders of the bones, joints, muscles, ligaments, tendons, nerves and skin.

chance of restoring optimal range of motion in the injured area. Even after surgical repair, a full range of motion is usually not achieved. Permanent loss of motion, joint contractures, and weakness and stiffness may be unavoidable. Scar tissue tends to form between the moving surfaces within joints, resulting in adhesions that hamper motion. The surgical repair may also split apart or loosen. Revision surgery may be required to remove scar tissue, insert tendon grafts, or perform other reconstructive procedures. Thus, successful tendon repair depends on many factors. Recovery of the full range of motion is less likely if there is a nerve injury or a broken bone next to the tendon injury; if a long period of time has elapsed between the injury and surgery; if the patient's tissues tend to form thick scars; and if the damage was caused by a crush injury. The location of the injury is also an important factor in determining how well a patient will recover after surgery.

### Morbidity and mortality rates

Mortality rates for tendon repairs are very low, partly because some of these procedures can be performed with local or regional anesthesia, and partly because most patients with tendon injuries are young or middle-aged adults in good general health. Morbidity varies according to the specific tendon involved; ruptures of the Achilles tendon or shoulder tendons are more difficult to repair than injuries to smaller tendons elsewhere in the body. In addition, some postoperative complications result from patient non-compliance; in one study, two out of 50 patients in the study sample had new injuries within three weeks after surgery because they did not follow the surgeon's recommendations. In general, tendon repairs performed in the United States are reported as having an infection rate of about 1.9%, with other complications ranging between 5.8% and 9.5%.

## QUESTIONS TO ASK THE DOCTOR

- What happens on the day of surgery?
- What type of anesthesia will be used?
- How long will it take to recover from the surgery?
- Can I expect normal flexibility in the affected area?
- What are the risks associated with tendon repair surgery?
- How many tendon repair procedures do you perform in a year?
- Will there be a scar?

### Alternatives

There are no alternatives to surgery for tendon repair as of 2008; however, research is providing encouraging findings. Although there is no presently approved drug that targets this notoriously slow and often incomplete healing process, a cellular substance recently discovered at the Lawrence Berkeley National Laboratory may lead to a new drug that would improve the speed and durability of healing for injuries to tendons and ligaments. The substance, called Cell Density Signal-1, or CDS-1, by its discoverer, cell biologist Richard Schwarz, acts as part of a chemical switch that turns on procollagen production. Procollagen is a protein manufactured in large amounts by embryonic tendon cells. It is transformed outside the cell into collagen, the basic component of such connective tissues as tendons, ligaments or bones. Amgen Inc. is planning to use genetic engineering to bring CDS-1 into mass production.

Prolotherapy represents a less invasive alternative to surgery. It is a form of treatment that stimulates the repair of injured or damaged structures. It involves the injection of dextrose or natural glycerin at the exact site of an injury to stimulate the immune system to repair the area. Thus, prolotherapy causes an inflammatory reaction at the exact site of injuries to such structures as ligaments, tendons, menisci, muscles, growth plates, joint capsules, and cartilage to stimulate these structures to heal. Specifically, prolotherapy causes fibroblasts to multiply rapidly. Fibroblasts are the cells that actually make up ligaments and tendons. The rapid production of new fibroblasts means that strong, fresh collagen tissue is formed, which is what is needed to repair injuries to ligaments or tendons.

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- American Academy of Orthopaedic Surgeons (AAOS). 6300 North River Road, Rosemont, Illinois 60018 4262. (847) 823 7186; (800) 346 AAOS. <http://www.aaos.org> (accessed April 10, 2008).
- American Physical Therapy Association (APTA). 1111 North Fairfax Street, Alexandria, VA 22314. (703) 684 APTA or (800) 999 2782. <http://www.apta.org> (accessed April 10, 2008).

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Monique Laberge, Ph D

## Tenotomy

### Definition

Tenotomy is the cutting of a tendon. This and related procedures are also called tendon release, tendon lengthening, and heel-cord release (for tenotomy of the Achilles tendon).



**A baby with club foot: a candidate for tenotomy surgery.**  
(Medical-on-Line / Alamy)

### Purpose

Tenotomy is performed in order to lengthen a muscle that has developed improperly, or become shortened and is resistant to stretch.

Clubfoot is a common developmental deformity in which the foot is turned inward, with shortening of one or more of the muscles controlling the foot and possibly some bone deformity as well.

A muscle can become shortened and resistant to stretch when it remains in a shortened position for many months. When this occurs, the tendon that attaches muscle to bone can shorten, and the muscle itself can develop fibrous tissue within it, preventing it from stretching to its full range of motion. This combination of changes is called contracture.

Contracture commonly occurs in upper motor neuron syndrome, following spinal cord injury, traumatic brain injury, stroke, multiple sclerosis, or cerebral palsy. Damage to the nerves controlling muscles lead to an imbalance of opposing muscle forces across a joint, which may allow one muscle to pull harder than another. For instance, excess pull from the biceps, unless opposed by the triceps, can bend the elbow joint. If the shortened bicep remains in this position, it will develop contracture, becoming resistant to stretching. Tenotomy is performed to lengthen the tendon, allowing the muscle to return to its normal length and allowing the joint to straighten.

When one muscle pulls much more strongly than its opposing muscle, it may cause the joint to become partially dislocated, which is called subluxation. Tenotomy is also performed to prevent or correct subluxation, especially of the hip joint in cerebral palsy.



Chronic pain or bone deformity may prevent a person from moving a joint through its full range of motion, leading to contracture.

Contracture also occurs in a variety of neuromuscular diseases, including muscular dystrophies and polio. Degeneration of one muscle can allow the opposing muscle to pull too hard across the joint, shortening the muscle.

### Demographics

Tenotomy is performed in infants with clubfoot, and in older patients who develop contractures or subluxations from neuromuscular disease, the upper motor neuron syndrome, or other disorders.

### Description

During a tenotomy, the tendon is cut entirely or part-way through, allowing the muscle to be stretched. Tenotomy may be performed through the skin (percutaneous tenotomy) or by surgically exposing the tendon (open tenotomy). The details of the operation differ for each tendon.

During a percutaneous lengthening of the Achilles tendon, a thin blade is inserted through the skin to partially sever the tendon in two or more places. This procedure is called a Z-plasty, and is very rapid, requiring only a few minutes. It may be performed under **local anesthesia**.

More severe contracture may be treated with an open procedure. In this case, the tendon may be cut lengthwise, and the two pieces joined lengthwise to form a single longer tendon. This procedure takes approximately half an hour. This type of tenotomy is usually performed under **general anesthesia**.

If multiple joints are to be treated (for example, ankle, knee, and hip), these are often performed at the same time.

### Diagnosis/Preparation

Patients requiring tenotomy are those with contracture or developmental deformity leading to muscle shortening that has not responded sufficiently to treatment with casts, splints, stretching exercises, or medication. Tests performed before surgery include determining the range of motion of the joint involved, and possibly x rays to determine if there is a bone deformity impeding movement or subluxation.

Patients undergoing general anesthesia will probably be instructed not to eat anything for up to 12 hours before the procedure.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Tenotomy is performed by an orthopedic surgeon in a hospital.

### Aftercare

After tenotomy, the patient may receive pain medication. This may range from over-the-counter (OTC) **aspirin** to intravenous morphine, depending on the severity of the pain. Ice packs may also be applied. The patient will usually spend the night in the hospital, especially children with swallowing or seizure disorders, who need to be monitored closely after anesthesia.

Casts are applied to the limb receiving the surgery. Before the cast is applied, the contracted muscle is stretched to its normal or near-normal extension. The cast then holds it in that position while the tendon regrows at its extended length. Braces or splints may also be applied.

After the casts come off (typically two to three weeks), intensive physical therapy is prescribed to strengthen the muscle and keep it stretched out.

### Risks

Tenotomy carries a small risk of excess bleeding and infection. Tenotomy performed under general anesthesia carries additional risks associated with the anesthesia itself.

### Normal results

Tenotomy allows the muscle to stretch out, providing more complete range of motion to the affected joint. This promotes better posture and movement and may improve the ability to walk, stand, reach, or perform other activities, depending on the location of the procedure. Pain may be reduced as well. Clubfoot is usually completely fixed by proper treatment. Contracture and subluxation may be only partially remedied, depending on the degree of muscle shortening and fibrotic changes within the muscle before the procedure.

### Morbidity and mortality rates

Properly performed, tenotomy does not carry the risk of mortality. It may cause temporary pain and bleeding, but these are usually easily managed.

## QUESTIONS TO ASK THE DOCTOR

- How will any pain be managed?
- How long will the cast(s) stay on?
- What will the physical therapy program be like afterward?

### Alternatives

Tenotomy is usually recommended only after other treatments have failed, or when the rate and severity of contracture or subluxation progression indicates no other, more conservative treatment is likely to be effective. Aggressive stretching programs can sometimes prevent or delay development of contracture.

### Resources

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- Browner, B. D., et al. *Skeletal Trauma: Basic Science, Management, and Reconstruction*, 3rd ed. Philadelphia: Elsevier, 2003.
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Richard Robinson

Testicular cancer surgery see **Orchiectomy**

Testicular torsion repair see **Orchiopexy**

## Tetracyclines

### Definition

Tetracyclines are broad-spectrum **antibiotics** that kill bacteria, which are one-celled disease-causing microorganisms that commonly multiply by cell division. Tetracyclines are also used to treat infections caused by such subcategories of bacteria as rickettsiae and spirochetes. The older tetracyclines became less useful in the early 2000s because many bacteria have developed resistance to this group of drugs; however, a new subgroup of tetracyclines known as glycylcyclines

was introduced in June 2005 to treat infections that are resistant to other antibiotics, including the older tetracyclines. The name tetracycline comes from the four (*tetra* in Greek) hydrocarbon rings found in the chemical structure of these antibiotics.

Tetracyclines are classified as antibiotics, which are chemical substances produced by a microorganism that are able to kill other microorganisms without being toxic to the person, animal, or plant being treated. They were first discovered in the 1940s when a scientist at Lederle Laboratories isolated chlortetracycline from a bacterium in the soil known as *Streptomyces aureofaciens*; the drug was given the trade name Aureomycin. Oxytetracycline (Terramycin) was then derived from the bacterium *Streptomyces rimosus*. After the chemical structure of oxytetracycline was worked out, researchers were able to make synthetic tetracyclines in the laboratory. In the early 2000s, some tetracyclines are derived directly from a bacterium known as *Streptomyces coelicolor*, while others are made in the laboratory from chlortetracycline or oxytetracycline. One of these semi-synthetic drugs, minocycline, was used to develop tigecycline (Tygacil), the first glycylcycline to receive regulatory approval for use in the United States. Tigecycline was the first new tetracycline to be approved since the early 1980s.

### Purpose

Tetracyclines are called broad-spectrum antibiotics, because they can be used to treat a wide variety of infections. Physicians may prescribe these drugs to treat eye infections, pneumonia, gonorrhea, syphilis, chlamydia, bubonic plague, anthrax, brucellosis, malaria, Rocky Mountain spotted fever, urinary tract infections, travelers' diarrhea, Lyme disease, and other infections caused by bacteria. These drugs are also used to treat acne and rosacea (a chronic inflammatory skin condition marked by flushing and redness). Tigecycline is used to treat skin and soft-tissue infections, as well as infections inside the abdomen. The tetracyclines will not work, however, for colds, flu, and other infections caused by viruses.

### Description

Tetracyclines are available only with a physician's prescription. They are sold in capsule, tablet, liquid, and injectable forms. Some commonly used medicines in this group are tetracycline (Achromycin V, Sumycin), demeclocycline (Declomycin), minocycline (Minocin), oxytetracycline (Terramycin), and doxycycline (Doryx, Vibramycin, Vivox). Tigecycline (Tygacil) is

not available in oral form, but must be given as a slow intravenous infusion over a period of 30–60 minutes.

Tetracyclines have been used for treatment of gum infections in dental surgery. In **orthopedic surgery**, they have been used as markers to identify living bone. The patient is given a tetracycline antibiotic for several weeks prior to surgery. Some of the tetracycline is absorbed into the bone during this period. Since tetracyclines glow under ultraviolet light, this absorption helps the surgeon distinguish the living bone from the dead tissue that must be removed.

Tetracycline may also be mixed with bone cement for prevention of infection in bone surgery. In nasal surgery, tetracycline ointments are used to help prevent postsurgical infections.

### Recommended dosage

The recommended dosage depends on the specific tetracycline, its strength, and the disease agent and severity of infection for which it is being taken. Patients should check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

To make sure an infection clears up completely, patients should take the full course of antibiotic medication. It is important to not stop taking the drug just because symptoms begin to improve.

Tetracyclines are most effective at constant levels in the blood. To keep blood levels constant, the medicine should be taken in doses spaced evenly throughout the day and night. It is important to not miss any doses.

These medicines work best when taken on an empty stomach with a full glass of water. The water will help prevent irritation of the stomach and esophagus (the tube-like structure that runs from the throat to the stomach). If the medicine still causes stomach upset, the patient may take it with food. Tetracyclines should never be taken with milk or milk products, however, as these foods may prevent the drugs from working properly. Patients should not drink or eat milk or dairy products within one to two hours of taking tetracyclines (except doxycycline and minocycline).

### Precautions

There are specific warnings that apply to tetracycline preparations taken by mouth to treat infections; they do not apply to topical ointments or tetracyclines mixed with bone cement. Also, these warnings apply primarily to tetracycline itself. Some members of the tetracycline family, particularly doxycycline and

## KEY TERMS

**Antibiotic**—A chemical substance produced by a microorganism that is able to kill other microorganisms without being toxic to the host. Antibiotics are used to treat diseases in humans, other animals, and plants.

**Bacterium (plural, bacteria)**—A one-celled microorganism that typically multiplies by cell division and whose nucleus is contained within a cell wall. Most diseases treated with tetracyclines are caused by bacteria.

**Brucellosis**—An infectious disease transmitted to humans from farm animals, most commonly goats, sheep, cattle, and dogs. It is marked by high fever, pains in the muscles and joints, heavy sweating, headaches, and depression.

**Glycylcyclines**—The name of a new subgroup of tetracyclines derived from minocycline, a semi-synthetic tetracycline. As of 2007, the only drug in this class approved for use is tigecycline.

**Gonorrhea**—A sexually transmitted disease (STD) that causes infection in the genital organs and may cause disease in other parts of the body.

**Microorganism**—An organism that is too small to be seen with the naked eye.

**Orthopedics**—The medical specialty concerned with treatment of diseases of bone.

**Rickettsia (plural, rickettsiae)**—A microorganism belonging to a subtype of gram-negative bacteria that multiply only within the cells of a living host. Rickettsiae are usually transmitted to humans and other animals through the bites of ticks, fleas, and lice. They are named for Howard Ricketts (1871–1910), an American doctor.

**Rocky Mountain spotted fever**—An infectious disease that is caused by a rickettsia and spread by ticks. Its symptoms include high fever, muscle pain, and spots on the skin.

**Rosacea**—A chronic inflammatory skin condition primarily affecting the skin of the nose, forehead, and cheeks, marked by flushing and reddening of the affected areas.

**Salicylates**—A group of drugs that includes aspirin and related compounds. Salicylates are used to relieve pain and reduce inflammation or fever.

**Spirochete**—A spiral-shaped bacterium. Spirochetes cause such diseases as syphilis and Lyme disease.

minocycline, have different adverse effects and precautions. Patients should consult their physician or pharmacist about these specific drugs.

Taking outdated tetracyclines can cause serious side effects, particularly damage to the kidneys. Patients should not take these medicines when:

- the color, appearance, or taste have changed
- the drug has been stored in a warm or damp area
- the expiration date on the label has passed

Outdated tetracyclines should be thrown out. Patients should check with their physician or pharmacist if they have any doubts about the effectiveness of their drugs.

Patients should not take antacids, calcium supplements, such as salicylates as Magan or Trilisate, magnesium-containing **laxatives**, or sodium bicarbonate (baking soda) within one to two hours of taking tetracyclines. Patients should also not take any medicines that contain iron (including multivitamin and mineral supplements) within two to three hours of taking tetracyclines.

Some people feel dizzy when taking these drugs. Tetracyclines may also cause blurred vision or interfere with color vision. Because of these possible side effects, anyone who takes these drugs should not drive, use machines, or do anything else that might be dangerous until they have found out how the drugs affect them.

Birth control pills may not work properly while tetracyclines are being taken. To prevent pregnancy, women should use alternative methods of birth control while taking tetracyclines.

Tetracyclines may increase the skin's sensitivity to sunlight. Even brief exposure to sun can cause severe sunburn or a rash. During treatment with these drugs, patients should avoid exposure to direct sunlight, especially high sun between 10 A.M. and 3 P.M.; wear a hat and tightly woven clothing that covers the arms and legs; use a sunscreen with a skin protection factor (SPF) of at least 15; protect the lips with a lip balm containing sun block; and avoid the use of tanning beds, tanning booths, or sunlamps. Sensitivity to sunlight and sunlamps may continue for two weeks to several months after stopping the medicine, so patients must continue to be careful about sun exposure.

Tetracyclines may permanently discolor the teeth of people who took the medicine in childhood. The drugs may also slow down the growth of children's bones. Tetracyclines should not be given to infants or children under eight years of age unless directed by the child's physician.

### *Special conditions*

People with certain medical conditions or who are taking other medicines may have problems if they take tetracyclines. Before taking these drugs, the patient must inform the doctor about any of these conditions.

**FOOD OR MEDICATION ALLERGIES.** Anyone who has had unusual reactions to tetracyclines in the past should inform his or her physician before taking the drugs again. The physician should also be told about any allergies to foods, dyes, preservatives, or other substances.

**PREGNANCY AND LACTATION.** Pregnant women should not take tetracyclines during the last four months of pregnancy. These drugs can prevent the baby's bones and teeth from developing properly and may cause the baby's adult teeth to be permanently discolored. Tetracyclines can also cause liver problems in pregnant women.

Women who are breastfeeding should also not take tetracyclines. The drugs pass into breast milk and can affect the nursing baby's teeth and bones. They may also make the baby more sensitive to sunlight and may increase its risk of contracting fungal infections.

**OTHER CONDITIONS.** Before using tetracyclines, people with any of these medical problems should make sure their physicians have been informed:

- diabetes
- liver disease
- kidney disease

### *Side effects*

The most common side effects of tetracyclines are stomach cramps or a burning sensation in the stomach, mild diarrhea, nausea, or vomiting. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as a sore mouth or tongue and itching of the rectal or genital areas, may occur. These reactions do not need medical attention, however, unless they do not go away or are bothersome.

Other rare side effects have been reported, including inflammation of the pancreas, impairment of the kidneys, skin peeling, headache, intracranial hypertension, and ulceration of the esophagus. Anyone who has unusual symptoms during or after treatment with tetracyclines should consult his or her physician.

### *Interactions*

Tetracyclines may interact with other medicines. When an interaction occurs, the effects of one or both



of the drugs may change or the risk of side effects may be greater. Anyone who takes tetracyclines should give the doctor a list of all other medications that they take on a regular basis, including over-the-counter (OTC) drugs, herbal preparations, traditional Chinese medicines, or other alternative medicines. Standard medications that may interact with tetracyclines include:

- antacids
- calcium supplements
- medicines that contain iron (including multivitamin and mineral supplements)
- laxatives containing magnesium
- digoxin
- cholesterol-lowering drugs, including cholestyramine (Questran) and colestipol (Colestid)
- salicylates
- penicillin compounds
- birth control pills

Herbal preparations containing St. John's wort have been reported to increase sensitivity to sunlight in patients taking tetracyclines. People who have been using St. John's wort to relieve mild depression should discontinue it while they are taking tetracyclines.

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Tetralogy of Fallot see **Heart surgery for congenital defects**

Therapeutic abortion see **Abortion, induced**

## Thermometer

### Definition

A thermometer is a device used to measure temperature.

### Purpose

A thermometer is used in health care to measure and monitor **body temperature**. In an office, hospital or other health care facility, it allows a caregiver to record a baseline temperature when a patient is admitted. Repeated measurements of temperature are useful to detect deviations from normal levels. Repeated measurements are also useful in monitoring the effectiveness of current medications or other treatments.

The patient's temperature is recorded to check for pyrexia or monitor the degree of hypothermia present in the body.

### Demographics

All health care professionals use thermometers. All health care facilities have thermometers. Most homes also have thermometers.

### Description

A thermometer can use any of several methods to register temperature. These include mercury; liquid-in-glass; electronic with digital display; infrared or tympanic; and disposable dot matrix. A thermometer

## KEY TERMS

**Axillary**—Pertaining to the armpit.

**Hypothermia**—Body temperature below 96°F (35.5°C).

**Oral**—Pertaining to the mouth.

**Pyrexia**—A temperature of 101°F (38.3°C) or higher in an infant younger than three months or above 102°F (38.9°C) for older children and adults.

**Rectal**—Pertaining to the rectum.

**Sublingual**—Under the tongue.

can be used in a clinical or emergency setting or at home. Thermometers can record body temperatures in the mouth (oral), armpit (axillary), eardrum (tympanic membrane), or anus (rectal).

A mercury thermometer consists of a narrow glass stem approximately 5 in (12.7 cm) in length with markings along one or both sides indicating the temperature scale in degrees Fahrenheit, Centigrade or both. Liquid mercury is held in a reservoir bulb at one end and rises through a capillary tube when the glass chamber is placed in contact with the body. Mercury thermometers are not used in modern clinical settings.

Electronic thermometers can record a wide range of temperatures between 94°F and 105°F (35°C and 42°C) and can record oral, axillary, or rectal temperatures. They have temperature sensors inside round-tipped probes that can be covered with disposable guards to prevent the spread of infection. The sensor is connected to a container housing the central processing unit. The information gathered by the sensor is then shown on a display screen. Some electronic models have such other features as memory recall of the last recording or a large display screen for easy reading. To use an electronic thermometer, the caregiver places the probe under the patient's arm or tongue, or in the patient's rectum. The probe is left in place for a period of time that depends on the model used. The device will beep when the peak temperature is reached. The time required to obtain a reading varies from three to 30 seconds.

A tympanic thermometer has a round-tipped probe containing a sensor that can be covered with a disposable guard to protect against the spread of ear infections. It is placed in the ear canal for 1 sec while an infrared sensor records the body heat radiated by the eardrum. The reading then appears on the unit's screen.

Digital and tympanic thermometers should be used in accordance with the manufacturer's guidelines.

Disposable thermometers are plastic strips with dots on the surface that have been impregnated with temperature-sensitive chemicals. The strips are sticky on one side to adhere to the skin under the armpit and prevent slippage. The dots change color at different temperatures as the chemicals in them respond to body heat. The temperature is readable after two to three minutes, depending on the instrument's guidelines. These products vary in length of use; they may be disposable, reusable, or used continuously for up to 48 hours. Disposable thermometers are useful for children, as they can record temperatures while children are asleep.

## Diagnosis/Preparation

### Training

Caregivers should be given training appropriate for the type of device used in their specific clinical setting.

### Operation

The patient should sit or lie in a comfortable position to ensure that temperature readings are taken in similar locations each time and to minimize the effects of stress or excitement on the reading.

The manufacturer's guidelines should be followed when taking a patient's temperature with a digital, tympanic, or disposable thermometer. Dot-matrix thermometers are placed next to the skin and usually held in place by an adhesive strip. With the tympanic thermometer, caregivers should ensure that the probe is properly inserted into the ear to allow an optimal reading. The reading will be less accurate if the sensor cannot accurately touch the tympanic membrane or if the ear canal is clogged by wax or debris.

A mercury thermometer can be used to monitor a temperature in three body locations:

- Axillary.
- Oral or sublingual. This placement is never used with infants.
- Rectal. This method is used with infants. The tip of a rectal mercury thermometer is usually colored blue to distinguish it from the silver tip of an oral/axillary thermometer.

Before recording a temperature using a mercury thermometer, the caregiver shakes the mercury down by holding the thermometer firmly at the clear end and flicking it quickly a few times with a downward wrist

motion toward the silver end. The mercury should be shaken down below 96°F (35.5°C) before the patient's temperature is taken.

In axillary placement, the silver tip of the thermometer is placed under the patient's right armpit, with the patient's arm pressing the instrument against the chest. The thermometer should stay in place for six to seven minutes. The caregiver can record the patient's other **vital signs** during this waiting period. After the waiting period has elapsed, the caregiver removes the thermometer and holds it at eye level to read it. The mercury will have risen to a level indicating the patient's temperature.

The procedure for taking a patient's temperature by mouth with a mercury thermometer is similar to the axillary method except that the silver tip of the thermometer is placed beneath the tongue for four to five minutes before being read. In both cases, the thermometer is wiped clean and stored in an appropriate container to prevent breakage.

To record the patient's rectal temperature with a mercury thermometer, a rectal thermometer is shaken down as described earlier. A small amount of water-based lubricant is placed on the colored tip of the thermometer to make it easier to insert. Infants must be positioned lying on their stomachs and held securely by the caregiver. The tip of the thermometer is inserted into the rectum no more than 0.5 in (1.3 cm) and held there for two to three minutes. The thermometer is removed, read as before, and cleansed with an antibacterial wipe. It is then stored in an appropriate container to prevent breakage. This precaution is important as mercury is poisonous when swallowed.

Liquid-in-glass thermometers contain alternatives to mercury (such as colored alcohol), but are used and stored in the same manner as mercury thermometers.

### *Maintenance*

Many digital and infrared thermometers are self-calibrating and need relatively little care. To ensure accuracy, mercury thermometers should be shaken down prior to every use and left in place for at least three minutes. They require careful storage to prevent breakage and thorough cleaning after each use to prevent cross-infection.

As of early 2003, there is a nationwide initiative to ban the sale of thermometers and blood pressure monitors containing mercury. Health activists are concerned about mercury from broken or unwanted instruments contaminating the environment. A mercury thermometer contains 0.7g (0.025 oz) of mercury; 1 g of the substance is enough to contaminate a 20-acre

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Most health professionals are trained in the proper operation of thermometers used in clinical settings. Most families have and use thermometers in the home.

lake. Several states have banned the use of products containing mercury. Most retail stores have stopped selling mercury thermometers. In October 1999, the Environmental Protection Agency (EPA) advised using alternative products to avoid the need for increased regulations in years to come and to protect human health and wildlife by reducing unnecessary exposure to mercury. According to a 2001 study by the Mayo Clinic, mercury-free devices can monitor information without compromising accuracy.

### Aftercare

A thermometer should be cleaned, disinfected and placed in an appropriate container for storage.

### Risks

Breakage of a glass thermometer creates a risk of cuts from broken glass and possible mercury poisoning. Improper operation of a tympanic thermometer can cause injury to the middle ear. As digital devices have replaced glass thermometers, however, the number of injuries has declined.

An additional risk is that old or broken thermometers may give inaccurate results.

### Normal results

A normal body temperature is defined as approximately 98.6°F (37°C). Body temperature is not constant throughout a 24-hour period. Some variation (0.3°F) is normal. Individuals also vary in their basal temperatures (0.3°F). A fever is defined as a temperature of 101°F (38.3°C) or higher in an infant younger than three months or above 102°F (38.9°C) for older children and adults. Hypothermia is recognized as a temperature below 96°F (35.5°C).

### Morbidity and mortality rates

Injuries caused by properly inserted and normally functioning thermometers are extremely rare.

## QUESTIONS TO ASK THE DOCTOR

What is the patient's temperature?

In the opinion of the professional, is the recorded temperature abnormal?

Based on the recorded temperature, what actions would the professional recommend?

### Alternatives

There are no convenient alternatives to using a thermometer to measure body temperature.

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- American Academy of Pediatrics. 141 Northwest Point Boulevard, Elk Grove Village, IL 60007 1098. (847) 434 4000; FAX: (847) 434 8000. www.aap.org. E mail: kidsdoc@aap.org
- American College of Physicians. 190 N. Independence Mall West, Philadelphia, PA 19106 1572. (800) 523 1546, x2600 or (215) 351 2600. www.acponline.org.

American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464 5000. www.ama-assn.org.

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## Thoracic surgery

### Definition

Thoracic surgery is any surgery performed in the chest (thorax).

### Purpose

The purpose of thoracic surgery is to treat diseased or injured organs in the thorax, including the esophagus (muscular tube that passes food to the stomach), trachea (windpipe that branches to form the right bronchus and the left bronchus), pleura (membranes that cover and protect the lung), mediastinum (area separating the left and right lungs), chest wall, diaphragm, heart, and lungs.

General thoracic surgery is a field that specializes in diseases of the lungs and esophagus. The field also encompasses accidents and injuries to the chest, esophageal disorders (esophageal cancer or esophagitis), lung cancer, **lung transplantation**, and surgery for emphysema.

### Description

The most common diseases requiring thoracic surgery include lung cancer, chest trauma, esophageal cancer, emphysema, and lung transplantation.

#### Lung cancer

Lung cancer is one of the most significant public health problems in the world. Approximately 213,380 new cases of lung and bronchial cancer occurred in 2007. It is the leading cause of cancer deaths among



## KEY TERMS

**Diaphragm**—A membrane in the thorax that moves to assist the breathing cycle.

**Dyspnea**—Difficulty breathing.

**Hemothorax**—Blood in the pleural cavity.

**Mediastinum**—The portion of the thorax that consists of the heart, thoracic parts of the great vessels, and thoracic parts of the trachea, esophagus, thymus, and lymph nodes.

both men and women, killing more than 160,390 people annually. The overall five-year survival rate for all types of lung cancer is about 15.5%, as compared to 64.8% for colon cancer, 89% for breast cancer, and 99.9% for prostate cancer.

Lung cancer develops primarily by exposure to toxic chemicals. Cigarette smoking is the most important risk factor responsible for the disease. Other environmental factors that may predispose a person to lung cancer include industrial substances such as arsenic, nickel, chromium, asbestos, radon, organic chemicals, air pollution, and radiation.

Most cases of lung cancer develop in the right lung because it contains the majority (55%) of lung tissue. Additionally, lung cancer occurs more frequently in the upper lobes of the lung than in the lower lobes. The tumor receives blood from the bronchial artery (a major artery in the pulmonary system).

Adenocarcinoma of the lung is the most frequent type of lung cancer, accounting for 45% of all cases. This type of cancer can spread (metastasize) earlier than another type of lung cancer called squamous cell carcinoma (which occurs in approximately 30% of lung cancer patients). Approximately 66% of squamous cell carcinoma cases are centrally located. They expand against the bronchus, causing compression. Small-cell carcinoma accounts for 20% of all lung cancers; and the majority (80%) are centrally located. Small-cell carcinoma is a highly aggressive lung cancer, with early metastasis to distant sites such as the brain and bone marrow (the central portion of certain bones, which produce formed elements that are part of blood).

Most lung tumors are not treated with thoracic surgery since patients seek medical care later in the disease process. Chemotherapy increases the rate of survival in patients with limited (not advanced) disease. Surgery may be useful for staging or diagnosis. Pulmonary resection (removal of the tumor and

neighboring lymph nodes) can be curative if the tumor is less than or equal to 1.8 in (3 cm), and presents as a solitary nodule. Lung tumors spread to other areas through neighboring lymphatic channels. Even if thoracic surgery is performed, postoperative chemotherapy may also be indicated to provide comprehensive treatment (i.e., to kill any tumor cells that may have spread via the lymphatic system).

Genetic engineering has provided insights related to the growth of tumors. A genetic mutation called a *k-ras* mutation frequently occurs, and is implicated in 90% of genetic mutations for adenocarcinoma of the lung. Mutations in the cancer cells make them resistant to chemotherapy, necessitating the use of multiple chemotherapeutic agents.

### *Chest trauma*

Chest trauma is a medical/surgical emergency. Initially, the chest should be examined after an airway is maintained. The mortality (**death**) rate for trauma patients with respiratory distress is approximately 50%. This figure rises to 75% if symptoms include both respiratory distress and shock. Patients with respiratory distress require **endotracheal intubation** (passing a plastic tube from the mouth to the windpipe) and mechanically assisted ventilator support. Invasive thoracic procedures are necessary in emergency situations.

Trauma requiring urgent thoracic surgery may include any of the following problems: a large clotted hemothorax, massive air leak, esophageal injury, valvular cardiac (heart) injury, proven damage to blood vessels in the heart, or chest wall defect.

### *Esophageal cancer*

The number of new cases of esophageal cancer is slowly rising, with about 14,500 people diagnosed annually. While the cause of esophageal cancer is not precisely known, the greatly increased rate of esophageal cancer seems to be tied to the epidemic of obesity in the United States. Obesity results in acid reflux into the esophagus, chronic esophageal irritation, and progression to abnormal cell types that result in esophageal cancer, specifically of adenocarcinoma of the esophagus. Smoking and alcohol seem to also result in chronic esophageal irritation, leading to an association with squamous cell carcinoma of the esophagus.

Difficulty swallowing (dysphagia) is the cardinal symptom of esophageal cancer. Radiography, endoscopy, computerized axial tomography (CT scan), and ultrasonography are part of a comprehensive diagnostic evaluation. The standard operation for patients with resectable esophageal carcinoma includes removal

of the tumor from the esophagus, a portion of the stomach, and the lymph nodes (within the cancerous region).

### ***Emphysema***

Lung volume reduction surgery (LVRS) is the term used to describe surgery for patients with emphysema. LVRS is intended to help persons whose disabling dyspnea (difficulty breathing) is related to emphysema and does not respond to medical management. Breathlessness is a result of the structural and functional pulmonary and thoracic abnormalities associated with emphysema. Surgery will assist the patient, but the primary pathogenic process that caused the emphysema is permanent because lung tissues lose the capability of elastic recoil during normal breathing (inspiration and expiration).

Patients are usually transferred out of the **intensive care unit (ICU)** within one day of surgery. Physical therapy and rehabilitation (coughing and breathing exercises) begin soon after surgery, and the patient is discharged when deemed clinically stable.

### ***Lung transplantation***

There are various types of lung transplantations: unilateral (one lung, the most common type); bilateral (both lungs); heart-lung; and living donor lobe transplantation.

The survival rate for persons receiving a single lung transplant is more than 82% at one year, almost 60% at three years, and more than 43% at five years. Double-lung transplants have similar success rates: 82% at one year, 64% at three years, and 48% at five years. A successful outcome is highly dependent on the patient's general medical condition. Those who have symptomatic osteoporosis (severe disease of the musculoskeletal system) or are users of **corticosteroids** may not have favorable outcomes.

The death rate occurs due to infections (pulmonary infections) or chronic rejection (bronchiolitis obliterans) if the donor lung was not a perfect genetic match. Patients are given postoperative **antibiotics** to prevent bacterial infections during the early period following surgery.

Bacterial pneumonia is usually severe. A bacterial genus known as *Pseudomonas* accounts for 75% of post-transplant pneumonia cases. Patients can also acquire viral and fungal infections, and an infection caused by a cell parasite known as *Pneumocystis carinii*. Infections are treated with specific medications intended to destroy the invading microorganism. Viral infections require treatment of symptoms.

Acute (quick onset) rejection is common within the first weeks after lung transplantation. Acute rejection is treated with steroids (bolus given intravenously), and is effective in 80% of cases. Chronic rejection is the most common problem, and typically begins with symptoms of fatigue and a vague feeling of illness. Treatment is difficult, and the results are unrewarding. There are several immunosuppressive protocols currently utilized for cases of chronic rejection. The goal of immunosuppressive therapy is to prevent the host's immune reaction from destroying the genetically foreign organ.

### **Diagnosis/Preparation**

The surgeon may use two common incisional approaches: sternotomy (incision through and down the breastbone) or via the side of the chest (**thoracotomy**).

An operative procedure known as video-assisted thoracoscopic surgery (VATS) is minimally invasive. During VATS, a lung is collapsed and the thoracoscope and **surgical instruments** are inserted into the thorax through any of three or four small incisions in the chest wall.

Another approach involves the use of a mediastinoscope or bronchoscope to visualize the internal anatomical structures during thoracic surgery or diagnostic procedures.

Preoperative evaluation for most patients (except emergency cases) must include cardiac tests, blood chemistry analysis, and **physical examination**. Like most operative procedures, the patient should not eat or drink food 10–12 hours prior to surgery. Patients who undergo thoracic surgery with the video-assisted approach tend to have shorter inpatient hospital stays.

### **Aftercare**

Patients typically experience severe pain after surgery, and are given appropriate pain medications. In uncomplicated cases, chest and urine (Foley catheter) tubes are usually removed within 24–48 hours. A highly trained and comprehensive team of respiratory therapists and nurses is vital for **postoperative care** that results in improved lung function via deep breathing and coughing exercises.

### **Risks**

Precautions for thoracic surgery include coagulation blood disorders (disorders that prevent normal blood clotting) and previous thoracic surgery. Risks include hemorrhage, myocardial infarction (heart attack), stroke, nerve injury, embolism (blood clot or

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Thoracic surgery is performed in a hospital by a specialist in general surgery who has received advanced training in thoracic surgery.

air bubble that obstructs an artery), and infection. Total lung collapse can occur from fluid or air accumulation, as a result of chest tubes that are routinely placed after surgery for drainage.

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## Thoracotomy

### Definition

Thoracotomy is the process of making of an incision (cut) into the chest wall.

### Purpose

A physician gains access to the chest cavity (called the thorax) by cutting through the chest wall. Reasons for the entry are varied. Thoracotomy allows for study of the condition of the lungs; removal of a lung or part of a lung; removal of a rib; and examination, treatment, or removal of any organs in the chest cavity. Thoracotomy also provides access to the heart, esophagus, diaphragm, and the portion of the aorta that passes through the chest cavity.

Lung cancer is the most common cancer requiring a thoracotomy. Tumors and metastatic growths can be removed through the incision (a procedure called resection). A biopsy, or tissue sample, can also be taken through the incision, and examined under a microscope for evidence of abnormal cells.

A resuscitative or emergency thoracotomy may be performed to resuscitate a patient who is near **death** as a result of a chest injury. An emergency thoracotomy provides access to the chest cavity to control injury-related bleeding from the heart, cardiac compressions to restore a normal heart rhythm, or to relieve pressure on the heart caused by cardiac tamponade (accumulation of fluid in the space between the heart's muscle and outer lining).

### Demographics

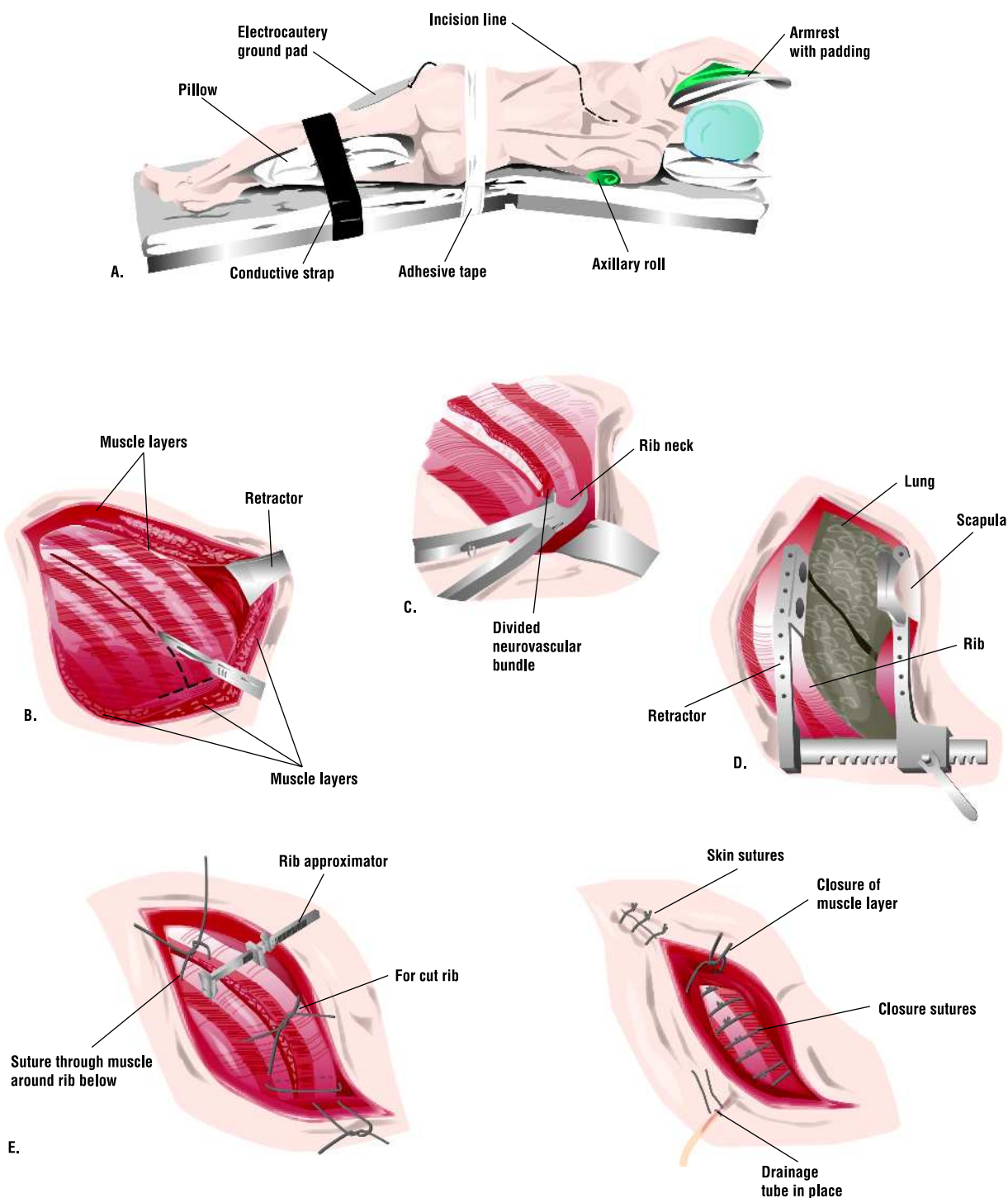
Thoracotomy may be performed to diagnose or treat a variety of conditions; therefore, no data exist as to the overall incidence of the procedure. Lung cancer, a common reason for thoracotomy, is diagnosed in approximately over 196,000 people each year and affects more men than women (108,355 diagnoses in men compared to 87,897 in women).

### Description

The thoracotomy incision may be made on the side, under the arm (axillary thoracotomy); on the front, through the breastbone (median sternotomy); slanting from the back to the side (posterolateral thoracotomy); or under the breast (anterolateral thoracotomy). The exact location of the cut depends on the reason for the surgery. In some cases, the physician is able to make the incision between ribs (called an intercostal approach) to minimize cuts through bone, nerves, and muscle. The incision may range from just under 5–10 in (12.7–25 cm).

During the surgery, a tube is passed through the trachea. It usually has a branch to each lung. One lung is deflated for examination and surgery, while the

# Thoracotomy



For a thoracotomy, the patient lies on his or her side with one arm raised (A). An incision is cut into the skin of the ribcage (B). Muscle layers are cut, and a rib may be removed to gain access to the cavity. (C). Retractors hold the ribs apart, exposing the lung (D). After any repairs are made, the cut rib is replaced and held in place with special materials (E). Layers of muscle and skin are stitched. (Illustration by GGS Information Services. Cengage Learning, Gale.)



## KEY TERMS

**Aorta**—The major artery carrying blood away from the heart.

**Catheter**—A tube inserted into a body cavity to drain fluid. An example would be a urinary catheter used to drain urine from the urethra.

**Diaphragm**—The large flat muscle that runs horizontally across the bottom of the chest cavity.

**Esophagus**—The muscular tube that connects the mouth and the stomach.

**Trachea**—The tube made of cartilage that carries air from the nose and mouth to the lungs.

**Urethra**—The tube that carries urine from the bladder to the outside of the body.

other one is inflated with the assistance of a mechanical device (a ventilator).

A number of different procedures may be commenced at this point. A lobectomy removes an entire lobe or section of a lung (the right lung has three lobes and the left lung has two). It may be done to remove cancer that is contained by a lobe. A **segmentectomy**, or wedge resection, removes a wedge-shaped piece of lung smaller than a lobe. Alternatively, the entire lung may be removed during a **pneumonectomy**.

In the case of an emergency thoracotomy, the procedure performed depends on the type and extent of injury. The heart may be exposed so that direct cardiac compressions can be performed; the physician may use one hand or both hands to manually pump blood through the heart. Internal paddles of a defibrillating machine may be applied directly to the heart to restore normal cardiac rhythms. Injuries to the heart causing excessive bleeding (hemorrhaging) may be closed with **staples** or **stitches**.

Once the procedure that required the incision is completed, the chest wall is closed. The layers of skin, muscle, and other tissues are closed with stitches or staples. If the breastbone was cut (as in the case of a median sternotomy), it is stitched back together with wire.

## Diagnosis/Preparation

Patients are told not to eat after midnight the night before surgery. They must tell their physicians about all known allergies so that the safest anesthetics can be selected. Older patients must be evaluated for heart ailments before surgery because of the additional strain on the heart.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Thoracotomy may be performed by a thoracic surgeon, a medical doctor who has completed surgical training in the areas of general surgery and surgery of the chest area, or an emergency room physician (in the case of emergency thoracotomy). The procedure is generally performed in a hospital operating room, although emergency thoracotomies may be performed in an emergency department or trauma center.

## Aftercare

Opening the chest cavity means cutting through skin, muscle, nerves, and sometimes bone. It is a major procedure that often involves a hospital stay of five to seven days. The skin around the drainage tube to the thoracic cavity must be kept clean, and the tube must be kept unblocked.

The pressure differences that are set up in the thoracic cavity by the movement of the diaphragm (the large muscle at the base of the thorax) make it possible for the lungs to expand and contract. If the pressure in the chest cavity changes abruptly, the lungs can collapse. Any fluid that collects in the cavity puts a patient at risk for infection and reduced lung function, or even collapse (called a pneumothorax). Thus, any entry to the chest usually requires that a chest tube remain in place for several days after the incision is closed.

The first two days after surgery may be spent in the **intensive care unit (ICU)** of the hospital. A variety of tubes, catheters, and monitors may be required after surgery.

## Risks

The rich supply of blood vessels to the lungs makes hemorrhage a risk; a blood **transfusion** may become necessary during surgery. **General anesthesia** carries risks such as nausea, vomiting, headache, blood pressure issues, or allergic reaction. After a thoracotomy, there may be drainage from the incision. There is also the risk of infection; the patient must learn how to keep the incision clean and dry as it heals.

After the chest tube is removed, the patient is vulnerable to pneumothorax. Physicians strive to reduce the risk of collapse by timing the removal of the tube. Doing so at the end of inspiration (breathing

## QUESTIONS TO ASK THE DOCTOR

Why is thoracotomy being recommended?

What diagnostic tests will be performed to determine if thoracotomy is necessary?

What type of incision will be used and where will it be located?

What type of procedure will be performed?

How long is the recovery time and what is expected during this period?

If a biopsy is the only reason for the procedure, is a thoracoscopy or a guided needle biopsy an option (instead of thoracotomy)?

in) or the end of expiration (breathing out) poses less risk. Deep breathing exercises and coughing should be emphasized as an important way that patients can improve healing and prevent pneumonia.

### Normal results

The results following thoracotomy depend on the reasons why it was performed. If a biopsy was taken during the surgery, a normal result would indicate that no cancerous cells are present in the tissue sample. The procedure may indicate that further treatment is necessary; for example, if cancer was detected, chemotherapy, radiation therapy, or more surgery may be recommended.

### Morbidity and mortality

One study following lung cancer patients undergoing thoracotomy found that 10–15% of patients experienced heartbeat irregularities, readmittance to the ICU, or partial or full lung collapse; 5–10% experienced pneumonia or extended use of the ventilator (greater than 48 hours); and up to 5% experienced wound infection, accumulation of pus in the chest cavity, or blood clots in the lung. The mortality rate in the study was 5.8%, with patients **dying** as a result of the cancer itself or of postoperative complications.

### Alternatives

Video-assisted **thoracic surgery** (VATS) is a less invasive alternative to thoracotomy. Also called thoracoscopy, VATS involves the insertion of a thoracoscope (a thin, lighted tube) into a small incision

through the chest wall. The surgeon can visualize the structures inside the chest cavity on a video screen. Instruments such as a stapler or grasper may be inserted through other small incisions. Although initially used as a diagnostic tool (to visualize the lungs or to remove a sample of lung tissue for further examination), VATS is being increasingly used to remove some lung tumors, and is usually appropriate for those under 2.4 in (6 cm). In some practices, as many as 8% of all lobectomies are now performed using VATS technique.

An alternative to emergency thoracotomy is a tube thoracostomy, a tube placed through chest wall to drain excess fluid. Over 80% of patients with a penetrating chest wound can be successfully managed with a thoracostomy.

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Diane M. Calabrese  
Stephanie Dionne Sherk

Thrombocyte count see **Complete blood count**

## Thrombolytic therapy

### Definition

Thrombolytic therapy is the use of drugs that dissolve blood clots. The name “thrombolytic” comes from two Greek words that mean “clot” and “loosening.”

### Purpose

When a blood clot forms in a blood vessel, it may cut off or severely reduce blood flow to parts of the body that are served by that blood vessel. This event can cause serious damage to those parts of the body. If the clot forms in an artery that supplies blood to the heart, for example, it can cause a heart attack. A clot that cuts off blood to the brain can cause a stroke. Thrombolytic therapy is used to dissolve blood clots that could cause serious, and possibly life-threatening, damage if they are not removed. Research suggests that when used to treat stroke, thrombolytic therapy can prevent or reverse paralysis and other problems that otherwise might result.

In heart attacks, thrombolytic therapy is an alternative to stenting, a procedure in which a spring-like device is inserted into a blocked blood vessel. In general, stenting is the preferred treatment, since it both removes the clot and opens the blood vessel, which may have internal cholesterol deposits. Thrombolytic therapy only removes the clot, but it can be administered in hospitals with fewer resources than are required for insertion of a stent.

Thrombolytic therapy is also used to dissolve blood clots that form in catheters or tubes put into people's bodies for medical treatments, such as dialysis or chemotherapy.

### Description

Thrombolytic therapy uses drugs called thrombolytic agents, such as alteplase (Activase), anistreplase (Eminase), streptokinase (Streptase, Kabikinase), urokinase (Abbokinase), and tissue plasminogen activator (TPA) to dissolve clots. These drugs are given as injections, and given only under a physician's supervision.

### Recommended dosage

The physician supervising thrombolytic therapy decides on the proper dose for each patient. He or she will take into account the type of drug, the purpose for which it is being used, and in some cases, the patient's weight.

## KEY TERMS

**Arteries**—Blood vessels that carry blood away from the heart to the cells, tissues, and organs of the body.

**Chemotherapy**—Treatment of an illness with chemical agents. The term is usually used to describe the treatment of cancer with drugs that kill cancer cells.

**Dialysis**—A process used to separate waste products from the blood in people whose kidneys are not working well.

**Hemorrhagic stroke**—A disruption of the blood supply to the brain caused by bleeding into the brain.

**Stent**—A thin rodlike or tubelike device, inserted into a vein or artery to keep the vessel open.

**Stroke**—A serious medical event in which blood flow to the brain is stopped by a blood clot in an artery or because an artery has burst. Strokes may cause paralysis and changes in a person's speech, memory, and behavior.

### Precautions

For thrombolytic therapy to be effective in treating stroke or heart attack, prompt medical attention is very important. The drugs must be given within a few hours of the beginning of a stroke or heart attack. This type of treatment is not right, however, for every patient who has a heart attack or a stroke. Only a qualified medical professional can decide whether a thrombolytic agent should be used. To increase the chance of survival and reduce the risk of serious permanent damage, anyone who has signs of a heart attack or stroke should get immediate medical help.

Thrombolytic therapy may cause bleeding in other parts of the body. This side effect is usually not serious, but severe bleeding does occur in some patients, especially older people. Some people have had minor hemorrhagic strokes in which there has been a small amount of bleeding into the brain. These hemorrhagic strokes have been blocked by clots that would be broken up by use of a thrombolytic agent, so that removal of the harmful clot would cause equally dangerous bleeding. To lower the risk of serious bleeding, people who are given thrombolytic medications should move around as little as possible and should not try to get up on their own unless told to do so by a health care professional. Following all the instructions of the health care providers in charge is very important.

Thrombolytic therapy may be more likely to cause serious bleeding in people who have certain medical conditions or have recently had certain procedures. Before being given a thrombolytic agent, anyone with any of these problems or conditions should tell the physician in charge:

- blood disease or current or past bleeding problems in any part of the body
- heart or blood vessel disease
- stroke (recent or in the past)
- high blood pressure
- brain tumor or other brain disease
- stomach ulcer or colitis
- severe liver disease
- active tuberculosis
- recent falls, injuries, or blows to the body or head
- recent injections into a blood vessel
- recent surgery, including dental surgery
- tubes recently placed in the body for any reason
- recent delivery of a baby

In addition, anyone who has had a recent streptococcal (strep) infection should tell the physician in charge. Some thrombolytic agents may not work properly in people who have just had a strep infection, so the physician may want to use a different drug.

People who take certain medicines may be at greater risk for severe bleeding when they are given a thrombolytic agent.

Women who are pregnant should tell the physician in charge before being given a thrombolytic agent. There is a slight chance that a woman who is given thrombolytic therapy during the first five months of pregnancy will have a miscarriage. Streptokinase and urokinase, however, have both been used without problems in pregnant women.

After being treated with thrombolytic therapy, women who are breastfeeding should check with their physicians before starting to breastfeed again.

### Side effects

Anyone who has fever or who notices bleeding or oozing from their gums, from cuts, or from the site where the thrombolytic agent was injected should immediately tell their health care provider.

People who are given thrombolytic therapy should also be alert to the signs of bleeding inside the body and should check with a physician immediately if any of the following symptoms occur:

- blood in the urine
- blood in the stool, or black, tarry stools
- constipation
- coughing up blood
- vomiting blood or material that looks like coffee grounds
- nosebleeds
- unexpected or unusually heavy vaginal bleeding
- dizziness
- sudden, severe, or constant headaches
- pain or swelling in the abdomen or stomach
- back pain or backache
- severe or constant muscle pain or stiffness
- stiff, swollen, or painful joints

Other side effects of thrombolytic agents are possible. Anyone who has unusual symptoms during or after thrombolytic therapy should tell a health care professional.

### Interactions

People who take certain medicines may be at greater risk for severe bleeding when they receive a thrombolytic agent. Anyone who is given a thrombolytic agent should tell the physician in charge about all other prescription or nonprescription (over-the-counter) medicines he or she is taking. Among the medicines that may increase the chance of bleeding are:

- aspirin and other medicines for pain and inflammation
- blood thinners (anticoagulants)
- antiseizure medicines, including divalproex (Depakote) and valproic acid (Depakene)
- cephalosporins, including cefamandole (Mandol), cefoperazone (Cefobid), and cefotetan (Cefotan)

In addition, anyone who has been treated with anistreplase or streptokinase within the past year should tell the physician in charge. These drugs may not work properly if they are given again, so the physician may want to use a different thrombolytic agent.

Patients who are taking thrombolytic medications should not take vitamin E supplements or certain herbal preparations without consulting their doctor. High doses of vitamin E can increase the risk of hemorrhagic stroke. Ginger, borage, angelica, dong quai, feverfew, and other herbs can intensify the anticlotting effect of thrombolytic medications and increase the risk of bleeding.



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Thyroid gland removal see **Thyroidectomy**

## Thyroidectomy

### Definition

Thyroidectomy is a surgical procedure in which all or part of the thyroid gland is removed. The thyroid gland is located in the forward (anterior) part of the neck just under the skin and in front of the Adam's

apple. The thyroid is one of the body's endocrine glands, which means that it secretes its products inside the body, into the blood or lymph. The thyroid produces several hormones that have two primary functions: they increase the synthesis of proteins in most of the body's tissues, and they raise the level of the body's oxygen consumption.

### Purpose

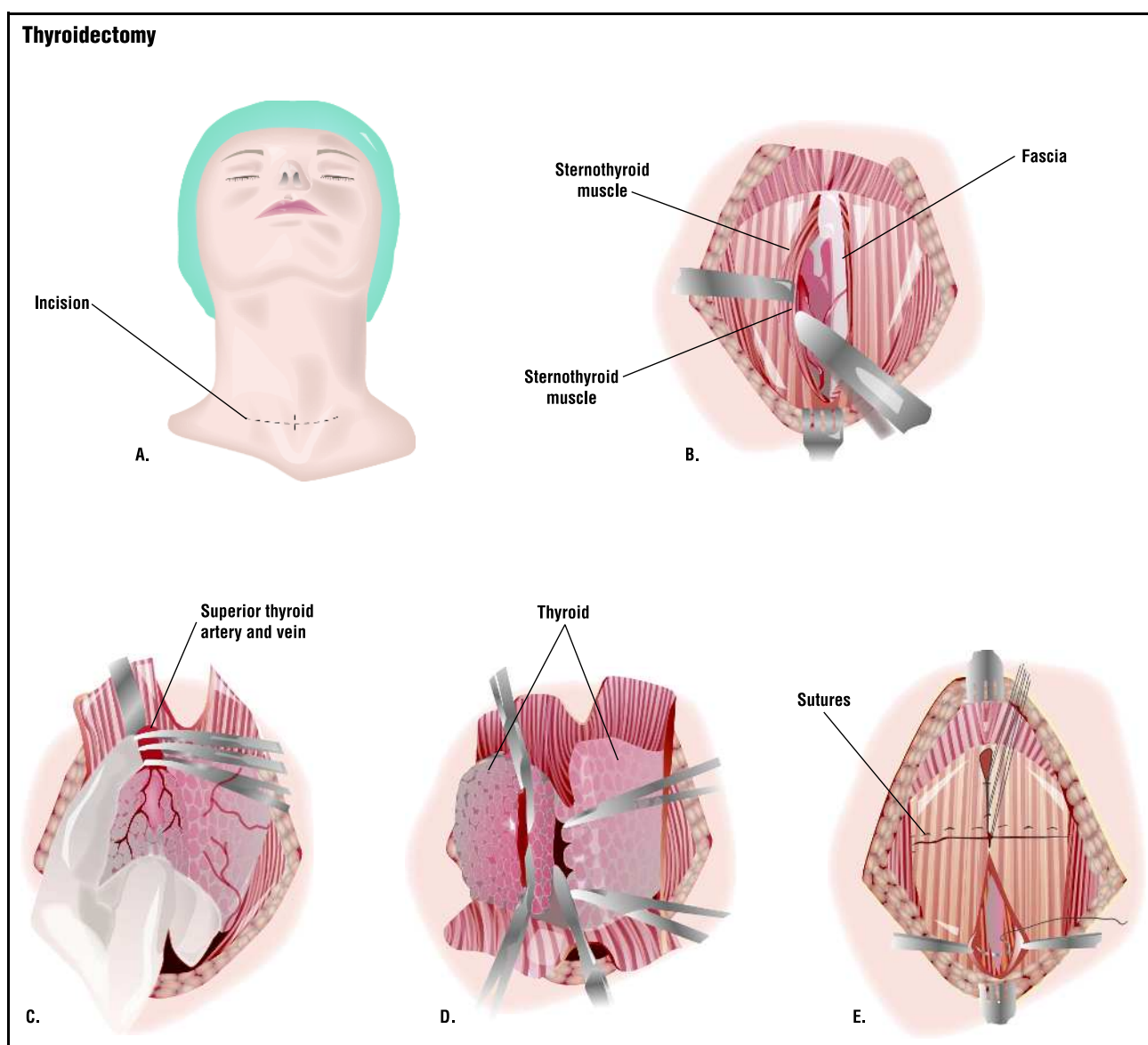
All or part of the thyroid gland may be removed to correct a variety of abnormalities. If a person has a goiter, which is an enlargement of the thyroid gland that causes swelling in the front of the neck, the swollen gland may cause difficulties with swallowing or breathing. Hyperthyroidism (overactivity of the thyroid gland) produces hypermetabolism, a condition in which the body uses abnormal amounts of oxygen, nutrients, and other materials. A thyroidectomy may be performed if the hypermetabolism cannot be adequately controlled by medication, or if the condition occurs in a child or pregnant woman. Both cancerous and noncancerous tumors (frequently called nodules) may develop in the thyroid gland. These growths must be removed, in addition to some or all of the gland itself.

### Demographics

Screening tests indicate that about 6% of the United States population has some disturbance of thyroid function, but many people with mildly abnormal levels of thyroid hormone do not have any disease symptoms. It is estimated that between 12 and 15 million people in the United States and Canada received treatment for thyroid disorders as of 2002. In 2001, there were approximately 34,500 thyroidectomies performed in the United States. Females are somewhat more likely than males to require a thyroidectomy.

### Description

A thyroidectomy begins with **general anesthesia** administered by an anesthesiologist. The anesthesiologist injects drugs into the patient's veins and then places an airway tube in the windpipe to ventilate (provide air for) the person during the operation. After the patient has been anesthetized, the surgeon makes an incision in the front of the neck at the level where a tight-fitting necklace would rest. The surgeon locates and takes care not to injure the parathyroid glands and the recurrent laryngeal nerves, while freeing the thyroid gland from these surrounding



To remove the thyroid gland, an incision is made at the front of the neck (A). Muscles and connecting tissue, or fascia, are divided (B). The veins and arteries above and below the thyroid are severed (C), and the gland is removed in two parts (D). The tissues and muscles are repaired before the skin incision is closed (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

structures. The next step is clamping off the blood supply to the portion of the thyroid gland that is to be removed. Next, the surgeon removes all or part of the gland. If cancer has been diagnosed, all or most of the gland is removed. If other diseases or nodules are present, the surgeon may remove only part of the gland. The total amount of glandular tissue removed depends on the condition being treated. The surgeon may place a drain, which is a soft plastic tube that allows tissue fluids to flow out of an area, before closing the incision. The incision is closed with either

sutures (**stitches**) or metal clips. A dressing is placed over the incision and the drain, if one has been placed.

People generally stay in the hospital one to four days after a thyroidectomy.

### Diagnosis/Preparation

Thyroid disorders do not always develop rapidly; in some cases, the patient's symptoms may be subtle or difficult to distinguish from the symptoms of other disorders. Patients suffering from hypothyroidism

## KEY TERMS

**Endocrine**—A type of organ or gland that secretes hormones or other products inside the body, into the bloodstream or the lymphatic system. The thyroid is an endocrine gland.

**Endocrinologist**—A physician who specializes in treating persons with diseases of the thyroid, parathyroid, adrenal glands, and the pancreas.

**Goiter**—An enlargement of the thyroid gland due to insufficient iodine in the diet.

**Hyperthyroidism**—Abnormal overactivity of the thyroid gland. People with hyperthyroidism are hypermetabolic, lose weight, exhibit nervousness, have muscular weakness and fatigue, sweat heavily, and have increased urination and bowel movements. This condition is also called thyrotoxicosis.

**Hypothyroidism**—Abnormal underfunctioning of the thyroid gland. People with hypothyroidism have a lowered body metabolism, gain weight, and are sluggish.

**Parathyroid glands**—Two pairs of smaller glands that lie close to the lower surface of the thyroid gland. They secrete parathyroid hormone, which regulates the body's use of calcium and phosphorus.

**Recurrent laryngeal nerve**—A nerve which lies very near the parathyroid glands and serves the larynx or voice box.

**Thyroid storm**—An unusual complication of thyroid function that is sometimes triggered by the stress of thyroid surgery. It is a medical emergency.

are sometimes misdiagnosed as having a psychiatric depression. Before a thyroidectomy is performed, a variety of tests and studies are usually required to determine the nature of the thyroid disease. Laboratory analysis of blood determines the levels of active thyroid hormones circulating in the body. The most common test is a blood test that measures the level of thyroid-stimulating hormone (TSH) in the bloodstream. Sonograms and computed tomography scans (**CT scans**) help to determine the size of the thyroid gland and location of abnormalities. A nuclear medicine scan may be used to assess thyroid function or to evaluate the condition of a thyroid nodule, but it is not considered a routine test. A needle biopsy of an abnormality or aspiration (removal by suction) of fluid from the thyroid gland may also be performed to help determine the diagnosis.

If the diagnosis is hyperthyroidism, a person may be asked to take antithyroid medication or iodides before the operation. Continued treatment with antithyroid drugs may be the treatment of choice. Otherwise, no other special procedure must be followed prior to the operation.

## Aftercare

A thyroidectomy incision requires little to no care after the dressing is removed. The area may be bathed gently with a mild soap. The sutures or the metal clips are removed three to seven days after the operation.

## Risks

There are definite risks associated with the procedure. The thyroid gland should be removed only if there is a pressing reason or medical condition that requires it.

As with all operations, people who are obese, smoke, or have poor nutrition are at greater risk for developing complications related to the general anesthetic itself.

Hoarseness or voice loss may develop if the recurrent laryngeal nerve is injured or destroyed during the operation. Nerve damage is more apt to occur in people who have large goiters or cancerous tumors.

Hypoparathyroidism (underfunctioning of the parathyroid glands) can occur if the parathyroid glands are injured or removed at the time of the thyroidectomy. Hypoparathyroidism is characterized by a drop in blood calcium levels resulting in muscle cramps and twitching.

Hypothyroidism (underfunctioning of the thyroid gland) can occur if all or nearly all of the thyroid gland is removed. Complete removal, however, may be intentional when the patient is diagnosed with cancer. If a person's thyroid levels remain low, thyroid replacement medications may be required for the rest of his or her life.

A hematoma is a collection of blood in an organ or tissue, caused by a break in the wall of a blood vessel. The neck and the area surrounding the thyroid gland have a rich supply of blood vessels. Bleeding in the area of the operation may occur and be difficult to control or stop. If a hematoma occurs in this part of the body, it may be life-threatening. As the hematoma enlarges, it may obstruct the airway and cause a person to stop breathing. If a hematoma does develop in the neck, the surgeon may need to perform drainage to clear the airway.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Thyroidectomies are usually performed by surgeons with specialized training in otolaryngology, head and neck surgery. Occasionally, a general surgeon will perform a thyroidectomy. The procedure is performed in a hospital under general anesthesia.

Wound infections can occur. If they do, the incision is drained, and there are usually no serious consequences.

### Normal results

Most patients are discharged from the hospital one to four days after a thyroidectomy. Most resume their normal activities two weeks after the operation. People who have cancer may require subsequent treatment by an oncologist or endocrinologist.

### Morbidity and mortality rates

The mortality of thyroidectomy is essentially zero. Hypothyroidism is thought to occur in 12–50% of persons in the first year after a thyroidectomy. Late-onset hypothyroidism develops among an additional 1–3% of persons each year. Although hypothyroidism may recur many years after a partial thyroidectomy, 43% of recurrences occur within five years.

Mortality from thyroid storm, an uncommon complication of thyroidectomy, is in the range of 20–30%. Thyroid storm is characterized by fever, weakness and wasting of the muscles, enlargement of the liver, restlessness, mood swings, change in mental status, and in some cases, coma. *Thyroid storm is a medical emergency requiring immediate treatment.* After a partial thyroidectomy, thyroid function returns to normal in 90–98% of persons.

### Alternatives

Injectations of radioactive iodine were used to destroy thyroid tissue in the past. This alternative is rarely performed in 2003.

### Resources

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Bland, K. I., W. G. Cioffi, and M. G. Sarr. *Practice of General Surgery*. Philadelphia, PA: Saunders, 2001.

## QUESTIONS TO ASK THE DOCTOR

- Which parts of the thyroid will be removed?
- What will my neck look like after surgery?
- Is the surgeon a board certified otolaryngologist?
- How many radical neck procedures has the surgeon performed?
- What is the surgeon's complication rate?
- Will I need any medications after surgery?

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American Academy of Otolaryngology Head and Neck Surgery. One Prince St., Alexandria, VA 22314 3357. (703) 836 4444. [www.entnet.org/index2.cfm](http://www.entnet.org/index2.cfm).

American College of Surgeons. 633 North St. Clair Street, Chicago, IL 60611 3231. (312) 202 5000. Fax: (312) 202 5001. [www.facs.org](http://www.facs.org).

American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464 5000. [www.ama-assn.org](http://www.ama-assn.org).

American Osteopathic College of Otolaryngology Head and Neck Surgery. 405 W. Grand Avenue, Dayton, OH 45405. (937) 222 8820 or (800) 455 9404. Fax: (937) 222 8840. Email: [info@aocohns.org](mailto:info@aocohns.org).



Association of Thyroid Surgeons. 717 Buena Vista St.,  
Ventura, CA 93001, FAX: (509) 479 8678.  
www.thyroidsurgery.org.

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L. Fleming Fallon, Jr., MD, DrPH

Tissue plasminogen activator see **Thrombo-  
lytic therapy**

Tissue typing see **Human leukocyte antigen  
test**

Tongue removal see **Glossectomy**

Tonsil removal see **Tonsillectomy**

## Tonsillectomy

### Definition

Tonsillectomy is a surgical procedure to remove the tonsils. The tonsils are part of the lymphatic system, which is responsible for fighting infection.

### Purpose

Tonsils are removed when a person, most often a child, has any of the following conditions:

- obstruction
- sleep apnea (a condition in which an individual snores loudly and stops breathing temporarily at intervals during sleep)
- inability to swallow properly because of enlarged tonsils
- a breathy voice or other speech abnormality due to enlarged tonsils
- recurrent or persistent abscesses or throat infections

Physicians are not in complete agreement on the number of sore throats that necessitate a tonsillectomy. Most would agree that four cases of strep throat in any one year; six or more episodes of tonsillitis in

one year; or five or more episodes of tonsillitis per year for two years indicate that the tonsils should be removed.

### Demographics

A tonsillectomy is one of the most common surgical procedures among children. It is uncommon among adults. More than 400,000 tonsillectomies are performed each year in the United States. Approximately 70% of surgical candidates are under age 18.

### Description

A tonsillectomy is usually performed under **general anesthesia**, although adults may occasionally receive a local anesthetic. The surgeon depresses the tongue in order to see the throat, and removes the tonsils with an instrument resembling a scoop or scissors.

Alternate methods for removing tonsils are being investigated, including lasers and other electronic devices.

### Diagnosis/Preparation

Tonsillectomy procedures are not performed as frequently today as they once were. One reason for a more conservative approach is the risk involved when a person is put under general anesthesia.

In some cases, a tonsillectomy may need to be modified or postponed:

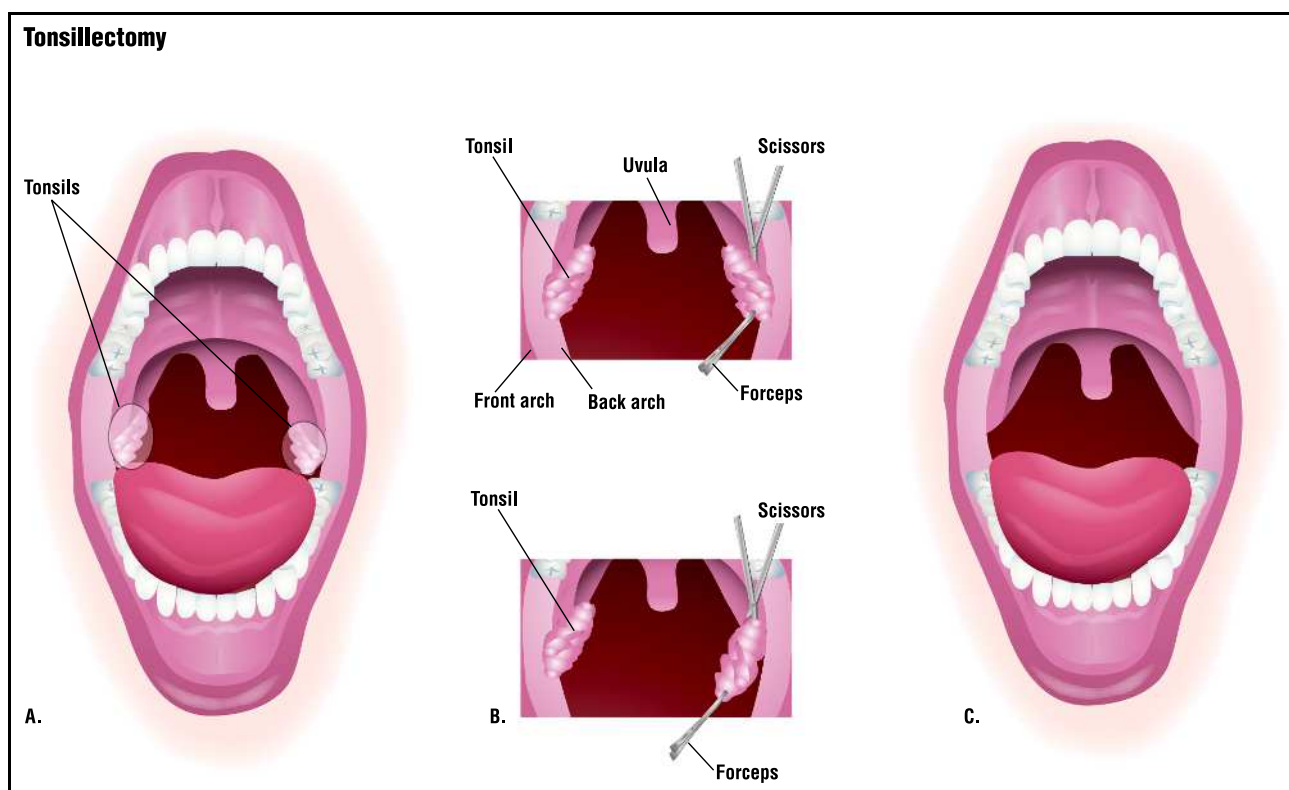
- Bleeding disorders must be adequately controlled prior to surgery.
- Acute tonsillitis should be successfully treated prior to surgery. Treatment may postpone the surgery three to four weeks.

### Aftercare

Persons are turned on their side after the operation to prevent the possibility of blood being drawn into the lungs (aspirated). **Vital signs** are monitored. Patients can drink water and other non-irritating liquids when they are fully awake.

Adults are usually warned to expect a very sore throat and some bleeding after the operation. They are given **antibiotics** to prevent infection, and some receive pain-relieving medications. For at least the first 24 hours, individuals are instructed to drink fluids and eat soft, pureed foods.

People are usually sent home the day of surgery. They are given instructions to call their surgeon if there is bleeding or earache, or fever that lasts longer than three days. They are told to expect a white scab to



**Tonsils are removed through the mouth (A). The surgeon uses a scissors to cut away the tonsils, and a forceps to pull them away (B).** (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Abscess**—A localized area of tissue destruction and pus formation.

**Sleep apnea**—A condition marked by loud snoring during sleep and periodic episodes of suspended breathing.

**Tonsils**—Oval masses of lymphoid tissue on each side of the throat.

## Normal results

Normal results include the correction of the condition for which the surgery was performed.

## Morbidity and mortality rates

Morbidity other than minor post-surgical infection is uncommon. About one in every 15,000 tonsillectomies ends in **death**, either from the anesthesia or bleeding five to seven days after the operation.

## Alternatives

There are no alternatives to surgical removal of the tonsils. Drug therapy may be used for recurrent infections involving the tonsils.

## Resources

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form in the throat between five and 10 days after surgery.

## Risks

There is a chance that children with previously normal speech will develop a nasal-sounding voice. In addition, children younger than five years may be emotionally upset by the hospital experience. There are risks associated with any surgical procedure, including post-operative infection and bleeding.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A tonsillectomy is performed in an outpatient facility associated with a hospital by a general surgeon or otolaryngologist (physician who specializes in treating disorders of the ear, nose, and throat).

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### ORGANIZATIONS

- American College of Surgeons. 633 North St. Clair Street, Chicago, IL 60611 32311. (312) 202 5000. Fax: (312) 202 5001. E mail: postmaster@facs.org. <http://www.facs.org>.
- American Academy of Otolaryngology Head and Neck Surgery. One Prince St., Alexandria, VA 22314 3357. (703) 836 4444. <http://www.entnet.org/index2.cfm>.
- American Cancer Society. 1599 Clifton Road NE, Atlanta, GA 30329. (800) 227 2345. <http://www.cancer.org>.
- American Osteopathic College of Otolaryngology Head and Neck Surgery. 405 W. Grand Avenue, Dayton, OH 45405. (937) 222 8820 or (800) 455 9404, fax (937) 222 8840. Email: [info@aocohns.org](mailto:info@aocohns.org).

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## QUESTIONS TO ASK THE DOCTOR

What will be the resulting functional status of the body after the operation?

Is the surgeon board certified in head and neck surgery?

How many tonsillectomy procedures has the surgeon performed?

What is the surgeon's complication rate?

Has the surgeon operated on children?

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L. Fleming Fallon, Jr., MD, Dr.PH.

## Tooth extraction

### Definition

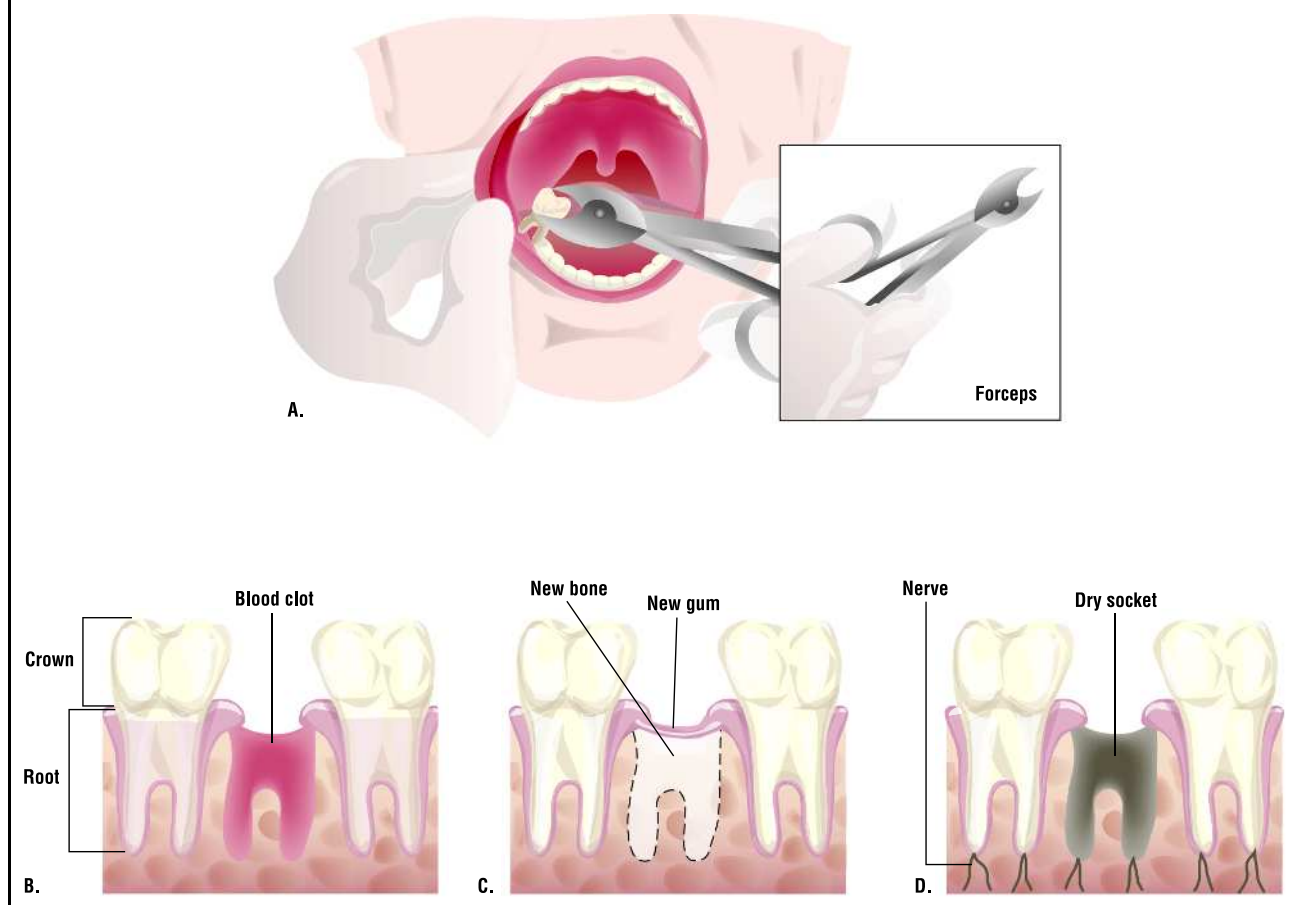
Tooth extraction is the removal of a tooth from its socket in the bone.

### Purpose

Extraction is performed for positional, structural, or economic reasons. Teeth are often removed because they are impacted. Teeth become impacted when they are prevented from growing into their normal position in the mouth by gum tissue, bone, or other teeth. Impaction is a common reason for the extraction of wisdom teeth. Extraction is the only known method that will prevent further problems with impaction.

Teeth may also be extracted to make more room in the mouth prior to straightening the remaining teeth (orthodontic treatment), or because they are so badly positioned that straightening is impossible. Extraction may be used to remove teeth that are so badly decayed or broken that they cannot be restored. In addition,

## Tooth extraction



A dental surgeon uses special forceps to pull out a tooth (A). In its place, a blood clot forms (B), which becomes new bone with gum tissue over the top (C). If the blood clot does not form or falls out, a dry socket occurs (D). No new bone forms, and the nerves are exposed, causing pain. (Illustration by GGS Information Services. Cengage Learning, Gale.)

some patients choose extraction as a less expensive alternative to filling or placing a crown on a severely decayed tooth.

### Demographics

Exact statistics concerning tooth extraction are not available. Experts estimate that over 20 million teeth are extracted each year in the United States. Many of these are performed in conjunction with orthodontic procedures. Some extractions are due to tooth decay.

### Description

Tooth extraction can be performed with **local anesthesia** if the tooth is exposed and appears to be easily removable in one piece. The dentist or oral

surgeon uses an instrument called an elevator to luxate, or loosen, the tooth; widen the space in the underlying bone; and break the tiny elastic fibers that attach the tooth to the bone. Once the tooth is dislocated from the bone, it can be lifted and removed with forceps.

If the extraction is likely to be difficult, a general dentist may refer the patient to an oral surgeon. Oral surgeons are specialists who are trained to administer nitrous oxide (laughing gas), an intravenous sedative, or a general anesthetic to relieve pain. Extracting an impacted tooth or a tooth with curved roots typically requires cutting through gum tissue to expose the tooth. It may also require removing portions of bone to free the tooth. Some teeth must be cut and removed in sections. The extraction site may or may not require one or more **stitches** (sutures) to close the incision.



## KEY TERMS

**Dry socket**—A painful condition following tooth extraction in which a blood clot does not properly fill the empty socket. Dry socket leaves the underlying bone exposed to air and food particles.

**Extraction site**—The empty tooth socket following removal of a tooth.

**Impacted tooth**—A tooth that is growing against another tooth, bone, or soft tissue.

**Luxate**—To loosen or dislocate a tooth from its socket.

**Nitrous oxide**—A colorless, sweet-smelling gas used by dentists for mild anesthesia. It is sometimes called laughing gas because it makes some people feel giddy or silly.

**Oral surgeon**—A dentist who specializes in surgical procedures of the mouth, including extractions.

**Orthodontic treatment**—The process of realigning and straightening teeth to correct their appearance and function.

## Diagnosis/Preparation

In some situations, tooth extractions may be temporarily postponed. These situations include:

- Infection that has progressed from the tooth into the bone. Infections may complicate administering anesthesia. They can be treated with antibiotics before the tooth is extracted.
- Use of drugs that thin the blood (anticoagulants). These medications include warfarin (Coumadin) and aspirin. The patient should stop using these medications for three days prior to extraction.
- People who have had any of the following procedures in the previous six months: heart valve replacement, open heart surgery, prosthetic joint replacement, or placement of a medical shunt. These patients may be given antibiotics to reduce the risk of bacterial infection spreading from the mouth to other parts of the body.

Before extracting a tooth, the dentist will take the patient's medical history, noting allergies and other prescription medications that the patient is taking. A dental history is also recorded. Particular attention is given to previous extractions and reactions to anesthetics. The dentist may then prescribe **antibiotics** or recommend stopping certain medications prior to the

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Teeth are most often extracted by maxillofacial or oral surgeons. Occasionally, a general dentist will extract a tooth. Teeth are most commonly removed in an outpatient facility adjacent to a hospital under general anesthesia.

extraction. The tooth is x-rayed to determine its full shape and position, especially if it is impacted.

Patients scheduled for deep anesthesia should wear loose clothing with sleeves that are easily rolled up to allow the dentist to place an intravenous line. They should not eat or drink anything for at least six hours before the procedure. Arrangements should be made for a friend or relative to drive them home after the surgery.

## Aftercare

An important aspect of aftercare is encouraging a clot to form at the extraction site. The patient should put pressure on the area by biting gently on a roll or wad of gauze for several hours after surgery. Once the clot is formed, it should not be disturbed. The patient should not rinse, spit, drink with a straw, or smoke for at least 24 hours after the extraction and preferably longer. He or she should also avoid vigorous **exercise** for the first three to five days after the extraction.

For the first two days after the procedure, the patient should drink liquids without using a straw and eat soft foods. Any chewing must be done on the side away from the extraction site. Hard or sticky foods should be avoided. The mouth may be gently cleaned with a toothbrush, but the extraction area should not be scrubbed.

Wrapped ice packs can be applied to reduce facial swelling. Swelling is a normal part of the healing process; it is most noticeable in the first 48–72 hours after surgery. As the swelling subsides, the patient's jaw muscles may feel stiff. Moist heat and gentle exercise will restore normal jaw movement. The dentist or oral surgeon may prescribe medications to relieve postoperative pain.

## Risks

Potential complications of tooth extraction include postoperative infection, temporary numbness

## QUESTIONS TO ASK THE DOCTOR

- Why are you suggesting a tooth extraction?
- What will my mouth look like after surgery?
- Is the oral surgeon board certified in maxillofacial surgery?
- How many teeth extractions has the oral surgeon performed?
- What is the oral surgeon's complication rate?
- Will I need medication after surgery?

from nerve irritation, jaw fracture, and jaw joint pain. An additional complication is called dry socket. When a blood clot does not properly form in the empty tooth socket, the bone beneath the socket is exposed to air and contamination by food particles; as a result, the extraction site heals more slowly than is normal or desirable.

### Normal results

The wound usually closes in about two weeks after a tooth extraction, but it takes three to six months for the bone and soft tissue to be restructured. Such complications as infection or dry socket may prolong the healing process.

### Morbidity and mortality rates

Mortality from tooth extraction is very rare. Complications include a brief period of pain and swelling; post-extraction infections; and migration of adjacent teeth into the empty space created by an extraction. Most people experience some pain and swelling after having a tooth extracted. With the exception of removing wisdom teeth, migration into the empty space is common. Braces or orthodontic appliances usually control this problem.

### Alternatives

Alternatives to tooth extraction depend on the reason for the extraction. Postponing or canceling an extraction to correct tooth crowding will cause malocclusion and an undesirable appearance. Not removing an impacted wisdom tooth may cause eventual misalignment, although it may have no impact. Not removing a decayed or abscessed tooth may lead to septicemia and other complications.

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- American Board of Oral and Maxillofacial Surgery. 625 North Michigan Avenue, Suite 1820, Chicago, IL 60611. (312) 642-0070; FAX: (312) 642-8584. [www.aboms.org](http://www.aboms.org).
- American Dental Association. 211 E. Chicago Avenue, Chicago, IL 60611. (312) 440-2500. [www.ada.org](http://www.ada.org).
- British Association of Oral and Maxillofacial Surgeons, Royal College of Surgeons. 35-43 Lincoln's Inn Fields, London, UK WC2A 3PN. [www.baoms.org.uk](http://www.baoms.org.uk).

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L. Fleming Fallon, Jr., MD, DrPH

## Tooth replantation

### Definition

Tooth replantation is the reinsertion and splinting of a tooth that has been avulsed (knocked or torn out) of its socket.

### Purpose

Teeth are replanted to prevent permanent loss of the tooth, and to restore the landscape of the mouth so that the patient can eat and speak normally.

### Demographics

According to the National Center for Health Statistics, about 5 million teeth are accidentally avulsed in the United States each year. Most teeth that are replanted are lost through trauma, usually falls and other types of accidents. The most common traumata resulting in tooth avulsion are sports accidents that result in falls or blows to the head. The mandatory use of mouth guards, which are plastic devices that protect the upper teeth, has prevented approximately 200,000 oral injuries each year in football alone. The American Dental Association recommends the use of mouth guards for any sport that involves speed, contact, or the potential for falls. These categories include not only contact sports like football, wrestling, and boxing, but also gymnastics, baseball, hockey, bicycling, skateboarding, and skiing. Without a mouth guard, a person is 60 times more likely to experience dental trauma if he or she participates in these sports.

Other common causes of trauma to the mouth resulting in avulsed teeth include motor vehicle accidents, criminal assaults, and fist fights. Domestic violence is the most common cause of avulsed teeth in women over the age of 21.

### Description

In most cases, only permanent teeth are replanted. Primary teeth (baby teeth) do not usually have long enough roots for successful replantation. The only exception may be the canine teeth, which have longer roots and therefore a better chance of staying in place. In some cases, however, the dentist may choose to replant a child's primary tooth because there is risk to the permanent tooth that has not yet emerged.

To replant a tooth, the dentist or oral surgeon will first administer a local anesthetic to numb the patient's gums. He or she will then reinsert the avulsed tooth in its socket and anchor it within the mouth by installing

## KEY TERMS

**Avulsion**—A ripping out or tearing away of a tooth or other body part.

**Canine tooth**—In humans, the tooth located in the mouth next to the second incisor. The canine tooth has a pointed crown and the longest root of all the teeth.

**Crown**—The top part of the tooth.

**Endodontist**—A dentist who specializes in the diagnosis and treatment of disorders affecting the pulp of a tooth, the root of the tooth, or the tissues surrounding the root. Some patients with avulsed teeth may be treated by an endodontist.

**Eruption**—The emergence of a tooth through the gum tissue.

**Fibroblasts**—Connective tissue cells that help to hold the teeth in their sockets in the jawbone.

**Mouth guard**—A plastic device that protects the upper teeth from injury during athletic events.

**Primary teeth**—A child's first set of teeth, sometimes called baby teeth.

a splint made of wire and composite resin. Some dentists remove the root canal nerve of the tooth and replace it with a plastic material before reinserting the tooth. The splint holds the tooth in place for two to six weeks. At that time, the splint can be removed and the tooth examined for stability.

### Diagnosis/Preparation

When a tooth is dislodged, it is critical to recover the tooth, preserve it under proper conditions, and get the patient to a dentist immediately. The tooth should be handled carefully; it should be picked up or touched by its crown (the top part of the tooth), not by its root. The tooth should be rinsed and kept moist, but not cleaned or brushed. The use of toothpaste, soap, mouthwash, or other chemicals can remove the fibroblasts clinging to the root of the tooth. Fibroblasts are connective tissue cells that act as a **glue** between teeth and the underlying bone.

The avulsed tooth can be placed in milk or a special Save-a-Tooth (R) kit, which is a tooth-preserving cup that contains a medium for preserving the fibroblasts around the tooth. The tooth and the patient should go to the dentist within 30 minutes of the accident since fibroblasts begin to die within that time. Rapid treatment improves the chances for successful

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Tooth replantations are performed by general dentists, endodontists, and oral surgeons, usually as office or outpatient procedures. In some cases, the patient may be treated in the emergency room of a hospital.

replantation. In some cases, artificial fibroblasts can be substituted for the patient's own connective tissue cells.

If the tooth is a primary tooth, it should be rinsed and kept moist also. The dentist should be consulted to determine whether the tooth should be replanted by examining the gums and the emergent tooth. The dentist will take a set of x rays to determine how soon the permanent tooth is likely to emerge. Sometimes an artificial spacer is placed where the primary tooth was lost until the permanent tooth comes in.

Any injury to the gum is treated before the tooth is replanted. The dentist may give the patient an antibiotic medication to reduce the risk of infection. Cold compresses can reduce swelling. **Stitches** may be necessary if the gum is lacerated. The dentist may also take x rays of the mouth to see if there are other injuries to the jawbone or nearby teeth.

### Aftercare

The patient may take **aspirin** or **acetaminophen** for pain. **Antibiotics** may also be given for infection. The patient should avoid rinsing the mouth, spitting, or smoking for the first 24 hours after surgery. He or she should limit food to a soft diet for the next few days.

Beginning 24 hours after surgery, the patient should rinse the mouth gently with a solution of salt and lukewarm water every one to two hours. The salt helps to reduce swelling in the tissues around the tooth.

Any kind of traumatic injury always carries the risk of infection. Patients with heart disease or disorders of the immune system should be monitored following tooth replantation. Dentists recommend consulting a physician within 48 hours of the dental surgery to determine the risk of tetanus, particularly if the patient has not received a tetanus booster within the past five years.

Adults with replanted teeth should have periodic checkups. According to the American Association of

## QUESTIONS TO ASK THE DOCTOR

- How should I take care of the replanted tooth?
- How long will it take to assess the results of treatment?
- What can be done if the tooth cannot be replanted?
- Where can I be fitted for a mouth guard?

Endodontists, it takes about two to three years after replantation before the dentist can fully evaluate the outcome of treatment.

### Risks

In addition to infection, tooth replantation carries the risks of excessive bleeding and rejection of the tooth. Rejection is a rare complication. An additional risk is that the root of the tooth may become fused to the underlying bone.

### Normal results

Most permanent tooth replantations are successful when the patient acts quickly (within two hours). If the tooth is rejected, the dentist may attach the tooth to the bone with tissue glue.

### Morbidity and mortality rates

Mortality following tooth replantation is almost unheard of. The rate of complications varies according to the circumstances of the injury, the patient's age, and his or her general health. A history of smoking increases the risk of rejection of the tooth, as well as infection.

### Alternatives

There are no effective medical alternatives to oral surgery for replanting an avulsed tooth. Over-the-counter **analgesics** (pain relievers), prescription antibiotics, and some herbal preparations may be useful in relieving pain, reducing swelling, or preventing infection.

Herbal preparations that have been found useful as mouthwashes following oral surgery include calendula (*Calendula officinalis*) and clove (*Eugenia caryophyllata*).



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Janie Franz

Topical antibiotics see **Antibiotics, topical**

Total hip replacement see **Hip replacement**

Total knee replacement see **Knee replacement**

Total shoulder replacement see **Shoulder joint replacement**

Total wrist replacement see **Wrist replacement**

## Trabeculectomy

### Definition

Trabeculectomy is a surgical procedure that removes part of the trabeculum in the eye to relieve pressure caused by glaucoma.

### Purpose

Glaucoma is a disease that injures the optic nerve, causing progressive vision loss. Glaucoma is a major cause of blindness in the United States. If caught early, glaucoma-related blindness is easily prevented. However, because it does not produce symptoms until late in its cycle, periodic tests for the disease are necessary.

Glaucoma is usually associated with an increase in the pressure inside the eye, called intraocular pressure (IOP). This increase occurs in front of the iris in a fluid called the aqueous humor. Aqueous humor exits through tiny channels between the iris and the cornea, in an area called the trabeculum. When the trabeculum is blocked, pressure from the build up of aqueous humor either increases rapidly with pain and redness, or builds slowly with no symptoms until there is a significant loss of vision. Trabeculectomy is the last treatment employed for either type of glaucoma. It is used only after medications and laser trabeculoplasty have failed to alleviate IOP.

### Demographics

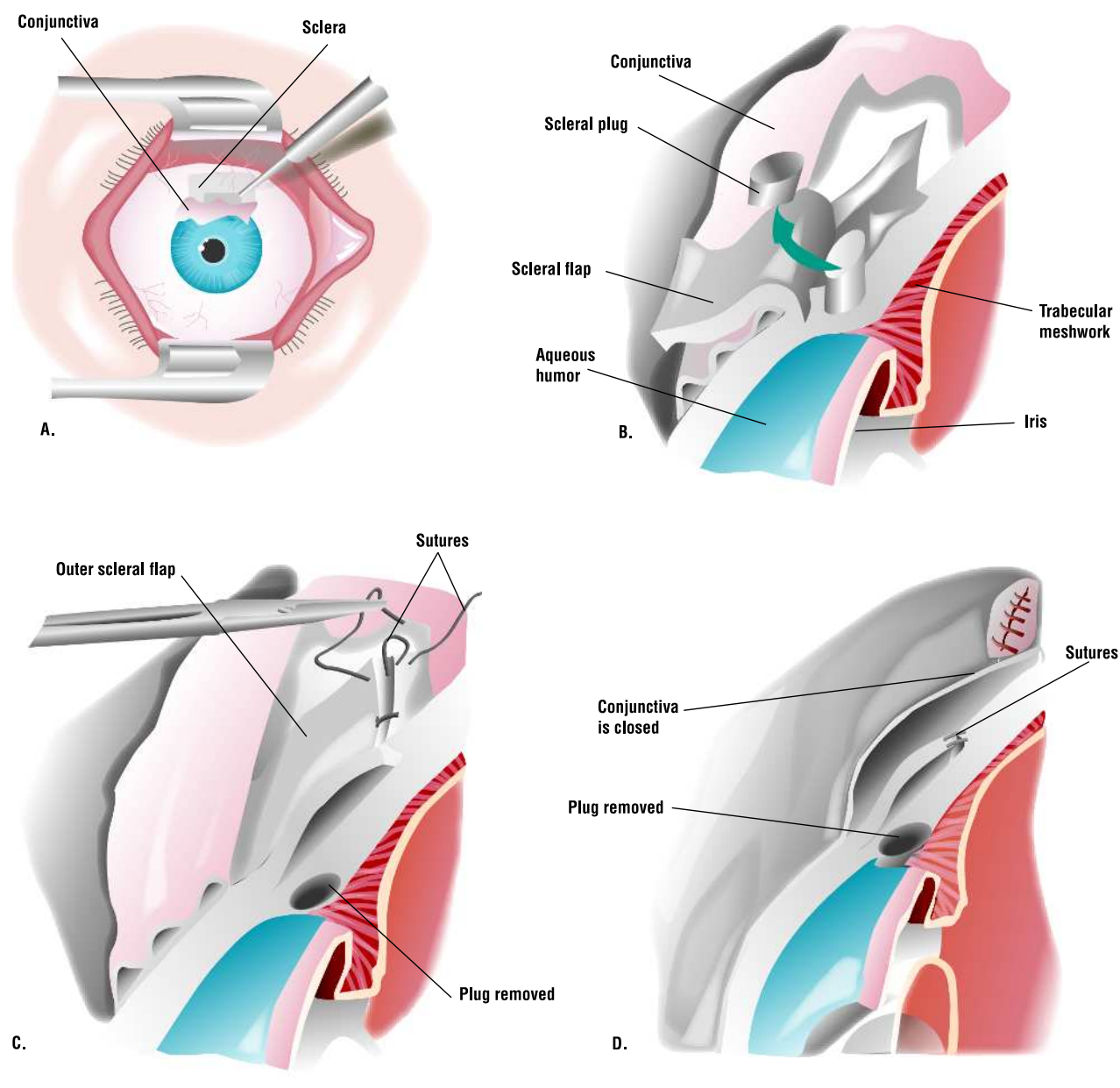
Glaucoma can develop at any age, but people over 45 are at higher risk. African Americans are more likely to develop glaucoma, especially primary open-angle glaucoma. Other factors, such as a family history of glaucoma, greatly increase the risk of contracting the disease. Diabetes and previous eye injury also increase chances of developing glaucoma.

### Description

The procedure is performed in an **operating room**, usually under local anesthetic. However, some ophthalmologists give patients only a topical anesthetic. A trabeculectomy involves removing a tiny piece of the eyeball, where the cornea connects to the sclera, to create a flap that allows fluid to escape the anterior chamber without deflating the eye. The area is called the trabeculum. After the procedure, fluid can flow out onto the eye's surface, where it is absorbed by the conjunctiva, the transparent membrane that lines the sclera and the eyelids.

Sometimes, an additional piece is taken from the iris so that anterior chamber fluid can also flow backward into the vitreous. This procedure is called an **iridectomy**.

## Trabeculectomy



During a trabeculectomy, the patient's eye is held open with a speculum (A). The outer layer, or conjunctiva, and the white of the eye, or sclera, are cut open (A). A superficial scleral flap is created and a plug of sclera and underlying trabecular network is removed (B). This allows the fluid in the eye to circulate, relieving pressure. The scleral flap is closed and sutured (C). The conjunctiva is closed (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

### Diagnosis/Preparation

The procedure is fully explained and any alternative methods to control intraocular pressure are discussed. Antiglaucoma drugs are prescribed before

surgery. Added pressure on the eye caused from coughing or sneezing should be avoided.

Several eye drops are applied immediately before surgery. The eye is sterilized, and the patient draped. A

## KEY TERMS

**Cornea**—Transparent film that covers the iris and pupil.

**Iris**—Colored part of the eye, which is suspended in aqueous humor and perforated by the pupil.

**Sclera**—White, outer coating of the eyeball.

**Trabeculoplasty**—Laser surgery that creates perforations in the trabeculum, to drain built-up aqueous humor and relieve pressure.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Ophthalmologists and optometrists may detect and treat glaucoma; however, only ophthalmologists can perform surgery. Ophthalmologists who are glaucoma subspecialists may have an additional two years of fellowship training.

The outpatient surgery is performed in a hospital or surgery suite designed for ophthalmic surgery.

speculum is inserted to keep the eyelids apart during surgery.

## Aftercare

Eye drops, and perhaps patching, will be needed until the eye is healed. Driving should be restricted until the ophthalmologist grants permission. The patient may experience blurred vision. Severe eye pain, light sensitivity, and vision loss should be reported to the physician.

Antibiotic and anti-inflammatory eye drops must be used for at least six weeks after surgery. Additional medicines may be prescribed to reduce scarring.

## Risks

Infection and bleeding are risks of any surgery. Scarring can cause the drainage to stop. One-third of trabeculectomy patients will develop cataracts.

## Normal results

Trabeculectomy will delay the progression of glaucoma. In many cases, people still require medication to lower IOP.

## Morbidity and mortality rates

Trabeculectomy is considered a safe procedure. Infection is a complication that could lead to more serious medical problems; however, it is controllable with eye drops.

## Alternatives

Physicians will first try to lower IOP with glaucoma medications. Several types of eye drops are effective for this use. Sometimes a patient must instill

more than one eye drop, several times a day. Compliance is very important when using these eye drops; missed dosages will raise IOPs.

Lasers are now used to treat both closed-angle and open-angle glaucoma. Peripheral iridectomy is used for people with acute angle-closure glaucoma attacks and chronic closed-angle glaucoma. The procedure creates a hole to improve the flow of aqueous humor.

Laser trabeculoplasty uses an argon laser to create tiny burns on the trabecular meshwork, which lowers IOP. The effects, however, are not permanent, and the patient must be retreated.

Transscleral cyclophotocoagulation treats the ciliary body with a laser to decrease production of aqueous humor, which reduces IOP.

A tube shunt might be implanted to create a drainage pathway in patients who are not candidates for trabeculectomy.

## Resources

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## QUESTIONS TO ASK THE DOCTOR

Will IOP-lowering medication be needed after the surgery?

How long will it take to determine if the surgery was a success?

Can cataracts be treated in conjunction with glaucoma surgery?

When will vision return to normal?

### ORGANIZATIONS

The Glaucoma Foundation. 116 John Street, Suite 1605 New York, NY 10038. (212) 285 0080. E mail: info@glaucomafoundation.org. www.glaucomafoundation.org

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Mary Bekker

Tracheoesophageal fistula repair see

**Esophageal atresia repair**

Tracheostomy see **Tracheotomy**

## Tracheotomy

### Definition

A tracheotomy is a surgical procedure that opens up the windpipe (trachea). It is performed in emergency situations, in the **operating room**, or at bedside of critically ill patients. The term tracheostomy is sometimes used interchangeably with tracheotomy. Strictly speaking, however, tracheostomy usually refers to the opening itself while a tracheotomy is the actual operation.

### Purpose

A tracheotomy is performed if enough air is not getting to the lungs, if the person cannot breathe without help, or is having problems with mucus and other secretions getting into the windpipe because of difficulty swallowing. There are many reasons why air cannot get to the lungs. The windpipe may be blocked by a swelling; by a severe injury to the neck, nose, or

mouth; by a large foreign object; by paralysis of the throat muscles; or by a tumor. The patient may be in a coma, or need a ventilator to pump air into the lungs for a long period of time

### Demographics

Emergency tracheotomies are performed as needed in any person requiring one.

### Description

#### *Emergency tracheotomy*

There are two different procedures that are called tracheotomies. The first is done only in emergency situations and can be performed quite rapidly. The emergency room physician or surgeon makes a cut in a thin part of the voice box (larynx) called the cricothyroid membrane. A tube is inserted and connected to an oxygen bag. This emergency procedure is sometimes called a **cricothyroidotomy**.

#### *Surgical tracheotomy*

The second type of tracheotomy takes more time and is usually done in an operating room. The surgeon first makes a cut (incision) in the skin of the neck that lies over the trachea. This incision is in the lower part of the neck between the Adam's apple and top of the breastbone. The neck muscles are separated and the thyroid gland, which overlies the trachea, is usually cut down the middle. The surgeon identifies the rings of cartilage that make up the trachea and cuts into the tough walls. A metal or plastic tube, called a tracheotomy tube, is inserted through the opening. This tube acts like a windpipe and allows the person to breathe. Oxygen or a mechanical ventilator may be hooked up to the tube to bring oxygen to the lungs. A dressing is placed around the opening. Tape or **stitches** (sutures) are used to hold the tube in place.

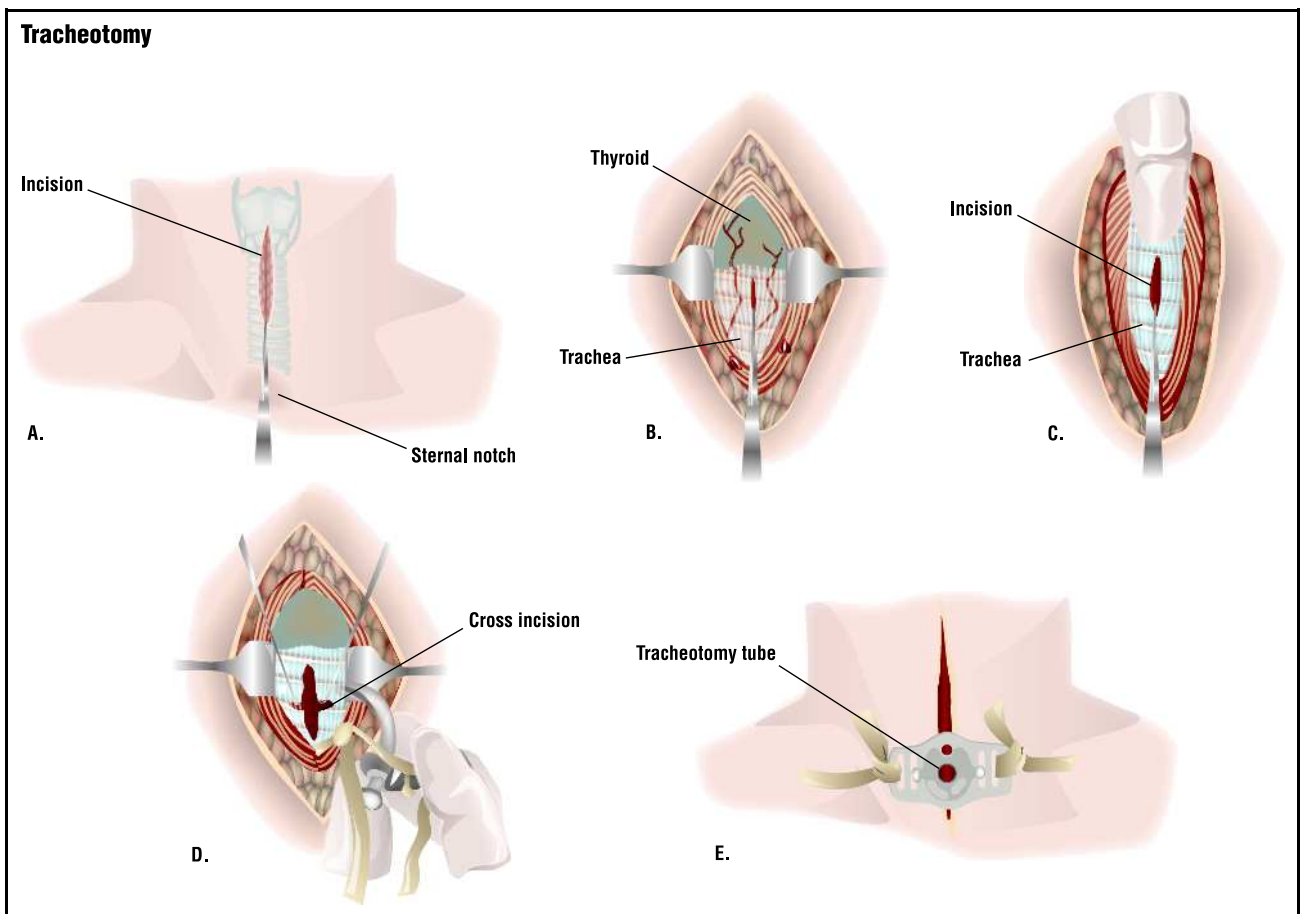
After a nonemergency tracheotomy, the patient usually stays in the hospital for three to five days, unless there is a complicating condition. It takes about two weeks to recover fully from the surgery.

### Diagnosis/Preparation

#### *Emergency tracheotomy*

In the emergency tracheotomy, there is no time to explain the procedure or the need for it to the patient. The patient is placed on his or her back with face upward (supine), with a rolled-up towel between the shoulders. This positioning of the patient makes it easier for the doctor to feel and see the structures in





For a tracheotomy, an incision is made in the skin just above the sternal notch (A). Just below the thyroid, the membrane covering the trachea is divided (B), and the trachea itself is cut (C). A cross incision is made to enlarge the opening (D), and a tracheostomy tube may be put in place (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

the throat. A local anesthetic is injected across the cricothyroid membrane.

### *Nonemergency tracheotomy*

In a nonemergency tracheotomy, there is time for the doctor to discuss the surgery with the patient, to explain what will happen and why it is needed. The patient is then put under **general anesthesia**. The neck area and chest are then disinfected and surgical drapes are placed over the area, setting up a sterile surgical field.

### **Aftercare**

#### *Postoperative care*

A **chest x ray** is often taken, especially in children, to check whether the tube has become displaced or if complications have occurred. The doctor may prescribe **antibiotics** to reduce the risk of infection. If the patient can breathe without a ventilator, the room is

humidified; otherwise, if the tracheotomy tube is to remain in place, the air entering the tube from a ventilator is humidified. During the hospital stay, the patient and his or her family members will learn how to care for the tracheotomy tube, including suctioning and clearing it. Secretions are removed by passing a smaller tube (catheter) into the tracheotomy tube.

It takes most patients several days to adjust to breathing through the tracheotomy tube. At first, it will be hard even to make sounds. If the tube allows some air to escape and pass over the vocal cords, then the patient may be able to speak by holding a finger over the tube. Special tracheostomy tubes are also available that facilitate speech.

The tube will be removed if the tracheotomy is temporary. Then the wound will heal quickly and only a small scar may remain. If the tracheotomy is permanent, the hole stays open and, if it is no longer needed, it will be surgically closed.

## KEY TERMS

**Cartilage**—A tough, fibrous connective tissue that forms various parts of the body, including the trachea and larynx.

**Cricothyroidotomy**—An emergency tracheotomy that consists of a cut through the cricothyroid membrane to open the patient's airway as fast as possible.

**Larynx**—A structure made of cartilage and muscle that connects the back of the throat with the trachea. The larynx contains the vocal cords.

**Trachea**—The tube that leads from the larynx or voice box to two major air passages that bring oxygen to each lung. The trachea is sometimes called the windpipe.

**Ventilator**—A machine that helps patients to breathe. It is sometimes called a respirator.

### Home care

After the patient is discharged, he or she will need help at home to manage the tracheotomy tube. Warm compresses can be used to relieve pain at the incision site. The patient is advised to keep the area dry. It is recommended that the patient wear a loose scarf over the opening when going outside. He or she should also avoid contact with water, food particles, and powdery substances that could enter the opening and cause serious breathing problems. The doctor may prescribe pain medication and antibiotics to minimize the risk of infections. If the tube is to be kept in place permanently, the patient can be referred to a speech therapist in order to learn to speak with the tube in place. The tracheotomy tube may be replaced four to 10 days after surgery.

Patients are encouraged to go about most of their normal activities once they leave the hospital. Vigorous activity is restricted for about six weeks. If the tracheotomy is permanent, further surgery may be needed to widen the opening, which narrows with time.

## Risks

### Immediate risks

There are several short-term risks associated with tracheotomies. Severe bleeding is one possible complication. The voice box or esophagus may be damaged during surgery. Air may become trapped in the surrounding tissues or the lung may collapse. The tracheotomy tube can be blocked by blood clots, mucus, or the pressure of the airway walls. Blockages can be prevented by

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Tracheotomy is performed by a surgeon in a hospital. In an emergency, a tracheotomy may be performed on the scene by another medical professional.

suctioning, humidifying the air, and selecting the appropriate tracheotomy tube. Serious infections are rare.

### Long-term risks

Over time, other complications may develop following a tracheotomy. The windpipe itself may become damaged for a number of reasons, including pressure from the tube, infectious bacteria that forms scar tissue, or friction from a tube that moves too much. Sometimes the opening does not close on its own after the tube is removed. This risk is higher in tracheotomies with tubes remaining in place for 16 weeks or longer. In these cases, the wound is surgically closed. Increased secretions may occur in patients with tracheostomies, which require more frequent suctioning.

### High-risk groups

The risks associated with tracheotomies are higher in the following groups of patients:

- children, especially newborns and infants
- smokers
- alcoholics
- obese adults
- persons over 60
- persons with chronic diseases or respiratory infections
- persons taking muscle relaxants, sleeping medications, tranquilizers, or cortisone

## Normal results

Normal results include uncomplicated healing of the incision and successful maintenance of long-term tube placement.

## Morbidity and mortality rates

The overall risk of **death** from a tracheotomy is less than 5%.

## Alternatives

For most patients, there is no alternative to emergency tracheotomy. Some patients with pre-existing neuromuscular disease (such as ALS or muscular

## QUESTIONS TO ASK THE DOCTOR

- How do I take care of my tracheostomy?
- How many of your patients use noninvasive ventilation?
- Am I a candidate for noninvasive ventilation?

dystrophy) can be successfully managed with emergency noninvasive ventilation via a face mask, rather than with tracheotomy. Patients who receive nonemergency tracheotomy in preparation for **mechanical ventilation** may often be managed instead with noninvasive ventilation, with proper planning and education on the part of the patient, caregiver, and medical staff.

### Resources

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## Traction

### Definition

Traction is force applied by weights or other devices to treat bone or muscle disorders or injuries.

### Purpose

Traction treats fractures, dislocations, or muscle spasms in an effort to correct deformities and promote healing.

### Description

Traction is referred to as a pulling force to treat muscle or skeletal disorders. There are two major types of traction: skin and skeletal traction, within which there are a number of treatments.

#### Skin traction

Skin traction includes weight traction, which uses lighter weights or counterweights to apply force to fractures or dislocated joints. Weight traction may be employed short-term, (e.g., at the scene of an accident) or on a temporary basis (e.g., when weights are connected to a pulley located above the patient's bed). The weights, typically weighing five to seven pounds, attach to the skin using tape, straps, or boots. They bring together the fractured bone or dislocated joint so that it may heal correctly.

In obstetrics, weights pull along the pelvic axis of a pregnant woman to facilitate delivery. In elastic traction, an elastic device exerts force on an injured limb.

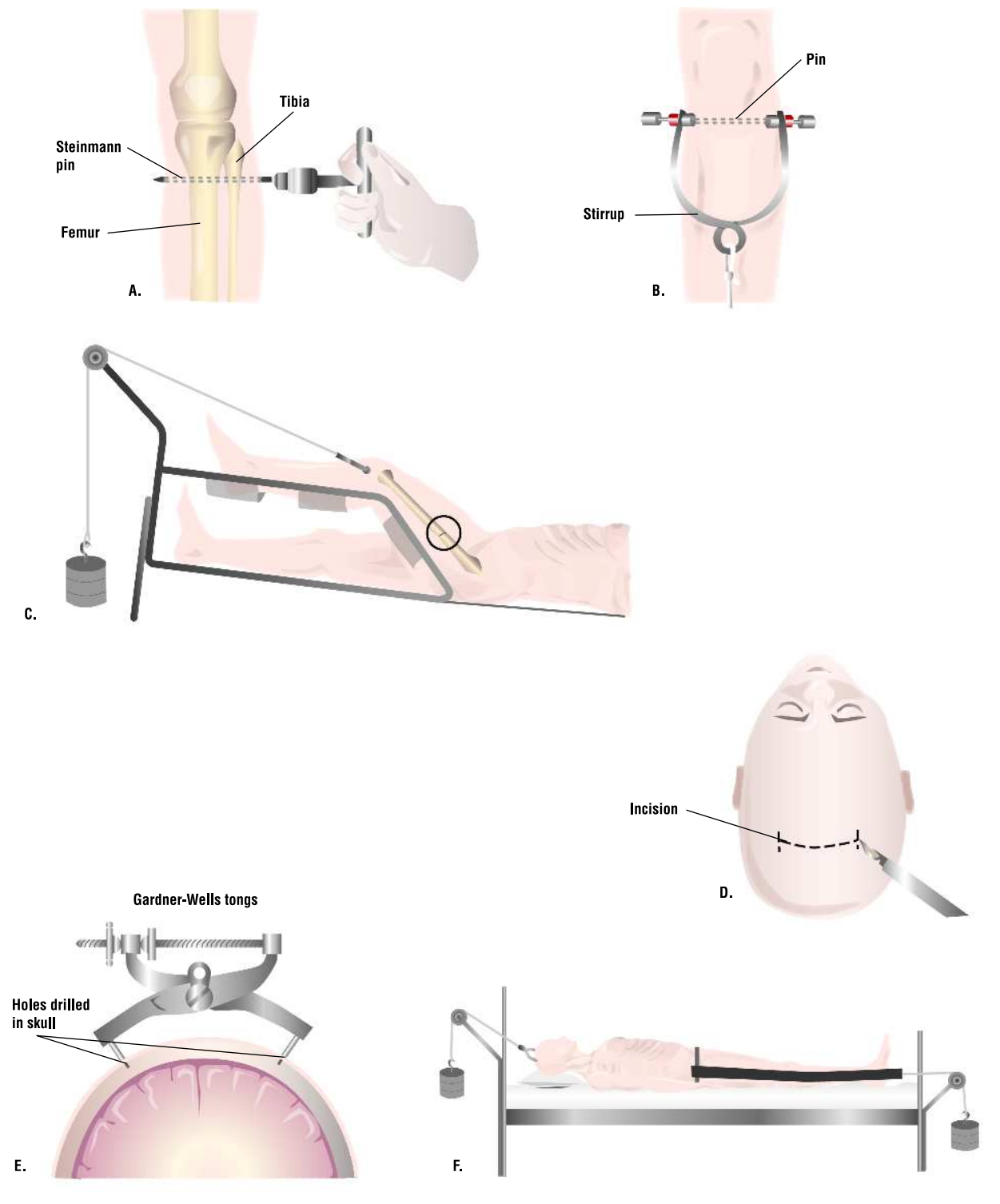
Skin traction also refers to specialized practices, such as Dunlop's traction, used on children when a fractured arm must maintain a flexed position to avoid circulatory and neurological problems. Buck's skin traction stabilizes the knee, and reduces muscle spasm for knee injuries not involving fractures. In addition, splints, surgical collars, and corsets also may be used.

#### Skeletal traction

Skeletal traction requires an invasive procedure in which pins, screws, or wires are surgically installed for use in longer term traction requiring heavier weights. This is the case when the force exerted is more than skin traction can bear, or when skin traction is not appropriate for the body part needing treatment. Weights used in skeletal traction generally range from 25–40 lb (11–18 kg). It is important to place the pins correctly because they may stay in place for several months, and are the hardware to which weights and pulleys are attached. The pins must be clean to avoid infection. Damage may result if the alignment and weights are not carefully calibrated.

Other forms of skeletal traction are tibia pin traction, for fractures of the pelvis, hip, or femur; and overhead arm traction, used in certain upper arm

## Traction



For tibial traction, a pin is surgically placed in the lower leg (A). The pin is attached to a stirrup (B), and weighted (C). In cervical traction, an incision is made into the head (D). Holes are drilled into the skull, and a halo or tongs are applied (E). Weights are added to pull the spine into place (F). (Illustration by GGS Information Services. Cengage Learning, Gale.)



## KEY TERMS

**Skeletal traction**—Traction in which pins, screws, or wires are surgically connected to bone to which weights or pulleys are attached to exert force.

**Skin traction**—Traction in which weights or other devices are attached to the skin.

**Weight traction**—Sometimes used interchangeably with skin traction.

fractures. Cervical traction is used when the neck vertebrae are fractured.

Proper care is important for patients in traction. Prolonged immobility should be avoided because it may cause **bedsores** and possible respiratory, urinary, or circulatory problems. Mobile patients may use a trapeze bar, giving them the option of controlling their movements. An **exercise** program instituted by caregivers will maintain the patient's muscle and joint mobility. Traction equipment should be checked regularly to ensure proper position and exertion of force. With skeletal traction, it is important to check for inflammation of the bone, a sign of foreign matter introduction (potential source of infection at the screw or pin site).

## Diagnosis/Preparation

Both skin and skeletal traction require x rays prior to application. If skeletal traction is required, standard preoperative surgical tests are conducted, such as blood and urine studies. X rays may be repeated over the course of treatment to insure that alignment remains correct, and that healing is proceeding.

## Normal results

There have been few scientific studies on the effects of traction. Criteria (such as randomized controlled trials and monitored compliance) do exist, but an outcome study incorporating all of them has not yet been done. Some randomized controlled trials emphasize that traction does not significantly influence long-term outcomes of neck pain or lower back pain.

## Resources

### BOOKS

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## QUESTIONS TO ASK THE DOCTOR

How long will traction be required?

What are the risks and benefits?

What is the goal of traction?

What is the chance of complications?

## PERIODICALS

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Nancy McKenzie, Ph.D.

Tranquilizers see **Antianxiety drugs**

## Transfusion

### Definition

Transfusion is the process of transferring whole blood or blood components from a donor to a recipient.

### Purpose

Transfusions are given to restore lost blood, to improve clotting time, and to improve the ability of the blood to deliver oxygen to the body's tissues. About 32,000 pints of donated blood are transfused each day in the United States.

In the United States, blood collection is strictly regulated by the Food and Drug Administration (FDA), which has rules for the collection, processing, storage, and transportation of blood and blood products. In addition, the American Red Cross, the American Association of Blood Banks (AABB), and most states have specific rules for the collection and processing of blood. The main purpose of regulation is to ensure the quality of transfused blood and to prevent the transmission of infectious diseases through donated blood. Before blood and blood products are used, they are extensively tested for such infectious

## KEY TERMS

**ABO blood groups**—A system in which human blood is classified according to the A and B antigens found in red blood cells. Type A blood has the A antigen, type B has the B antigen, AB has both, and O has neither.

**Antibody**—A simple protein produced by the body to destroy bacteria, viruses, or other foreign bodies. The production of each antibody is triggered by a specific antigen.

**Antigen**—A substance that stimulates the immune system to manufacture antibodies (immunoglobulins). The function of antibodies is to fight off such intruder cells as bacteria or viruses. Antigens stimulate the blood to fight other blood cells that have the wrong antigens. If a person with blood type A is given a transfusion with blood type B, the A antigens will fight the foreign blood cells as though they were an infectious agent.

**Apheresis**—A procedure in which whole blood is withdrawn from a donor, a specific blood component is separated and collected, and the remainder is reinfused into the patient.

**Autologous blood**—The patient's own blood, drawn and set aside before surgery for use during surgery in case a transfusion is needed.

**Fractionation**—The process of separating the various components of whole blood.

**Hemoglobin**—The red pigment in red blood cells that transports oxygen.

**Hemolysis**—The destruction of red blood cells through disruption of the cell membrane, resulting in the release of hemoglobin. A hemolytic transfusion reaction is one that results in the destruction of red blood cells.

**Immunoglobulin**—An antibody.

**Infusion**—Introduction of a substance directly into a vein or tissue by gravity flow.

**Injection**—Forcing a fluid into the body by means of a needle and syringe.

**Plasma**—The liquid portion of blood, as distinguished from blood cells. Plasma constitutes about 55% of blood volume.

**Platelets**—Disk-shaped structures found in blood that play an active role in blood clotting. Platelets are also known as thrombocytes.

**Rh (rhesus) factor**—An antigen present in the red blood cells of 85% of humans. A person with Rh factor is Rh positive (Rh+); a person without it is Rh negative (Rh-). The Rh factor was first identified in the blood of a rhesus monkey.

**Serum (plural, sera)**—The clear fluid that separates from blood when the blood is allowed to clot completely. Blood serum can also be defined as blood plasma from which fibrinogen has been removed.

agents as hepatitis and human immunodeficiency virus (HIV).

### *Blood and its components*

Either whole blood or its components can be used for transfusion. Most blood collected from donors is broken down (fractionated) into components that are used to treat specific problems or diseases. Treating patients with fractionated blood is the most efficient way to use the blood supply.

**WHOLE BLOOD.** Whole blood is used exactly as received from the donor. Blood components are parts of whole blood, such as red blood cells (RBCs), white blood cells (WBCs), plasma, platelets, clotting factors, and immunoglobulins. Whole blood is used only when needed or when fractionated components are not available, because too much whole blood can raise the recipient's blood pressure. Use of blood components is a more efficient way to use the blood

supply, because blood that has been fractionated can be used to treat more than one person.

Whole blood is generally used when a person has lost a large amount of blood. Such blood loss can be caused by injury or surgical procedures. Whole blood is given to help restore the blood volume, which is essential for maintaining blood pressure. It is also given to ensure that the body's tissues are receiving enough oxygen. Whole blood is occasionally given when a required blood fraction is unavailable in isolated form.

**RED BLOOD CELLS.** Red blood cells (RBCs) carry oxygen throughout the body. They pick up oxygen as they pass through the lungs, and give up oxygen to the other tissues of the body as they are pumped through the arteries and veins. When patients do not have enough RBCs to properly oxygenate their bodies, they can be given a transfusion with RBCs obtained from donors. This type of transfusion will increase the

amount of oxygen carried to the tissues of the body. RBCs are recovered from whole blood after donation. They are then typed, removed from the watery blood plasma to minimize their volume (packed), and stored. RBCs are given to people with anemia (including thalassemia), whose bone marrow does not make enough RBCs, or who have other conditions that decrease the number of RBCs in the blood. Occasionally, red blood cells from rare blood types are frozen. Once frozen, RBCs can survive for as long as 10 years. Packed RBCs are given in the same manner as whole blood.

**WHITE BLOOD CELLS.** White blood cells (WBCs) are another infection-fighting blood component. On rare occasions, white blood cells are given by transfusion to treat life-threatening infections. Such transfusions are given when the WBC count is very low or when the patient's WBCs are not functioning normally. Most of the time, however, **antibiotics** are used in these cases.

**PLASMA.** Plasma is the clear yellowish liquid portion of blood. It contains many useful proteins, especially clotting factors and immunoglobulins. After plasma or plasma factors are processed, they are usually frozen. Some plasma fractions are freeze-dried. These fractions include clotting factors I through XIII. Some people have an inherited disorder in which the body produces too little of the clotting factors VIII (hemophilia A) or IX (hemophilia B). Transfusions of these clotting factors help to stop bleeding in people with hemophilia. Frozen plasma must be thawed before it is used; freeze-dried plasma must be mixed with liquid (reconstituted). In both cases, these blood fractions are usually small in volume and can be injected with a **syringe and needle**.

**PLATELETS.** Platelets are small disk-shaped structures in the blood that are essential for clotting. People who do not have enough platelets (a condition called thrombocytopenia) have bleeding problems. People who have lymphoma or leukemia and people who are receiving cancer therapy do not make enough platelets. Platelets have a very short shelf life; they must be used within five days of **blood donation**. After a unit of blood has been donated and processed, the platelets in it are packed into bags. A platelet transfusion is given in the same manner as whole blood.

**IMMUNOGLOBULINS.** Immunoglobulins are the infection-fighting fractions in blood plasma. They are also known as gamma globulin, antibodies, and immune sera. Immunoglobulins are given to people who have difficulty fighting infections, especially people whose immune systems have been depressed by such diseases as AIDS. Immunoglobulins are also

used to prevent tetanus after a cut has been contaminated; to treat animal bites when rabies is suspected; or to treat severe childhood diseases. Generally, the volume of immunoglobulins used is small, and it can be injected.

## Demographics

In order to donate blood, an individual must be at least 17 years old, weigh at least 110 lb (50 kg), and be in generally good health. The average blood donor is a white, married, college-educated male between the ages of 30 and 50. Twenty-five percent of people receiving blood transfusions are over the age of 65, although the elderly constitute only 13% of the population. Fewer than 5% of Americans donate blood each year.

## Description

Blood is collected from the donor by inserting a large needle into a vein in the arm, usually one of the larger veins near the inside of the elbow. A tourniquet is placed on the upper arm to increase the pressure in the arm veins, which makes the veins swell and become more accessible. Once the nurse or technician has identified a suitable vein, she or he sterilizes the area where the needle will be inserted by scrubbing the skin with a soap solution or an antiseptic that contains iodine. Sometimes both solutions are used. The donor lies on a bed or cot during the procedure, which usually takes between 10 and 20 minutes. Generally, an 18-gauge needle is used. This size of needle fits easily into the veins and yet is large enough to allow blood to flow easily. Human blood will sometimes clot in a smaller needle and stop flowing. The donor's blood is collected in a sterile plastic bag that holds one pint (450 ml). The bags contain an anticoagulant to prevent clotting and preservatives to keep the blood cells alive. A sample of the donor's blood is collected at the time of donation and tested for infectious diseases. The blood is not used until the test results confirm that it is safe. Properly handled and refrigerated, whole blood can last for 42 days.

The recipient of a transfusion is prepared in much the same way as the blood donor. The site for the needle insertion is carefully washed with a soap-based solution followed by an antiseptic containing iodine. The skin is then dried and the transfusion needle inserted into the vein. During the early stages of a transfusion, the recipient is monitored closely to detect any adverse reactions. If no signs of adverse reaction are evident, the patient is monitored occasionally for the duration of the transfusion period. Upon completion of the transfusion, a compress is placed over the needle insertion site to prevent extensive bleeding.

### ***Blood typing***

All donated blood is typed, which means that it is analyzed to determine which of several major and minor blood types (also called blood groups) it belongs to. Blood types are genetically determined. The major types are classified by the ABO system. This system groups blood with reference to two substances in the red blood cells called antigen A and antigen B. The four ABO blood types are A, B, AB, and O. Type A blood has the A antigen, type B has the B antigen, type AB has both, and type O has neither. These four types of blood are further classified by the Rh factor. The Rh, or rhesus factor, is also an antigen in the red blood cells. A person who has the Rh factor is Rh positive; a person who does not have the factor is Rh negative. If a person has red blood cells with both the B and the Rh antigens, that person is said to have a B positive (B+) blood type. Blood types determine which kinds of donated blood a patient can receive. Generally, patients are limited to receiving only blood of the exact same ABO and Rh type as their own. For example, a person with B+ blood can receive blood or blood cells only from another person with B+ blood. An exception is blood type O. Individuals with type O blood are called universal donors, because people of all blood types can accept their blood.

Blood can also be typed with reference to several other minor antigens, such as Kell, Kidd, Duffy, and Lewis. These minor antigens can become important when a patient has received many transfusions. These patients tend to build up an immune response to the minor blood groups that do not match their own. They may have an adverse reaction upon receiving a transfusion with a mismatched minor blood group. A third group of antigens that may cause a reaction are residues from the donor's plasma attached to the RBCs. To eliminate this problem, the RBCs are rinsed to remove plasma residues. These rinsed cells are called washed RBCs.

### ***Other transfusion procedures***

Autologous transfusion is a procedure in which patients donate blood for their own use. Patients who are to undergo surgical procedures requiring a blood transfusion may choose to donate several units of blood ahead of time. The blood is stored at the hospital for the patient's exclusive use. Autologous donation assures that the blood type is an exact match. It also assures that no infection will be transmitted through the blood transfusion. Autologous donation accounts for 5% of blood use in the United States each year.

Directed donors are family or friends of the patient who needs a transfusion. Some people think that family and friends provide a safer source of blood than the general blood supply. Studies do not show that directed donor blood is any safer. Blood that is not used for the identified patient becomes part of the general blood supply.

Apheresis is a special procedure in which only certain specific components of a donor's blood are collected. The remaining blood fractions are returned to the donor. A special blood-processing instrument is used in apheresis. It fractionates the blood, saves the desired component, and pumps all the other components back into the donor. Because donors give only part of their blood, they can donate more frequently. For example, people can give almost 10 times as many platelets by apheresis as they could give by donating whole blood. The donation process takes about one to two hours.

### ***Preparation***

The first step in blood donation is the taking of the donor's medical history. Blood donors are questioned about their general health, their lifestyle, and any medical conditions that might disqualify them. These conditions include hepatitis, AIDS, cancer, heart disease, asthma, malaria, bleeding disorders, and high blood pressure. Screening prevents people from donating who might transmit diseases or whose medical condition would place them at risk if they donated blood. Some geographical areas or communities have a high rate of hepatitis or AIDS. Blood collection in most of these areas has been discontinued indefinitely.

The blood pressure, temperature, and pulse of donors are taken to ensure that they are physically able to donate blood. One pint (450 mL) of blood is usually withdrawn, although it is possible to donate smaller amounts. The average adult male has 10–12 pints of blood in his body; the average adult female has 8–9 pints in hers. Within hours after donating, most people's bodies have replaced the fluid lost with the donated blood, which brings their blood volume back to normal. Replacement of the blood cells and platelets, however, can take several weeks. Pregnant women and people with low blood pressure or anemia should not donate blood or should limit the amount of blood they give. Generally, people are allowed to donate blood only once every two months. This restriction ensures the health of the donor and discourages people from selling their blood. The former practice of paying donors for blood has essentially stopped. Donors who sell blood tend to be at high risk for the transmission of blood-borne diseases.



## Aftercare

Recipients of blood transfusion are monitored during and after the transfusion for signs of an adverse reaction. Blood donors are generally given fluids and light refreshments to prevent such possible side effects as dizziness and nausea. They are also asked to remain in the donation area for 15–20 minutes after giving blood to make sure that they are not likely to faint when they leave.

## Risks

### *Risks for donors*

For donors, the process of giving blood is very safe. Only sterile equipment is used and there is no chance of catching an infection from the equipment. There is a slight chance of infection at the puncture site if the skin is not properly washed before the collection needle is inserted. Some donors feel lightheaded when they sit up or stand for the first time after donating. Occasionally, a donor will faint. Donors are encouraged to drink plenty of liquids to replace the fluid lost with the donated blood. It is important to maintain the fluid volume of the blood so that the blood pressure will remain stable. Strenuous **exercise** should be avoided for the rest of the day. It is normal to feel some soreness or to find a small bluish bruise at the site of the needle insertion. Most donors have very slight symptoms or no symptoms at all after giving blood.

### *Risks for recipients*

A number of precautions must be taken for transfusion recipients. Donated blood must be matched with the recipient's blood type, as incompatible blood types can cause a serious adverse reaction (transfusion reaction). Blood is introduced slowly by gravity flow directly into the veins (intravenous infusion) so that medical personnel can observe the patient for signs of adverse reactions. People who have received many transfusions may develop an immune response to some factors in foreign blood cells. This immune reaction must be evaluated before the patient is given new blood.

Adverse reactions to mismatched blood (transfusion reaction) is a major risk of blood transfusion. Transfusion reaction occurs when antibodies in the recipient's blood react to foreign blood cells introduced by the transfusion. The antibodies bind to the foreign cells and destroy them. This destruction is called a hemolytic reaction. In addition, a transfusion reaction may also cause a hypersensitivity of the immune system that may in turn result in tissue

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Blood may be donated at hospital donor centers, Red Cross chapter houses, or other locations where special blood drives have been organized (churches, places of business, schools, colleges, etc.). The procedure of blood donation is generally performed by a nurse or phlebotomist (a person who has been trained to draw blood). Blood transfusions are generally administered in a hospital or emergency center with a blood bank.

damage within the patient's body. The patient may also have an allergic reaction to mismatched blood.

The first symptoms of transfusion reaction are a feeling of general discomfort and anxiety. Breathing difficulties, flushing, and a sense of pressure in the chest or back pain may also be present. Evidence of a hemolytic reaction can be seen in the urine, which will be colored from the hemoglobin leaking from the destroyed red blood cells. Severe hemolytic reactions are occasionally fatal. Reactions to mismatches of minor factors are milder. These symptoms include itchiness, dizziness, fever, headache, rash, and swelling. Sometimes the patient will experience breathing difficulties and muscle spasms. Most adverse reactions from mismatched blood are not life-threatening.

Infectious diseases can also be transmitted through donated blood and constitute another major risk of blood transfusion. The infectious diseases most often acquired from blood transfusion in the United States are hepatitis and HIV.

Patients who are given too much blood can develop high blood pressure, a concern for people who have heart disease. Very rarely, an air embolism is created when air is introduced into a patient's veins through the tubing used for intravenous infusion. The danger of embolism is greatest when infusion is begun or ended. Care must be taken to ensure that all air is bled out of the tubing before infusion begins, and that the infusion is stopped before air can enter the patient's blood system.

## Normal results

Most individuals will feel only a slight sting from the needle used during the blood donation process, and will not experience any side effects after the procedure is over. Plasma is regenerated by the body

## QUESTIONS TO ASK THE DOCTOR

- Why is a transfusion recommended for my condition?
- Do I have the option of donating my own blood for future use?
- Will I need a transfusion of whole blood or blood components?
- What alternatives to blood transfusion are available to me?

within 24 hours, and red blood cells within a few weeks. Patients who receive a blood transfusion will usually experience mild or no side effects.

### Morbidity and mortality rates

The risk of acquiring an infectious disease from a blood transfusion is very low. The risk of HIV transmission is one in 2,135,000 units of blood; hepatitis B virus (HBV), one in 205,000 units; and hepatitis C virus (HCV), one in 1,935,000 units. Bacterial contamination (a cause of infection) is identified in one in 500,000 for red blood cell units and one in 15,400 for apheresis platelet units. In about 1 in 600,000 to 800,000 transfusions a “fatal misidentification error” occurs; and in about 1 in 12,000 to 19,000 cases a non-fatal error occurs.

### Alternatives

There are several alternatives to blood transfusion. These include:

- Volume expanders. Certain fluids (saline, Ringer’s lactate solution, dextran, etc.) may be used to increase the patient’s blood volume without adding additional blood cells.
- Blood substitutes. Much research is currently being done into compounds that can replace some or all of the functions of blood components. One such compound, called HBOC-201 or Hemopure, is hemoglobin derived from bovine (cow) blood. Hemopure shows promise as a substitute for red blood cell transfusion.
- Bloodless surgery. It may be possible to avoid excessive blood loss through careful planning prior to surgery. Specialized instruments can minimize the amount of blood lost during a procedure. It is also possible to collect some of the blood lost during surgery and reinfuse it into the patient at the end of the operation.

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## Transplant surgery

### Definition

Transplant surgery is the surgical removal of organs, tissue, or blood products from a donor and surgically placing or infusing them into a recipient. There are four categories of transplantation, classified by tissue origin: autograft (donor and recipient are the same person); isograft or syngeneic graft (donor and recipient are genetically identical, as in identical twins); allograft or homograft (donor and recipient are genetically unrelated but belong to the same species, i.e., both are human beings) and xenograft or heterograft (donor and recipient belong to different species, i.e., chimpanzee or rabbit tissues have been used in humans on an experimental basis).

## KEY TERMS

**Antibody**—A substance produced by the immune system in response to specific antigens, thereby helping the body fight infection and foreign substances. An antibody screen involves mixing the white blood cells of the donor with the serum of the recipient to determine if antibodies in the recipient react with the antigens of the donor.

**Autologous blood**—The patient's own blood, drawn and set aside for use during surgery in case a transfusion is needed.

**Bone densitometry test**—A test that quickly and accurately measures the density of bone.

**Brain death**—Irreversible cessation of brain function. Patients with brain death have no potential capacity for survival or for recovery of any brain function.

**Cadaveric donor**—An organ donor who has recently died of causes not affecting the organ intended for transplant.

**Compatible donor**—A person whose tissue and blood type are the same as the recipient's.

**Confirmatory typing**—Repeat tissue typing to confirm the compatibility of the donor and patient before transplant.

**Donor**—A person who supplies organ(s), tissue or blood to another person for transplantation.

**Harvesting**—The process of removing tissues or organs from a donor and preserving them for transplantation.

**Hemodilution**—A technique in which the fluid content of the blood is increased without increasing the number of red blood cells.

**Human leucocyte antigen (HLA)**—A group of protein molecules located on bone marrow cells that can provoke an immune response. A donor's and a recipient's HLA types should match as closely as possible to prevent the recipient's immune system from attacking the donor's marrow as a foreign material that does not belong in the body.

**Immunosuppression**—The use of medications to suppress the immune system to prevent organ rejection.

**Organ procurement**—The process of donor screening, and the evaluation, removal, preservation, and distribution of organs for transplantation.

**Pulmonary function test**—A test that measures the capacity and function of the lungs as well as the blood's ability to carry oxygen. During the test, the patient breathes into a device called a spirometer.

**Rejection**—An immune response that occurs when a transplanted organ is viewed as a foreign substance by the body. If left untreated, rejection can lead to organ failure and even death.

## Purpose

Transplant surgery is a treatment option for diseases or conditions that have not improved with other medical treatments and have led to organ failure or injury. Transplant surgery is generally reserved for people with end-stage disease who have no other options.

The decision to perform transplant surgery is based on the patient's age, general physical condition, specific diagnosis, and stage of the disease. Transplant surgery is not recommended for patients who have liver, lung, or kidney problems; poor leg circulation; cancer; or chronic infections.

## Demographics

The typical cut-off age for a transplant recipient ranges between 40 and 55 years; however, a person's general health is usually a more important factor. In addition, the percentage of transplant recipients over age 50 has increased since 1996.

On average, 66 people receive transplants every day from either a living or deceased donor. Between January and October 2007, 23,703 transplants were performed in the United States; 18,388 organs came from deceased donors, while 5,315 came from living donors.

The national waiting list for most transplanted organs continues to grow every year, even though the number of recipients waiting for a heart transplant has leveled off in recent years, and the waiting list for heart-lung transplants has decreased over the past few years. As of January 2008, there were about 98,000 eligible recipients waiting for an organ transplant in the United States.

## Description

*Organ donors*

Organ donors are classified as living donors or cadaveric (non-living) donors. All donors are carefully screened to make sure there is a suitable blood type

match and to prevent any transmissible diseases or other complications.

**LIVING DONORS.** Living donors may be family members or biologically unrelated to the recipient. From 1992 to 2001, the number of biologically unrelated living donors increased tenfold. Living donors must be physically fit, in good general health, and have no existing disorders such as diabetes, high blood pressure, cancer, kidney disease, or heart disease. Of all the organs transplanted in 2007, about 23% came from living donors. Organs that can be donated from living donors include:

- **Single kidneys.** In 2002, 52% of all kidney transplants came from living donors. There is little risk in living with one kidney because the remaining kidney compensates for and performs the work of both.
- **Liver.** Living donors can donate segments of the liver because the organ can regenerate and regain full function. The number of living donor liver transplants has doubled since 1999.
- **Lung.** Living donors can donate lobes of the lung although lung tissue does not regenerate.
- **Pancreas.** Living donors can donate a portion of the pancreas even though the gland does not regenerate.

Organs donated from living donors eliminate the need to place the recipient on the national waiting list. Transplant surgery can be scheduled at a mutually acceptable time rather than performed under emergency conditions. In addition, the recipient can begin taking immunosuppressant medications two days before the transplant surgery to prevent the risk of rejection. Living donor transplants are often more successful than cadaveric donor transplants because there is a better tissue match between the donor and recipient. The living donor's medical expenses are usually covered by the organ recipient's insurance company, but the amount of coverage may vary.

**CADAVERIC OR DECEASED DONORS.** Organs from cadaveric donors come from people who have recently died and have willed their organs before **death** by signing an organ donor card, or are brain-dead. The donor's family must give permission for organ donation at the time of death or diagnosis of brain death. Cadaveric donors may be young adults with traumatic head injuries, or older adults suffering from a stroke. The majority of deceased donors are older than the general population.

### *Transplant procedures*

**ORGAN HARVESTING.** Harvesting refers to the process of removing cells or tissues from the donor and preserving them until they are transplanted. If the donor is deceased, the organ or tissues are harvested in

a sterile **operating room**. They are packed carefully for transportation and delivered to the recipient via ambulance, helicopter, or airplane. Organs from deceased donors should be transplanted within a few hours of harvesting. After the recipient is notified that an organ has become available, he or she should not eat or drink anything.

When the organ is harvested from a living donor, the recipient's transplant surgery follows immediately after the donor's surgery. The recipient and the donor should not eat or drink anything after midnight the evening before the scheduled operation.

**PREOPERATIVE PROCEDURES.** After arriving at the hospital, the recipient will have a complete physical and such other tests as a **chest x ray**, blood tests, and an **electrocardiogram** (EKG) to evaluate his or her fitness for surgery. If the recipient has an infection or major medical problem, or if the donor organ is found to be unacceptable, the operation will be canceled.

The recipient will be prepared for surgery by having the incision site shaved and cleansed. An intravenous tube (IV) will be placed in the arm to deliver medications and fluids, and a sedative will be given to help the patient relax.

**TRANSPLANT SURGERY.** After the patient has been brought to the operating room, the anesthesiologist will administer a general anesthetic. A central venous catheter may be placed in a vein in the patient's arm or groin. A breathing tube will be placed in the patient's throat. The breathing tube is attached to a mechanical ventilator that expands the lungs during surgery.

The patient will then be connected to a heart-lung bypass machine, also called a cardiopulmonary bypass pump, which takes over for the heart and lungs during the surgery. The heart-lung machine removes carbon dioxide from the blood and replaces it with oxygen. A tube is inserted into the patient's aorta to carry the oxygenated blood from the bypass machine back to the heart for circulation to the body. A nasogastric tube is placed to drain stomach secretions, and a urinary catheter is inserted to drain urine during the surgery.

The surgeon carefully removes the diseased organ and replaces it with the donor organ. The blood vessels of the donated organ are connected to the patient's blood vessels, allowing blood to flow through the new organ.

### **Diagnosis/Preparation**

#### *Pre-transplant evaluation*

Several tests are performed before the transplant surgery to make sure that the patient is eligible to



receive the organ and to identify and treat any problems ahead of time. The more common pre-transplant tests include:

- tissue typing
- blood tests
- chest x ray
- pulmonary function tests
- computed tomography (CT) scan
- heart function tests (electrocardiogram, echocardiogram, and cardiac catheterization)
- sigmoidoscopy
- bone densitometry test

The pre-transplant evaluation usually includes a dietary and social work assessment. In addition, the patient must undergo a complete dental examination to reduce the risk of infection from bacteria in the mouth.

#### *Insurance considerations*

Organ transplantation is an expensive procedure. Insurance companies and health maintenance organizations (HMOs) may not cover all costs. Many insurance companies require precertification letters of medical necessity. As soon as transplantation is discussed as a treatment option, the patient should contact his or her insurance provider as soon as possible to determine what costs will be covered. In the United States as of early 2008, a kidney transplant may cost as much as \$100,000, a liver transplant \$250,000, and a heart transplant \$860,000. There are, however, organizations that can assist with raising funds to cover the cost of transplantation, such as the National Foundation for Transplants and the National Transplant Assistance Fund and Catastrophic Injury Program.

#### *Patient education and lifestyle changes*

Before undergoing transplant surgery, the transplant team will ensure that the patient understands the potential benefits and risks of the procedure. In addition, a team of health care providers will review the patient's social history and psychological test results to ensure that he or she is able to comply with the regimen that is needed after transplant surgery. An organ transplant requires major lifestyle changes, including dietary adjustments, complex drug treatments, and frequent examinations. The patient must be committed to making these changes in order to become a candidate for transplant. Most transplant centers have extensive patient education programs.

**Smoking cessation** is an important consideration for patients who use tobacco. Many transplant

programs require the patient to be a nonsmoker for a certain amount of time (usually six months) before he or she is eligible to participate in the pre-transplant screening evaluation. The patient must also be committed to avoid tobacco products after the transplant.

#### *Informed consent*

Patients are legally required to sign an **informed consent** form prior to transplant surgery. Informed consent signifies that the patient is a knowledgeable participant in making healthcare decisions. The doctor will discuss all of the following with the patient before he or she signs the form: the nature of the surgery; reasonable alternatives to the surgery; and the risks, benefits, and uncertainties of each option. Informed consent also requires the doctor to make sure that the patient understands the information that has been given.

#### *Finding a donor*

After the patient has completed the pre-transplant evaluation and has been approved for transplant surgery, the next step is locating a donor. Organs from cadaveric donors are located through a computerized national waiting list maintained by the United Network for Organ Sharing (UNOS) to assure equal access to and fair distribution of organs. When a deceased organ donor is identified, a transplant coordinator from an organ procurement organization enters the donor's data in the UNOS computer. The computer then generates a list of potential recipients. This list is called a match run. Factors affecting a potential organ recipient's ranking on the match run list include: tissue match, blood type, size of the organ, length of time on the waiting list, immune status, and the geographical distance between the recipient and donor. For some transplants, such as heart, liver, and intestinal segments, the degree of medical urgency is also taken into consideration.

The organ is offered to the transplant team of the first person on the ranked waiting list. The recipient must be healthy enough to undergo surgery, available, and willing to receive the organ transplant immediately. The matching process involves cross matching, performing an antibody screen and a host of other tests.

Donor searching can be a long and stressful process. A supportive network of friends and family is important to help the patient cope during this time. The healthcare provider or social worker can also put the patient in touch with support groups for transplant patients.

### *Contact and travel arrangements*

The patient must be ready to go to the hospital as soon as possible after being notified that an organ is available. A suitcase should be kept packed at all times. Transportation arrangements should be made ahead of time. If the recipient lives more than a 90-minute drive from the transplant center, the transplant coordinator will help make transportation arrangements for the recipient and one friend or family member.

Because harvested organs cannot be preserved for more than a few hours, the transplant team must be able to contact the patient at all times. Some transplant programs offer a pager rental service, to be used only for receiving the call from the transplant center. The patient should clear travel plans with the transplant coordinator before taking any trips.

### *Blood donation and conservation*

Some transplant centers allow patients to donate their own blood before surgery, which is known as autologous donation. Autologous blood is the safest blood for **transfusion**, since there is no risk of disease transmission. Preoperative donation is an option for patients receiving an organ from a living donor, since the surgery can be scheduled in advance. In autologous donation, the patient donates blood once a week for one to three weeks before surgery. The blood is separated and the blood components needed are reinfused during the operation.

In addition to preoperative donation, there are several techniques for minimizing the patient's blood loss during surgery:

- Intraoperative blood collection. The blood lost during surgery is processed, and the red blood cells are reinfused during or immediately after surgery.
- Immediate preoperative hemodilution. The patient donates blood immediately before surgery to decrease the loss of red blood cells during the operation. The patient is then given fluids to restore the volume of the blood.
- Postoperative blood collection. The blood lost from the incision following surgery is collected and reinfused after the surgical site has been closed.

## Aftercare

### *Inpatient recovery*

A transplant recipient can expect to spend three to four weeks in the hospital after surgery. Immediately following the operation, the patient is transferred to an **intensive care unit (ICU)** for close monitoring of his or her **vital signs**. When the patient's condition is

stable, he or she is transferred to a hospital room, usually in a specialized transplant unit. The IV in the patient's arm, the urinary catheter, and a dressing over the incision remain in place for several days. A chest tube may be placed to drain excess fluids. Special stockings may be placed on the patient's legs to prevent blood clots in the deep veins of the legs. A breathing aid called an incentive spirometer is used to help keep the patient's lungs clear and active after surgery.

Medications to relieve pain will be given every three to four hours, or through a device known as a PCA (patient-controlled anesthesia). The PCA is a small pump that delivers a dose of medication into the IV when the patient pushes a button. The transplant recipient will also be given immunosuppressive medications to prevent the risk of organ rejection. These medications are typically taken by the recipient for the rest of his or her life.

A 2–4 week waiting period is necessary before the transplant team can evaluate the success of the procedure. Visitors are limited during this time to minimize the risk of infection. The patient will be given intravenous antibiotic, antiviral and antifungal medications, as well as blood and platelet transfusions to help fight off infection and prevent excessive bleeding. Blood tests are performed daily to monitor the patient's kidney and liver function, as well as his or her nutritional status. Other tests are performed as needed.

### *Outpatient recovery*

After leaving the hospital, the transplant recipient will be monitored through home or outpatient visits for as long as a year. Medication adjustments are often necessary, but barring complications, the recipient can return to normal activities about 6–8 months after the transplant.

Proper outpatient care includes:

- taking medications exactly as prescribed
- attending all scheduled follow-up visits
- contacting the transplant team at the first signs of infection or organ rejection
- having blood drawn regularly
- following dietary and exercise recommendations
- avoiding rough contact sports and heavy lifting
- taking precautions against infection
- avoiding pregnancy for at least a year

## Risks

Short-term risks following an organ transplant include pneumonia and other infectious diseases;

excessive bleeding; and liver disorders caused by blocked blood vessels. In addition, the new organ may be rejected, which means that the patient's immune system is attacking the new organ. Characteristic signs of rejection include fever, rash, diarrhea, liver problems, and a compromised immune system. Transplant recipients are given immunosuppressive medications to minimize the risk of rejection. In most cases, the patient will take these medications for the rest of his or her life.

Long-term risks include an elevated risk of cancer, particularly skin cancer. An estimated 6–8% of transplant patients develop cancer over their lifetime as compared to less than 1% in the general population.

There is a very small risk of infection from a transplanted organ, even though donors in the United States and Canada are carefully screened. In 2007, the Centers for Disease Control and Prevention (CDC) reported a case in which four organ recipients in the Chicago area developed hepatitis C and HIV infection from a high-risk donor. The diseases did not show up on screening tests because the donor contracted them about three weeks before his death, when there were not enough antibodies in his blood to be detected by present tests.

### Normal results

In a successful organ transplant, the patient returns to a more nearly normal lifestyle with increased strength and stamina.

### Morbidity and mortality rates

Mortality figures for transplant surgery include recipients who die before a match with a suitable donor can be found. About 17 patients die every day in the United States waiting for a transplant. In 2001, over 6,000 patients died because the organ they needed was not donated in time.

The Scientific Registry of Transplant Recipients gives the first-year survival rates for transplant surgery as follows:

- 97% of pancreas transplant recipients
- 95% of kidney transplant and kidney/pancreas recipients
- 90% of autologous bone marrow transplant patients
- 86% of liver transplant patients
- 85% of heart transplant patients
- 77% of lung transplant patients
- 70% of allogeneic bone marrow transplant patients

## WHO PERFORMS THIS PROCEDURE AND WHERE IS IT PERFORMED?

A transplant surgeon, along with a multidisciplinary team of transplant specialists, should perform the transplant surgery. Transplant surgeons are usually board-certified by the American Board of Surgery, as well as certified by the medical specialty board or boards related to the type of organ transplant performed. Members of transplant teams include infectious disease specialists, pharmacologists, psychiatrists, advanced care registered nurses, and transplant coordinators in addition to the surgeons and anesthesiologists.

Organ transplants are performed in special transplant centers, which should be members of the United Network for Organ Sharing (UNOS) as well as of state-level accreditation organizations.

Three-year survival rates are:

- 91% for kidney transplant patients
- 87% for pancreas and kidney/pancreas transplant patients
- 80% for liver transplant patients
- 79% for heart transplant patients
- 59% for lung transplant patients

As of early 2008, about 180,000 Americans are living with a transplanted organ.

### Alternatives

#### *Clinical trials*

Available alternatives to transplant surgery depend upon the individual patient's diagnosis and severity of illness. Some patients may be eligible to participate in clinical trials, which are research programs that evaluate a new medical treatment, drug or device. As of early 2008, the NIH has 1,092 studies of organ transplantation that are seeking new volunteers.

#### *Complementary and alternative (CAM) therapies*

Complementary therapies can be used along with standard treatments to help alleviate the patient's pain; strengthen muscles; and decrease depression, anxiety, and stress. Before trying a complementary treatment, however, patients should check with their doctors to make sure that it will not interfere with standard therapy.

## QUESTIONS TO ASK THE DOCTOR

- Who performs the transplant surgery? How many other transplant surgeries has this surgeon performed?
- Where will my organ come from?
- What is the typical waiting period before a donor is found?
- Will my insurance provider cover the expenses of my transplant?
- What types of precautions must I follow before and after my transplant?
- What are the signs of infection and rejection, and what types of symptoms should I report to my doctor?
- When will I find out if the transplant was successful?

or cause harm. Alternative approaches that have helped transplant recipients maintain a positive mental attitude both before and after surgery include meditation, **bio-feedback**, and various relaxation techniques. Massage therapy, music therapy, aromatherapy, and hydrotherapy are other types of treatment that can offer patients some pleasant sensory experiences as well as relieve pain. Acupuncture has been shown in a number of NIH-sponsored studies to be effective in relieving nausea and headache, as well as chronic muscle and joint pain. Some insurance carriers cover the cost of acupuncture treatments.

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- Children's Organ Transplant Association, Inc. 2501 West COTA Drive, Bloomington, IN 47403. (800) 366 2682. <http://www.cota.org> (accessed April 12, 2008).
- Coalition on Donation. 700 North 4th Street, Richmond, VA 23219. (804) 782 4920. <http://www.organtransplants.org/donor/coalition/> (accessed April 12, 2008).
- Division of Transplantation, Health Resources and Services Administration (HRSA). 5600 Fishers Lane, Rm. 14 45, Rockville, MD 20857. 301 443 3376. <http://www.organdonor.gov/> (accessed April 12, 2008).
- National Foundation for Transplants. 5350 Poplar Avenue, Suite 430, Memphis, TN 38119. (800) 489 3863 or (901) 684 1697. <http://www.transplants.org> (accessed April 12, 2008).
- National Heart, Lung and Blood Institute (NHLBI) Information Center. P. O. Box 30105, Bethesda, MD 20824 0105. (301) 251 2222. <http://www.nhlbi.nih.gov> (accessed April 12, 2008).
- National Transplant Assistance Fund and Catastrophic Injury Program. 150 N. Radnor Chester Road, Suite F 120, Radnor, PA 19087. (800) 642 8399. <http://www.transplantfund.org/> (accessed April 12, 2008).
- Partnership for Organ Donation. Two Oliver Street, Boston, MA 02109. (617) 482 5746. <http://www.transweb.org/partnership/> (accessed April 12, 2008).
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Transposition of the great arteries see **Heart surgery for congenital defects**

## Transurethral bladder resection

### Definition

Transurethral bladder resection is a surgical procedure used to view the inside of the bladder, remove tissue samples, and/or remove tumors. Instruments are passed through a cystoscope (a slender tube with a lens and a light) that has been inserted through the urethra into the bladder.

### Purpose

Transurethral resection is the initial form of treatment for bladder cancers. The procedure is performed to remove and examine bladder tissue and/or a tumor. It may also serve to remove lesions, and it may be the only treatment necessary for noninvasive tumors. This procedure plays both a diagnostic and therapeutic role in the treatment of bladder cancers.

### Demographics

Bladder cancer is the sixth most commonly diagnosed malignancy in the United States. According to the American Cancer Society, about 67,160 new cases of bladder cancer were projected to be diagnosed in the United States in 2007.

Industrialized countries such as the United States, Canada, France, Denmark, Italy, and Spain have the highest incidence rates for bladder cancer. Rates are lower in England, Scotland, and Eastern Europe. The lowest rates occur in Asia and South America.

Smoking is a major risk factor for bladder cancer; it increases one's risk by two to five times and accounts for approximately 50% of bladder cancers found in men and 30% found in women. If cigarette smokers quit, their risk declines in two to four years. Exposure to a variety of industrial chemicals also increases the risk of developing this disease. Occupational

exposures may account for approximately 25% of all urinary bladder cancers.

Men have a 1-in-30 chance of developing bladder cancer; women have a 1-in-90 chance of developing bladder cancer. The incidence of bladder cancer in the white population is almost twice that of the black population. For other ethnic and racial groups in the United States, the incidence of bladder cancer falls between that of whites and blacks.

There is a greater incidence of bladder cancer with advancing age. Of newly diagnosed cases in both men and women, approximately 80% occur in people aged 60 years and older.

### Description

Cancer begins in the lining layer of the bladder and grows into the bladder wall. Transitional cells line the inside of the bladder. Cancer can begin in these lining cells.

During transurethral bladder resection, a cystoscope is inserted through the urethra into the bladder. A clear solution is infused to maintain visibility and the tumor or tissue to be examined is cut away using an electric current. A biopsy is taken of the tumor and muscle fibers in order to evaluate the depth of tissue involvement, while avoiding perforation of the bladder wall. Every attempt is made to remove all visible tumor tissue, along with a small border of healthy tissue. The resected tissue is examined under the microscope for diagnostic purposes. An indwelling catheter may be inserted to ensure adequate drainage of the bladder postoperatively. At this time, interstitial radiation therapy may be initiated, if necessary.

### Diagnosis/Preparation

If there is reason to suspect a patient may have bladder cancer, the physician will use one or more methods to determine if the disease is actually present. The doctor first takes a complete medical history to check for risk factors and symptoms, and does a **physical examination**. An examination of the rectum and vagina (in women) may also be performed to determine the size of a bladder tumor and to see if and how far it has spread. If bladder cancer is suspected, the following tests may be performed, including:

- biopsy
- cystoscopy
- urine cytology
- bladder washings
- urine culture
- intravenous pyelogram

## KEY TERMS

**Biopsy**—The removal and microscopic examination of a small sample of body tissue to see whether cancer cells are present.

**Bladder irrigation**—To flush or rinse the bladder with a stream of liquid (as in removing a foreign body or medicating).

**Bladder washings**—A procedure in which bladder washing samples are taken by placing a salt solution into the bladder through a catheter (tube) and then removing the solution for microscopic testing.

**Bladder tumor marker studies**—A test to detect specific substances released by bladder cancer cells into the urine using chemical or immunologic (using antibodies).

**Chemotherapy**—The treatment of cancer with anti-cancer drugs.

**Cystoscopy**—A procedure in which a slender tube with a lens and a light is placed into the bladder to view the inside of the bladder and remove tissue samples.

**Immunotherapy**—A method of treating allergies in which small doses of substances that a person is allergic to are injected under the skin.

**Interstitial radiation therapy**—The process of placing radioactive sources directly into the tumor. These radioactive sources can be temporary (removed after the proper dose is reached) or permanent.

**Intravenous pyelogram**—An x ray of the urinary system after injecting a contrast solution that enables the doctor to see images of the kidneys, ureters, and bladder.

**Metastatic**—A change of position, state, or form; as a transfer of a disease-producing agency from the site of disease to another part of the body; a secondary growth of a cancerous tumor.

**Noninvasive tumors**—Tumors that have not penetrated the muscle wall and/or spread to other parts of the body.

**Radiation therapy**—The use of high-dose x rays to destroy cancer cells.

**Retrograde pyelography**—A test in which dye is injected through a catheter placed with a cystoscope into the ureter to make the lining of the bladder, ureters, and kidneys easier to see on x rays.

**Urine culture**—A test which tests urine samples in the lab to see if bacteria are present.

**Ureters**—Two thin tubes that carry urine downward from the kidneys to the bladder.

**Urethra**—The small tube-like structure that allows urine to empty from the bladder.

**Urine cytology**—The examination of the urine under a microscope to look for cancerous or precancerous cells.

- retrograde pyelography
- bladder tumor marker studies

Most of the time, the cancer begins as a superficial tumor in the bladder. Blood in the urine is the usual warning sign. Based on how they look under the microscope, bladder cancers are graded using Roman numerals 0 through IV. In general, the lower the number, the less the cancer has spread. A higher number indicates greater severity of cancer.

Because it is not unusual for people with one bladder tumor to develop additional cancers in other areas of the bladder or elsewhere in the urinary system, the doctor may biopsy several different areas of the bladder lining. If the cancer is suspected to have spread to other organs in the body, further tests will be performed.

Because different types of bladder cancer respond differently to treatment, the treatment for one patient could be different from that of another person with

bladder cancer. Doctors determine how deeply the cancer has spread into the layers of the bladder in order to decide on the best treatment.

### Aftercare

As with any surgical procedure, blood pressure and pulse will be monitored. Urine is expected to be blood-tinged in the early postoperative period. Continuous bladder irrigation (rinsing) may be used for approximately 24 hours after surgery. Most operative sites should be completely healed in three months. The patient is followed closely for possible recurrence with visual examination, using a special viewing device (cystoscope) at regular intervals. Because bladder cancer has a high rate of recurrence, frequent screenings are recommended. Normally, screenings would be needed every three to six months for the first three years, and every year after that, or as the physician considers necessary. **Cystoscopy** can catch a recurrence before it progresses to invasive cancer, which is difficult to treat.

## Risks

All surgery carries some risk due to heart and lung problems or the anesthesia itself, but these risks are generally extremely small. The risk of **death** from **general anesthesia** for all types of surgery, for example, is only about one in 1,600. Bleeding and infection are other risks of any surgical procedure. If bleeding becomes a complication, bladder irrigation may be required postoperatively, during which time the patient's activity is limited to bed rest. Perforation of the bladder is another risk, in which case the urinary catheter is left in place for four to five days postoperatively. The patient is started on antibiotic therapy preventively. If the bladder is lacerated accompanied by spillage of urine into the abdomen, an abdominal incision may be required.

## Normal results

The results of transurethral bladder resection will depend on many factors, including the type of treatment used, the stage of the patient's cancer before surgery, complications during and after surgery, the age and overall health of the patient, as well as the recurrence of the disease at a later date. The chances for survival are improved if the cancer is found and treated early.

## Morbidity and mortality rates

After a diagnosis of bladder cancer, up to 95% of patients with superficial tumors survive for at least five years. Patients whose cancer has grown into the lining of the bladder but not into the muscle itself, and is not in any lymph nodes or distant sites, have a five year survival rate as high as 85%. The five-year survival rate may be as high as 55% for patients whose tumors have invaded the bladder muscle, but not spread through the muscle into the surrounding fatty tissue. When the cancer has grown totally through the bladder muscle into the surrounding fatty tissue, and perhaps into nearby tissues such as the prostate, uterus, or vagina, the five-year survival rate is about 38%. For patients whose cancer has spread through the bladder wall to the pelvis or abdominal wall or has spread distantly to lymph nodes or other organs (such as the bones, liver, or lungs), the five-year survival rate is 16%.

The five-year survival rate refers to the percentage of patients who live at least five years after their cancer is found, although many people live much longer. Five-year relative survival rates do not take into account patients who die of other diseases. Every person's situation is unique and the statistics cannot

## WHO PERFORMS THIS PROCEDURE AND WHERE IS IT PERFORMED?

Transurethral bladder resections are usually performed in a hospital by a urologist, a medical doctor who specializes in the diagnosis and treatment of diseases of the urinary systems in men and women and also treats structural problems and tumors or stones in the urinary system. Urologists can prescribe medications and perform surgery. If a transurethral bladder resection is required by a female patient, and there are complicating factors, an urogynecologist may perform the surgery. Urogynecologists treat urinary problems involving the female reproductive system.

predict exactly what will happen in every case; these numbers provide an overall picture.

Mortality rates are two to three times higher for men than women. Although the incidence of bladder cancer in the white population exceeds those of the black population, black women die from the disease at a greater rate. This is due to a larger proportion of these cancers being diagnosed and treated at an earlier stage in the white population. The mortality rates for Hispanic and Asian men and women are only about one-half those for whites and blacks. Over the past 30 years, the age-adjusted mortality rate has decreased in both races and genders. This may be due to earlier diagnosis, better therapy, or both.

About 67,160 cases of bladder cancer were projected to be diagnosed in 2007 in the United States. There are over 500,000 bladder cancer survivors in the United States, and approximately 13,750 will die of the disease in 2007.

## Alternatives

Surgery, radiation therapy, immunotherapy, and chemotherapy are the main types of treatment for cancer of the bladder. One type of treatment or a combination of these treatments may be recommended, based on the stage of the cancer.

After the cancer is found and staged, the cancer care team discusses the treatment options with the patient. In choosing a treatment plan, the most significant factors to consider are the type and stage of the cancer. Other factors to consider include the patient's overall physical health, age, likely side effects of the treatment, and the personal preferences of the patient.

## QUESTIONS TO ASK THE DOCTOR

- What benefits can I expect from this operation?
- What are the risks of this operation?
- What are the normal results of this operation?
- What happens if this operation does not go as planned?
- Are there any alternatives to this surgery?
- What is the expected recovery time?

In considering treatment options, a **second opinion** may provide more information and help the patient feel more confident about the treatment plan chosen.

Alternative methods are defined as unproved or disproved methods, rather than evidence-based or proven methods to prevent, diagnose, and treat cancer. For some cancer patients, conventional treatment is difficult to tolerate and they may decide to seek a less unpleasant alternative. Others are seeking ways to alleviate the side effects of conventional treatment without having to take more drugs. Some do not trust traditional medicine, and feel that with alternative medicine approaches, they are more in control of making decisions about what is happening to their bodies.

A cancer patient should talk to the doctor or nurse before changing the treatment or adding any alternative methods. Some methods can be safely used along with standard medical treatment. Others may interfere with standard treatment or cause serious side effects.

The American Cancer Society (ACS) encourages people with cancer to consider using methods that have been proven effective or those that are currently under study. They encourage people to discuss all treatments they may be considering with their physician and other health care providers. The ACS acknowledges that more research is needed regarding the safety and effectiveness of many alternative methods. Unnecessary delays and interruptions in standard therapies could be detrimental to the success of cancer treatment.

At the same time, the ACS acknowledges that certain complementary methods such as aromatherapy, **biofeedback**, massage therapy, meditation, tai chi, or yoga may be very helpful when used in conjunction with conventional treatment.

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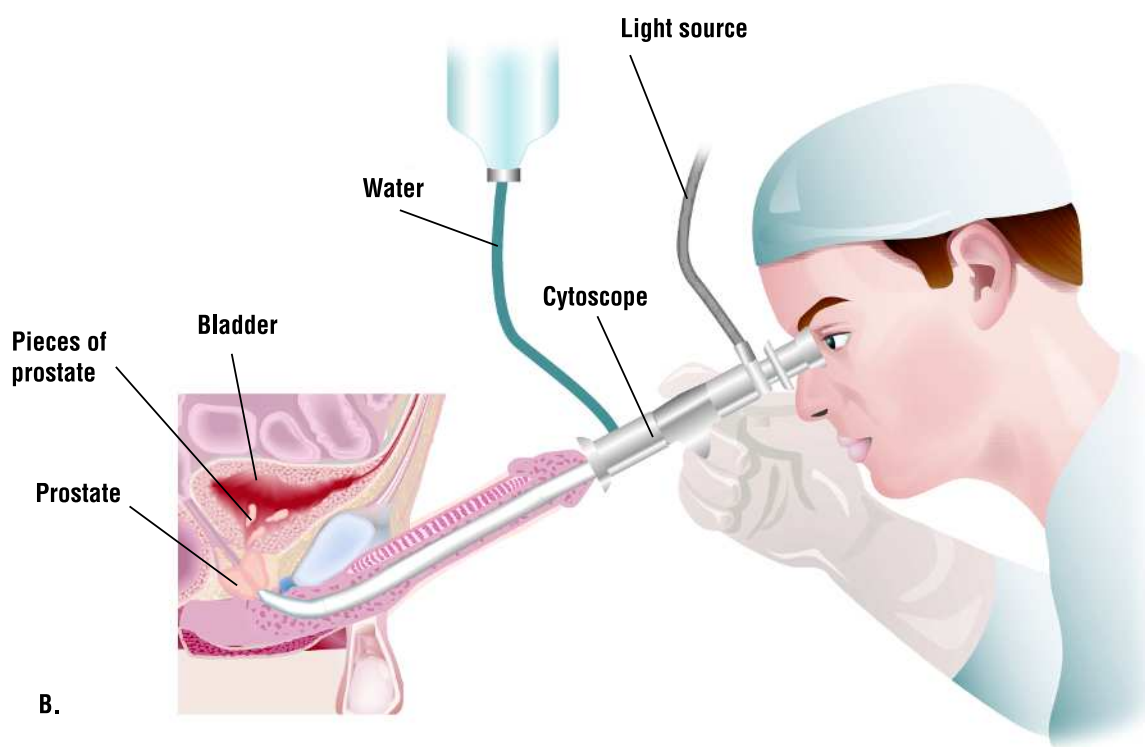
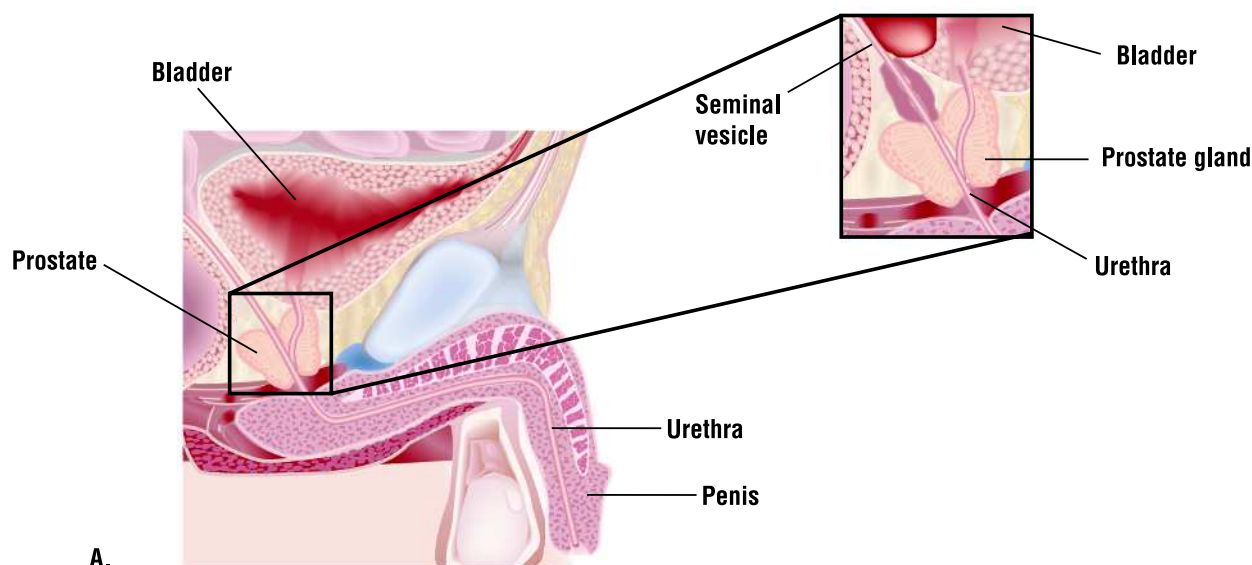
## Transurethral resection of the prostate

### Definition

Transurethral resection of the prostate (TURP) is a surgical procedure in which portions of the prostate gland are removed through the urethra.



## Transurethral resection of the prostate



An enlarged prostate can cause urinary problems due to its location around the male urethra (A). In TURP, the physician uses a cystoscope to gain access to the prostate through the urethra (B). The prostate material that has been restricting urine flow is cut off in pieces, which are washed into the bladder with water from the scope (B). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## Purpose

The prostate is a gland that is part of the male reproductive system. It consists of three lobes and surrounds the neck of the bladder and urethra (a tube that channels urine from the bladder to the outside through the tip of the penis). The prostate weighs approximately 1 oz (28 g) and is walnut-shaped. It is partly muscular and partly glandular, with ducts opening into the urethra. It secretes an antigen called prostate-specific antigen (PSA), and a slightly alkaline fluid that forms part of the seminal fluid (semen) that carries sperm.

The prostate gland undergoes several changes as a man ages. The pea-size gland at birth grows only slightly during puberty and reaches its normal adult shape and size when a male is in his early 20s. The prostate gland remains stable until the mid-40s. At that time, in most men, the number of cells begins to multiply and the gland starts to enlarge.

Enlargement of the prostate causes a common disorder called benign (i.e., non-cancerous) prostatic hyperplasia (BPH) or benign prostatic enlargement (BPE). BPH occurs due to hormonal changes in the prostate, and is characterized by the enlargement or overgrowth of the gland because of an increase in the number of its constituent cells. BPH can raise PSA levels two to three times higher than normal. Men with increased PSA levels have a higher chance of developing prostate cancer.

BPH usually affects the innermost part of the prostate first, and enlargement frequently results in a gradual squeezing of the urethra at the point where it runs through the prostate. The squeezing sometimes causes urinary symptoms (referred to as lower urinary tract symptoms, LUTS), which often include:

- straining when urinating
- hesitation before urine flow starts
- dribbling at the end of urination or leakage afterward
- weak or intermittent urinary stream
- painful urination
- inability to completely empty the bladder

Other symptoms (called storage symptoms) sometimes appear, and may include:

- urgent need to urinate
- bladder pain when urinating
- increased frequency of urination, especially at night
- bladder irritation during urination

The cause of BPH is not fully understood. As of 2008, it was thought to be caused by a hormone that

the prostate gland synthesizes from testosterone called dihydrotestosterone (DHT).

Until the mid 1980s, transurethral resection of the prostate was the treatment of choice for BPH, and the most common surgery performed by urologists. By the mid-2000s, TURP surgery was being performed less frequently because of less invasive alternatives such as microwave therapy and prostatic **laser surgery**. Transurethral refers to the procedure being performed through the urethra. Resection means surgical removal.

## Demographics

Before age 40, a small amount of prostatic hyperplasia is present in 80% of males, and about 10% of males under age 40 have fully developed BPH. Approximately 8–31% of males experience moderate to severe LUTS in their fifties. By age 80, about 80% of men have LUTS. A risk factor is the presence of normally functioning testicles; research indicates that castration can minimize prostatic enlargement. It appears that the glandular tissues that multiply abnormally use male hormones produced in the testicles differently than the normal tissues do.

Approximately 10 million American men and 30 million men worldwide have symptoms of BPH. It is more prevalent in the United States and Europe, and less common among Asians. BPH is more common in men who are married rather than single, and there is a strong inherited component to the disorder. A man's chance for developing BPH is greater if three or more family members have the condition. The average age of men having TURP surgery is 69.

## Description

TURP is a type of surgery that does not involve an external incision. The surgeon reaches the prostate by inserting an instrument through the urethra. In addition to TURP, two other types of transurethral surgery are commonly performed: transurethral incision of the prostate (TUIP), and transurethral laser incision of the prostate (TULIP). The TUIP procedure widens the urethra by making small cuts in the bladder neck (where the urethra and bladder meet), and in the prostate gland itself. In TULIP, a laser beam directed through the urethra melts the tissue.

The actual TURP procedure is simple. It is performed under general or **local anesthesia**. After an intravenous line (IV) is inserted, the surgeon examines the patient with a cystoscope, an instrument that allows him or her to see inside the bladder. The surgeon then inserts a device up the urethra via the penis

## KEY TERMS

**Benign prostatic hyperplasia (BPH)**—Also called benign prostatic enlargement (BPE). Non-cancerous enlargement of the prostate gland as a result of an increase in the number of its constituent cells.

**Benign tumor**—An abnormal growth that is not cancerous (malignant), and does not spread to other areas of the body.

**Cryoprostectomy**—Freezing of the prostate through the use of liquid nitrogen probes guided by transrectal ultrasound of the prostate.

**Digital rectal exam (DRE)**—Procedure in which the physician inserts a gloved finger into the rectum to examine the rectum and the prostate gland for signs of cancer.

**Prostate gland**—A gland in the male that surrounds the neck of the bladder and urethra. The prostate contributes to the seminal fluid.

**Prostatitis**—Inflammation of the prostate gland that may be accompanied by discomfort, pain, frequent urination, infrequent urination, and sometimes fever.

**Protozoan**—A single-celled, usually microscopic organism that is eukaryotic and, therefore, different from bacteria (prokaryotic).

**Transurethral surgery**—Surgery in which no external incision is needed. For prostate transurethral surgery, the surgeon reaches the prostate by inserting an instrument through the urethra.

**Urethra**—The tube that channels urine from the bladder to the outside. In the female, it measures 1 1.5 in (25 38 mm); in the male, 9.8 in (25 cm).

opening, and removes the excess capsule material that has been restricting the flow of urine. The density of the normal prostate differs from that of the restricting capsule, making it relatively easy for the surgeon to tell exactly how much to remove. After excising the capsule material, the surgeon inserts a catheter into the bladder through the urethra for the subsequent withdrawal of urine.

## Diagnosis/Preparation

Common BPH symptoms include:

- increase in urination frequency
- the need to urinate during the night
- difficulty starting urine flow

- a slow, interrupted flow and dribbling after urinating
- sudden, strong urges to pass urine
- a sensation that the bladder is not completely empty
- pain or burning during urination

In evaluating the prostate gland for BPH, the physician usually performs a complete **physical examination** as well as the following procedures:

- **Digital rectal examination (DRE)**. Recommended annually for men over age 50, the DRE is an examination performed by a physician who feels the prostate through the wall of the rectum. Hard or lumpy areas may indicate the presence of cancer.
- **Prostate-specific antigen (PSA) test**. Also recommended annually for men over the age of 50, the PSA test measures the levels of prostate-specific antigen secreted by the prostate. It is normal to observe small quantities of PSA in the blood. PSA levels vary with age, and tend to increase gradually in men over age 60. They also tend to rise as a result of infection (prostatitis), BPH, or cancer.

If the results of the DRE and PSA tests suggest a significant prostate disorder, the examining physician usually refers the patient to a urologist, a medical doctor who specializes in diseases of the urinary tract and male reproductive system. The urologist performs additional tests, including blood and urine studies, to establish a diagnosis.

Patients should select an experienced TURP surgeon to perform the procedure.

## Aftercare

When the patient awakens in the **recovery room** after the procedure, he already has a catheter in his penis, and is receiving pain medication via the IV line inserted prior to surgery. The initial recovery period lasts approximately one week, and includes some pain and discomfort from the urinary catheter. Spastic convulsions of the bladder and prostate are expected as they respond to the surgical changes.

The following medications or ones similar in function may be prescribed after TURP:

- **B&O suppository (belladonna and opium)**. This medication has the dual purpose of providing pain relief and reducing the ureter and bladder spasms that follow TURP surgery. It is a strong medication that must be used only as prescribed.
- **Bulk-forming laxative**. Because of the surgical trauma and large quantities of liquids that patients are required to drink, they may need some form of laxative to promote normal bowel movements.

- **Detrol.** This pain reliever is not as strong as **B&O**. There may be wide variations in its effectiveness and the patient's response. It also controls involuntary bladder contractions.
- **Macrobid.** This antibiotic helps prevent urinary tract infections.
- **Pyridium.** This medication offers symptomatic relief from pain, burning, urgency, frequency, and other urinary tract discomfort.

When discharged from the hospital, patients are advised to avoid weight lifting or strenuous **exercise**. They should check their temperature and report any fever to the physician, and drink plenty of liquids.

### Risks

Serious complications have become less common for prostate surgery patients because of advances in operative methods. Nerve-sparing surgical procedures help prevent permanent injury to the nerves that control erection, as well as injury to the opening of the bladder. However, there are risks associated with prostate surgery. The first is the possible development of incontinence (the inability to control urination), which may result in urine leakage or dribbling, especially immediately after surgery. Normal control usually returns within several weeks, but 3% of patients still experience incontinence three months after surgery. There is also a risk of impotence. For a month or so after surgery, most men are not able to become erect. Eventually, approximately 90% of men who were able to have an erection before surgery will be able to have an erection sufficient for sexual intercourse.

Other risks associated with TURP include blood loss requiring **transfusion**, and postoperative urinary tract infections.

TUR syndrome affects about 2% of TURP patients. Symptoms may include temporary blindness due to irrigation fluid entering the bloodstream. On very rare occasions, this can lead to seizures, coma, and even **death**. The syndrome may also include toxic shock due to bacteria entering the bloodstream, as well as internal hemorrhage.

### Normal results

TURP patients usually notice urine flow improvement as soon as the catheter is removed. Other improvements depend on the condition of the patient's prostate before TURP, his age, and overall health status. Patients are told to expect the persistence of some pre-surgery symptoms. In fact, some new symptoms may appear following TURP, such as occasional

blood and tissue in the urine, bladder spasms, pain when urinating, and difficulty judging when to urinate. TURP represents a major adaptation for the body, and healing requires some time. Full recovery may take up to one year. Patients are almost always satisfied with their TURP outcome, and the adaptation to new symptoms is offset by the disappearance of previous problems. For example, most patients no longer have to take daily prostate medication and quickly learn to gradually increase the time between urinating while enjoying uninterrupted and more restful sleep at night.

Normal postoperative symptoms, some of which are often temporary, include:

- urination at night and reduced flow
- mild burning and stinging sensation while urinating
- reduced semen at ejaculation
- bladder control problems
- mild bladder spasm
- fatigue
- urination linked to bowel movements

To eliminate these symptoms, patients are advised to exercise, retrain their bladders, take all medications that were prescribed, and get plenty of rest to facilitate the post-surgery healing process.

### Morbidity and mortality rates

TURP improves symptoms in about 90% of BPH patients. Overall, 90-day TURP mortality rates are less than 1.5%. The most common cause of death is an overwhelming systemic infection (sepsis). Following surgery, inadequate relief of BPH symptoms occurs in 20–25% of patients, and 15–20% require another operation within 10 years. Urinary incontinence affects about 3%, and about 10% of TURP patients become impotent.

### Alternatives

Conventional surgical alternatives for BPH patients include:

- **Interstitial laser coagulation.** In this procedure, a laser beam inserted in the urethra via a catheter heats and destroys the extra prostate capsule tissue.
- **Transurethral needle ablation (TUNA).** It uses radio waves to heat and destroy the enlarged prostate through needles positioned in the gland. It is generally less effective than TURP for reducing symptoms and increasing urine flow.
- **Transurethral electrovaporization.** This procedure is a modified version of TURP, and uses a device that



## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Transurethral resection of the prostate is performed in hospitals by experienced urologic surgeons who specialize in prostate disorders and in performing the TURP procedure.

produces electronic waves to vaporize the enlarged prostate.

- Photoselective vaporization of the prostate (PVP). This procedure uses a strong laser beam to vaporize the tissue in a 20–50 minute outpatient operation.
- Transurethral incision of the prostate (TUIP). In this procedure, a small incision is made in the bladder, followed by a few cuts into the sphincter muscle to release some of the tension.
- Transurethral microwave thermotherapy (TUMT). TUMT uses microwave heat energy to shrink the enlarged prostate through a probe inserted into the penis to the level of the prostate. This outpatient procedure takes about one hour. The patient can go home the same day, and is able to resume normal activities within a day or two. TUMT does not lead to immediate improvement, and it usually takes up to four weeks for urinary problems to completely resolve.
- Water-induced thermotherapy (WIT). WIT is administered via a closed-loop catheter system, through which heated water is maintained at a constant temperature. WIT is usually performed using only a local anesthetic gel to anesthetize the penis, and is very well tolerated. The procedure is FDA approved.
- Balloon dilation. In this procedure, a balloon is inserted in the urethra up to where the restriction occurs. At that point, the balloon expands to push out the prostate tissue and widen the urinary path. Improvements with this technique may only last a few years.

Some BPH patients have experienced improved prostate health from the following:

- Zinc supplements. This mineral plays an important role in prostate health because it decreases prolactin secretion and protects against heavy metals such as cadmium. Both prolactin and cadmium have been associated with BPH.
- Saw palmetto. Saw palmetto has long been used by Native Americans to treat urinary tract disturbances without causing impotence. It shows no significant side effects. A number of recent European clinical

## QUESTIONS TO ASK THE DOCTOR

- What are the alternative treatments for benign prostatic hyperplasia?
- What are the risks involved with TURP?
- How long will it take to recover from the surgery?
- How painful is the TURP surgery?
- When and how often will the catheter require flushing?
- How long will it take to feel improvement?
- What are the postoperative problems?
- How will the surgery affect the ability to achieve erection?
- How many TURP procedures does the surgeon perform in a year?
- Will the surgery have to be repeated?

studies have also shown that fat soluble extracts of the berry help increase urinary flow and relieve other urinary problems resulting from BPH.

- Garlic. Garlic is believed to contribute to overall body and prostate health.
- Pumpkin seed oil. This oil contains high levels of zinc and has been shown to help most prostate disorders. Eating raw pumpkin seeds each day has long been a folk remedy for urinary problems, but German health authorities have recently recognized pumpkin seeds as a legitimate BPH treatment.
- Pygeum bark. The bark of the *Pygeum africanus* tree has been used in Europe since early times in the treatment of urinary problems. In France, 81% of BPH prescriptions are for Pygeum bark extract.

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Treadmill stress test see **Stress test**

Tremor reduction surgery see **Pallidotomy;**  
**Deep brain stimulation**

Triglyceride test see **Lipid tests**

Trisegmentectomy see **Hepatectomy**

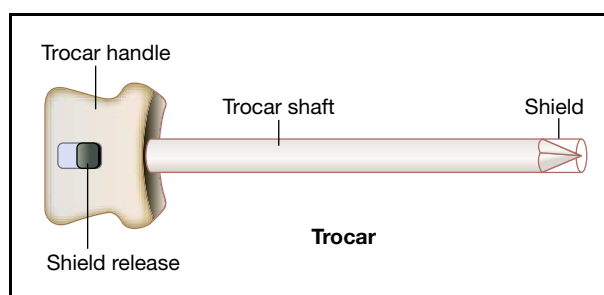
## Trocars

### Definition

A trocar is a surgical instrument. It is a hollow cylinder into which fits another piece called an obturator with a pointed or blunt end. It is used to insert various surgical implements into a blood vessel or body cavity. Trocars were originally three-sided pointed instruments, but are now made in multiple designs with varying degrees of sharpness. Sometimes only the obturator portion is referred to as the trocar and the entire apparatus is referred to as trocar and cannula.

### Procedures Using Trocars

Trocars may be used to insert **surgical instruments** during a **laparoscopy**, a procedure that allows for examination of the peritoneal cavity with minimal cutting of the body wall. Laparoscopic procedures in which trocars are used include **hysterectomy**, endometriosis ablation, and salpingectomy. Trocars can be used to help insert an intravenous cannula (flexible tube) into a blood vessel to allow for the administration of fluids or medication. Trocars may also be used on human cadavers during the embalming procedure to assist in draining bodily fluids in a process known as aspiration.



(Illustration by Electronic Illustrators Group.)

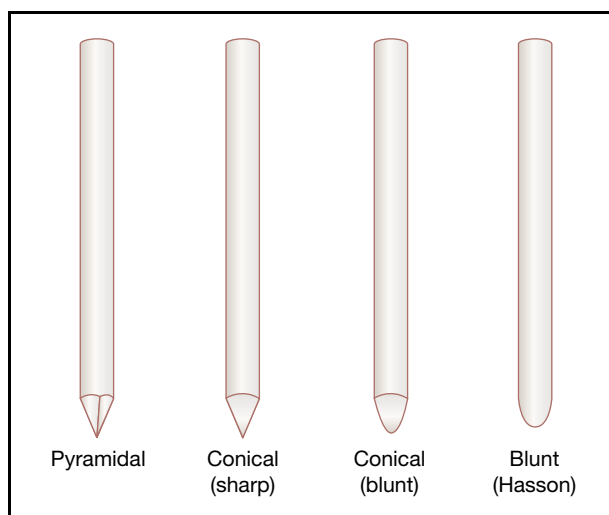
### Description of Trocar Usage

#### Laparoscopy

The first trocar used in a laparoscopic procedure is called the primary trocar. A primary trocar is inserted into the peritoneal cavity, and the obturator portion is withdrawn. The insertion of the primary trocar into the peritoneal cavity requires enough force to penetrate the body wall with the obturator, while avoiding damage to the underlying structures. Appropriate training and skill is required to properly insert the primary trocar with guided force known as a "controlled jab". The cannula remains in the insertion site and is used as an access port through which to put other instruments in place. Through the cannula, a laparoscope (camera), or other surgical tool may be inserted into the body cavity. Once the laparoscope is inserted, the surgeon can see the internal structures of the body. However, when the primary trocar is inserted, it is usually done without being able to view the structures lying just underneath it. Hence insertion of the primary trocar is sometimes referred to as a "blind jab". Potential for damage to internal organs is decreased by inflating the abdominal cavity with carbon dioxide gas before trocar insertion, to hold the body wall away from the organs. Multiple trocars may be used for each procedure. Laparoscopies commonly require two to five trocars for completion. Insertion of each trocar carries the risk for a life-threatening injury.

#### Embalming

Trocars are used during the embalming of human cadavers to insert tubes for drainage of bodily fluids. Once the blood has been replaced with embalming chemicals, the trocar is inserted and attached to a suction hose for aspiration. The insertion is made near the umbilicus in order to aspirate the main body cavities. Once the fluid is drained the trocar is detached from the aspirating hose and attached to a bottle of cavity-embalming fluid. The trocar is then used to fill



(Illustration by Electronic Illustrators Group.)

the body cavities with the fluid. The trocar puncture is sealed with a plastic plug called a trocar button.

### Description of Trocar Designs

Trocars have evolved from one to two basic designs to many. According to the last trocar review done by the FDA, in 2003 there were greater than 100 different brand names being produced from greater than 20 different manufacturers. Trocars may be pointed with a cutting blade at the tip, blunt and bladeless, fitted with a protective shield, or contain a tiny camera for guided, optical entry into the body.

#### Cutting Trocars

Cutting trocars have been designed with sharp tips in order to create an incision in the body wall and facilitate insertion of the cannula into the peritoneal cavity. Sharp trocar ends may be three-sided and pyramidal, or conical. Multiple types of cutting trocars exist, most of which require blind entry into the peritoneal cavity. Cutting trocars require the least amount of force to insert into the body cavity. However, they cause the greatest amount of postsurgical insertion site pain, scarring, and sometimes hernia formation. Cutting trocars pose the greatest risk for damage to a major blood vessel or puncture of internal organs such as the intestines. Cutting trocars are associated with the greatest number of life threatening injuries, especially in patients for whom trocar insertion is difficult to perform.

#### Shielded Cutting Trocars

Trocars have been designed with a retractable, protective shield that covers the pointed tip before

and after insertion into the peritoneal cavity. The shield was added to trocar designs in 1984 in an attempt to protect the abdominal and pelvic blood vessels and organs from accidental puncture with the trocar tip. For this reason shielded tips were originally called “safety trocars”. However, whether or not the shielded tip actually warrants the term “safety trocar” is controversial. Serious injuries as well as deaths have both been associated with shielded trocars. According to trocar safety reviews done by the FDA, shielded trocars may have a somewhat improved safety profile if used properly. However, a general concern for the use of shielded trocars is a mistaken sense of security on the part of the surgeon, leading to inadvertent injury despite the shield. The shield itself has been shown to damage blood vessels, and shielded trocars can still cause life-threatening injury. Because of a lack of data proving shielded trocars as “safe” and concern for the issues previously described, in 1996 the FDA asked manufacturers to stop using the term “safety trocars” when describing a shielded trocars.

#### Bladeless Trocars

Trocars have also been designed in varying degrees of bluntness to help prevent accidental damage to blood vessels or internal organs when inserted into the peritoneal cavity. A Hasson trocar is very blunt and pushes through the layers of the abdominal wall instead of cutting them. The tissue fibers are merely separated instead of sliced, and can reposition naturally after the trocar is removed. Compared with cutting trocars, the blunt trocars require more force to insert into the peritoneal cavity. However, they create smaller trocar insertion tissue defects that take less time to heal, decrease the incidence of hernia formation, cause less scarring, and less postsurgical trocar insertion site pain. Bladeless trocars were designed in an attempt to minimize trocar-related injury or puncture of internal structures.

A Hasson trocar is implemented using the Hasson “cut-down” or “open” technique. Hasson trocars are so blunt-ended that they can only be inserted into the peritoneal cavity after the surgeon makes a small 2 to 3 cm incision through which to push the trocar (hence the term “cut-down” technique). The surgeon can see the area through which the trocar is penetrating and so the procedure does not require blind insertion (hence the term “open” technique). The Hasson trocar can then be used along with retractors to introduce other tools such as a laparoscope into the body cavity. The Hasson technique offers the advantage over traditional cutting trocars of being an open technique (as opposed to blind), and so may further

minimize risk to blood vessels and internal organs. Whether or not the Hasson technique has succeeded as such is a matter of controversy, with studies especially differing on whether there is any real advantage regarding organ injury. Some types of blunt trocars are radially-expanding upon entry of the abdominal cavity to lift the abdominal wall up and away from the internal structures. Whether this design of trocar confers greater safety margins and reduces risk of injury is also controversial.

### ***Optical Trocars***

Each of the trocars discussed so far offer only blind access into the peritoneal cavity, potentially resulting in inadvertent, life threatening injury. In 1994, trocars were developed that have a tiny viewing “window” positioned at their tip for a laparoscope. This design of trocar enables the surgeon to observe the primary trocar insertion through the laparoscope and removes the necessity of a blind initial puncture. The surgeon can actually view each tissue layer being penetrated by the trocar device, as well as the underlying abdominal cavity and internal structures. While this design is an improvement over blind insertion trocars, injuries are still reported with optical trocars.

### **Risks**

Trocar use is associated with risk of life-threatening injury. Injuries most commonly occur during the initial insertion of the primary trocar, often a blind insertion of the trocar before the laparoscope can be inserted. The risk is that the force being applied to penetrate the abdominal wall may accidentally propel the trocar into a blood vessel or puncture an internal organ such as the large intestine. Blood vessel hemorrhage or life-threatening bacterial infections may result. Each patient and circumstance requires a different amount of force to be applied for trocar insertion. It requires skill and experience on the part of the surgeon to insert the trocar with sufficient force to penetrate the abdominal cavity, while still maintaining enough control to stop the movement of the trocar once the abdominal wall has been traversed. The safety margin between the force required for trocar insertion and trocar injury is very slim, especially for children and small, thin adults. Blunt trocars require more force for insertion than cutting trocars. Despite the blunt edges of these trocars, the extra force required for penetration contributes to risk of propelling the trocar into and injuring the bowels. Additionally, the larger a trocar is, the greater the risk of injury to the patient. For each patient, surgeons use the smallest trocar possible.

Patients who have had prior abdominal surgery have a higher risk of trocar injury. After abdominal surgery, the internal organs and other structures of the abdominal cavity sometimes develop scar tissue that causes them to adhere to the abdominal wall. If internal structures are attached to the site of trocar entry, even filling the abdomen with carbon dioxide gas is not sufficient to keep them out of the path of injury upon primary trocar insertion. For this reason, blind insertion trocars should not be used on patients with a history of abdominal surgery. If lower abdominal surgery is included in patient history, there is a location that may be safely used for trocar insertion known as Palmer’s Point. Palmer’s Point is located in the upper left quadrant of the abdomen, and usually does not contain internal structures that may be injured upon trocar insertion.

### **Morbidity and mortality rates**

The most common types of trocar injury are blood vessel damage leading to hemorrhage and bowel injury leading to peritoneal infection. The morbidity and mortality of trocar-related injuries increases when not caught early on. A delay in recognition or treatment of trocar injuries can be fatal for the patient. Injuries occur most frequently with insertion of the primary trocar, which may be the step in laparoscopies associated with the greatest risk.

Trocar use requires extensive training, experience, manual skill, muscular strength, control, and knowledge of the associated risks for each type of patient. Morbidity and mortality are due to a combination of the surgeon’s skill level, the type of trocar, and patient-based risk factors. Whether on the part of the patient or the doctor, the failure of recognition of the symptoms of injury in a timely manner contribute much to the morbidity and mortality of trocar usage.

#### ***Patient-based risk factors for injury with blind trocar insertion***

- Prior abdominal surgery
- Children
- Small, thin body type
- Alterations in abdomen skin due to multiple pregnancies
- Atrophied abdominal musculature

#### ***Alternatives to procedures with blind trocar insertion***

- Laparotomy
- Hasson open technique
- Radially-expanding and optical-access trocars



## KEY TERMS

**Atrophy**—Wasting of body tissues.

**Cadaver**—A dead body.

**Cannula**—A tube inserted into a body cavity.

**Endometriosis Ablation**—Procedure of removing endometrial tissue from deposition on structures within the abdominal cavity.

**Embalming**—Process of treating a dead body with chemicals to preserve it from decay.

**Hemorrhage**—Excessive blood loss through blood vessel walls.

**Hernia**—Protrusion of a structure through the tissues normally containing it.

**Hysterectomy**—Removal of the uterus.

**Laparoscope**—Tiny camera inserted into the body and used in surgical procedures called laparoscopies.

**Laparoscopy**—A type of minimally invasive surgery performed in the peritoneal cavity.

**Laparotomy**—Incision into the loin.

**Morbidity**—A state of disease or illness.

**Obturator**—Any structure that occludes an opening. A trocar obturator has a tip used to penetrate the body wall while being held in the cannula of the trocar apparatus.

**Peritoneal Cavity**—Part of the abdominal cavity holding many organs.

**Retractor**—Surgical tool used to hold structures away from the surgical field.

**Salpingectomy**—Removal of the uterine tube.

- Use of Palmer's point for trocar insertion (for patients with a history of prior abdominal surgery)

### *Potential signs and symptoms of internal hemorrhage into abdominal cavity*

- Anemia, fatigue, and pallor
- Low-grade fever
- Increased heart rate
- Low blood pressure
- Shoulder pain
- Dizziness
- Faintness
- Nausea
- Lack of appetite

### *Potential signs and symptoms of untreated bowel injury*

- Tender abdomen
- Pain
- Fever and chills
- Loss of appetite
- Nausea and vomiting
- Increased breathing rate
- Increased heart rate
- Low blood pressure
- Decreased urine production
- Inability to pass gas or feces

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Maria Basile, PhD

Troponins test see **Cardiac marker tests**

## Tubal ligation

### Definition

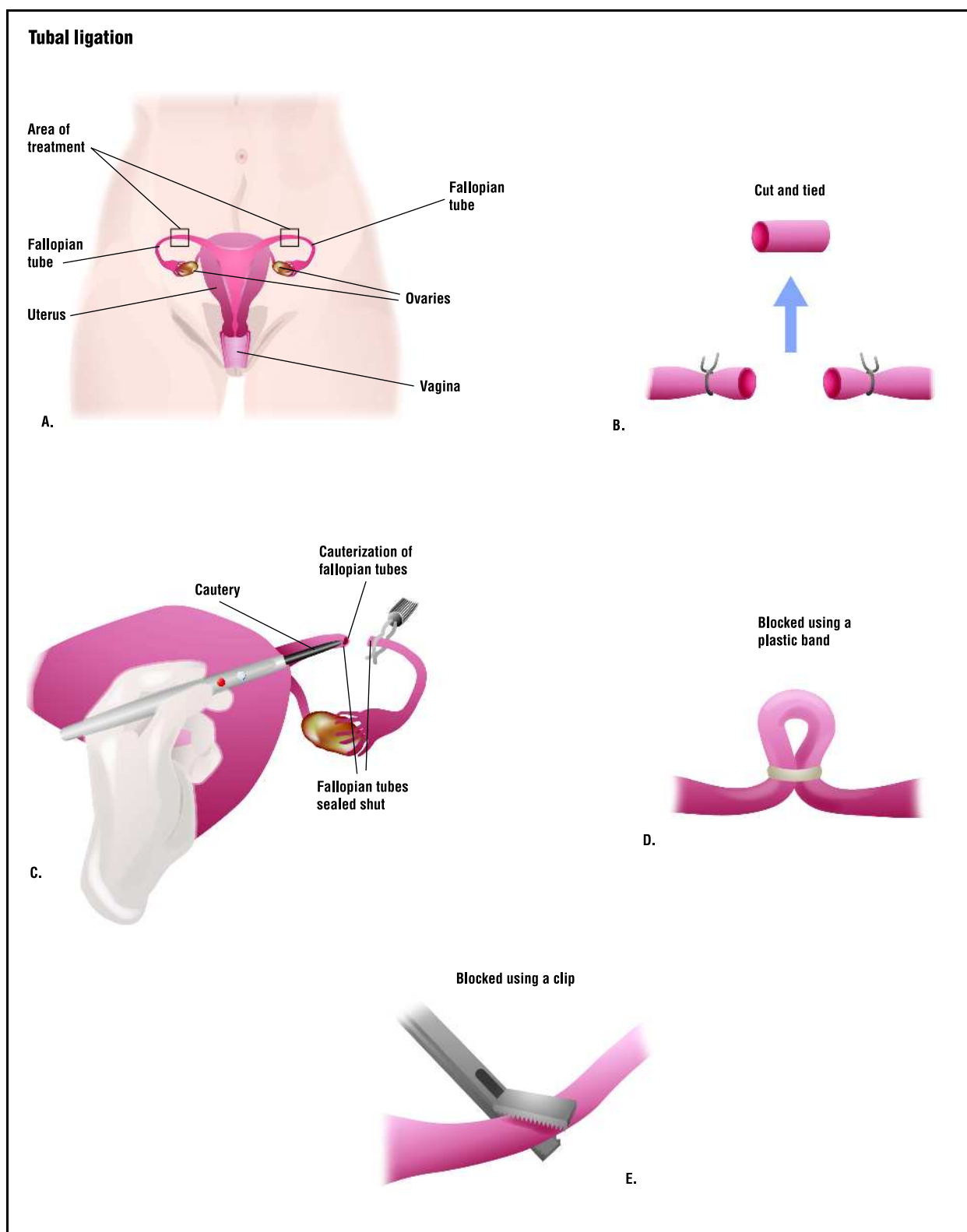
Tubal ligation is a permanent voluntary form of birth control (contraception) in which a woman's fallopian tubes are surgically cut, tied, or blocked off to prevent pregnancy.

### Purpose

Tubal ligation is performed in women who want to prevent future pregnancies. It is frequently chosen by women who do not want more children, but who are still sexually active and potentially fertile, and want to be free of the limitations of other types of birth control. Women who should not become pregnant for health concerns or other reasons may also choose this birth control method.

### Demographics

Tubal ligation is one of the leading methods of contraception. This form of contraception is chosen by about 650,000–700,000 annually in the United



In a tubal ligation, a woman's reproductive organs are accessed by abdominal incision or laparoscopy (A). The fallopian tubes are cut and tied (B), cauterized (C), blocked with a silicone band (D), or clipped (E) to ensure sperm is not able to fertilize an egg. (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Contraception**—The prevention of the union of the male's sperm with the female's egg.

**Ectopic pregnancy**—The implantation of a fertilized egg in a fallopian tube instead of the uterus.

**Electrocoagulation**—The coagulation or destruction of tissue through the application of a high-frequency electrical current.

**Female sterilization**—The process of permanently ending a woman's ability to conceive by tying off or cutting apart the fallopian tubes.

**Laparoscopy**—Abdominal surgery performed through a laparoscope, which is a thin telescopic instrument inserted through an incision near the navel.

**Laparotomy**—A procedure in which the surgeon opens the abdominal cavity to inspect the patient's internal organs.

**Vasectomy**—Surgical sterilization of the male, done by removing a portion of the tube that carries sperm to the urethra.

States. The typical tubal ligation patient is over age 30, is married, and has had two or three children.

### Description

Tubal ligation, or getting one's "tubes tied," refers to female sterilization, the surgery that ends a woman's ability to conceive. The operation is performed on the patient's fallopian tubes. These tubes, which are about 4 in (10 cm) long and 0.2 in (0.5 cm) in diameter, are found on the upper outer sides of the uterus. They open into the uterus through small channels. It is within the fallopian tube that fertilization, the joining of the egg and the sperm, takes place. During tubal ligation, the tubes are cut or blocked in order to close off the sperm's access to the egg.

Normally, tubal ligation takes about 20–30 minutes, and is performed under **general anesthesia**, spinal anesthesia, or **local anesthesia** with sedation. The surgery can be performed on either hospitalized patients within 24 hours after childbirth or on outpatients. The woman can usually leave the hospital the same day.

Tubal ligation should be postponed if the woman is unsure about her decision. While the procedure is sometimes reversible, it should be considered permanent and irreversible. As many as 10% of sterilized women regret having had the surgery, and about 1% seek treatment to restore their fertility.

The most common surgical approaches to tubal ligation include **laparoscopy** and mini-laparotomy. In a laparoscopic tubal ligation, a long, thin telescope-like surgical instrument called a laparoscope is inserted into the pelvis through a small cut about 0.5 in (1 cm) long near the navel. Carbon dioxide gas is pumped in to help move the abdominal wall to give the surgeon easier access to the tubes. Often, the **surgical instruments** are inserted through a second incision near the pubic hair line. An instrument may be placed through the vagina to hold the uterus in place.

In a mini-laparotomy, a 1.2–1.6 in (3–4 cm) incision is made just above the pubic bone or under the navel. A larger incision, or laparotomy, is rarely used today. Tubal ligation can also be performed at the time of a **cesarean section**.

The tubal ligation itself is performed in several ways, including:

- **Electrocoagulation.** A heated needle connected to an electrical device is used to cauterize or burn the tubes. Electrocoagulation is the most common method of tubal ligation.
- **Falope ring.** In this technique, an applicator is inserted through an incision above the bladder and a plastic ring is placed around a loop of the tube.
- **Hulka clip.** The surgeon places a plastic clip across a tube held in place by a steel spring.
- **Silicone rubber bands.** A band placed over a tube forms a mechanical block to sperm.

Tubal ligation costs between \$2,000 and \$2,500 when performed by a private physician, but is less expensive when performed at a family planning clinic. Most insurance plans cover treatment costs.

### Diagnosis/Preparation

Preparation for tubal ligation includes patient education and counseling. Before surgery, it is important that the woman understand the permanent nature of tubal ligation as well as the risks of anesthesia and surgery. Her medical history is reviewed, and a **physical examination** and laboratory testing are performed. The patient is not allowed to eat or drink for several hours before surgery.

### Aftercare

After surgery, the patient is monitored for several hours before she is allowed to go home. She is instructed on care of the surgical wound, and what signs to watch for, such as fever, nausea, vomiting, faintness, or pain. These signs could indicate that complications have occurred.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Tubal ligation is generally performed by an obstetrician/gynecologist, a medical doctor who has completed specialized training in the areas of women's general health, pregnancy, labor and childbirth, prenatal testing, and genetics. The procedure is performed in a hospital or family planning clinic, and usually as an outpatient procedure.

### Risks

While major complications are uncommon after tubal ligation, there are risks with any surgical procedure. Possible side effects include infection and bleeding. After laparoscopy, the patient may experience pain in the shoulder area from the carbon dioxide used during surgery, but the technique is associated with less pain than mini-laparotomy, as well as a faster recovery period. Mini-laparotomy results in a higher incidence of pain, bleeding, bladder injury, and infection compared with laparoscopy. Patients normally feel better after three to four days of rest, and are able to resume sexual activity at that time.

The possibility for treatment failure is very low—about five women per 1,000 will become pregnant during the first year after sterilization. The failure rate increases over time, so that 10 years after the procedure, the failure rate is 18 women per 1,000. Failure can happen if the cut ends of the tubes grow back together; if the tube was not completely cut or blocked off; if a plastic clip or rubber band has loosened or come off; or if the woman was already pregnant at the time of surgery.

### Normal results

After having her tubes tied, a woman does not need to use any form of birth control to avoid pregnancy. Tubal ligation is almost 100% effective for the prevention of conception.

### Morbidity and mortality rates

About 1–4% of patients experience complications following tubal ligation. There is a low risk (less than 1%, or seven per 1,000 procedures) of a later ectopic pregnancy. Ectopic pregnancy is a condition in which the fertilized egg implants in a place other than the uterus, usually in one of the fallopian tubes. Ectopic

## QUESTIONS TO ASK THE DOCTOR

- How many tubal ligations do you perform each year?
- What method of ligation will you use?
- What form of anesthesia will be used?
- How long will the procedure take?
- What side effects or complications might I expect?
- What is your failure rate?

pregnancies are more likely to happen in younger women, and in women whose tubes were closed off by electrocoagulation.

Rarely, **death** may occur as a complication of general anesthesia if a major blood vessel is cut. The mortality rate of tubal ligation is about 4-in-100,000 sterilizations.

### Alternatives

There are numerous options available to women who wish to prevent pregnancy. Oral contraceptives are the second most common form of contraception—the first being female sterilization—and have a success rate of 95–99.5%. Other methods of preventing pregnancy include **vasectomy** (99.9% effective) for the male partner; the male condom (86–97% effective); the diaphragm or cervical cap (80–94% effective); the female condom (80–95% effective); and abstinence.

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## Tube-shunt surgery

### Definition

Tube-shunt surgery, or Seton tube shunt glaucoma surgery, is a surgical method to treat glaucoma. Glaucoma is a potentially blinding disease affecting 2–3% of the United States population. The major known cause of glaucoma is a relative increase in intraocular pressure, or IOP. The purpose of glaucoma treatment, whether medical or surgical, is to lower the IOP.

Aqueous fluid is made continuously, and circulates throughout the eye before draining through channels in the eye's anterior chamber. When too much fluid is made, or it is not drained sufficiently, the IOP rises. This fluid build-up can lead to glaucoma. Normal intraocular pressure is under 21 mm/Hg. Glaucoma develops at IOPs higher than 21mm/Hg. However, approximately 20% of glaucoma patients never have pressures higher than 21 mm/Hg.

Seton tube implants are also called glaucoma drainage tubes or implants. The Seton implant is comprised of two parts:

- Tubing, a portion of which is implanted along the inside of the front of the eye. The distal (furthest from the center) end of the tubing protrudes through the anterior (front) or less commonly, the posterior (rear), chamber of the eye.
- An attached reservoir, called a plate, is placed under the conjunctiva of the eye at its equator, or midpoint.

## Purpose

The function of the implant is to lower the intraocular pressure by filtering excess aqueous fluid out of the eye. During the first few weeks after surgery, a bleb of fibrous tissue and collagen forms around the plate of the implant. The formation of a filtration bleb is essential for filtering the excessive aqueous fluid. The thickness of the bleb, as well as the size or number of plates, determines the rate at which aqueous flows out of the anterior chamber of the eye. The excess aqueous fluid is shunted through the tubing of the implant, and passes through the space that develops between the bleb and the plate. By diffusion, the fluid flows into the capillaries where it exits the eye and enters general circulation. The IOP is lowered as a result of this decrease in fluid.

There are various types of implants used in glaucoma surgery. They fall into two categories: the non-valved (free flow implants) and valved (resisted-flow implants). One of the first free-flow implants was the Molteno implant, which consists of one or two polypropylene reservoirs connected to a silicone tube. The non-valved Baerveldt implant is larger than the Molteno, and is available in three sizes.

The restrictive implants, which include the Krupin and Ahmed implant, have valves that automatically close if the intraocular pressure is too low. This is important because in the first few weeks after surgery (before the bleb forms), the aqueous fluid can flow unimpeded through the implant. As a result, hypotony (low level of fluid in the eye) can develop.

Newer implants such as the Express shunt and the Gore-Tex tube shunt are in early stages of use.

## Demographics

Seton tube implants are employed to treat all forms of glaucoma, but are primarily used in patients with elevated IOP despite aggressive medical treatment. They are also used when other types of surgery, such as conventional filtration, or **trabeculectomy**, have not been successful, or would not be recommended. A trabeculectomy should not be performed on patients with neovascular glaucoma, as well as those who have ocular complications caused by previous glaucoma surgeries.

Implants are often placed in the eyes of patients with uveitic glaucoma (fluctuating IOP). The surgeon implants a tube with a ligature, and manipulates the ligature to control pressure. Seton tubes are also used in young patients with aniridia, who often develop glaucoma. These tubes should not be used for patients

## KEY TERMS

**Anterior chamber**—The front chamber of the eye bound by the cornea in front and the iris in the back. The anterior chamber is filled with aqueous humor. The drainage site for the aqueous fluid is in the anterior chamber.

**Choroid**—The middle, highly vascular layer of the eye that lies between the sclera and the retina.

**Conjunctiva**—A thin membrane covering the sclera (white of the eye).

**Cornea**—The clear part of the eye, surrounded by the sclera, through which light passes into the eye.

**Glaucoma**—A group of eye diseases, of which the primary feature is a relative elevation in the intraocular pressure, or IOP. The damage caused by pressure changes in the eye are potentially blinding.

**IOP**—A measure of the pressure in the eye. The gold standard for measurement of IOP is Goldmann tonometry.

**Ophthalmologist**—A physician with either an M.D. or D.O. degree, who has had residency

training in the diagnosis and treatment of eye diseases.

**Posterior chamber**—The posterior part of the eye bound by the lens in front and the retina in back. The posterior chamber is filled with a jellylike substance called the vitreous.

**Rectus muscles**—The muscles responsible for movement of the eye.

**Retina**—The innermost layer in which the receptors for vision are located.

**Sclera**—The outer layer of the eye covering all of the front part of the eye, except for the cornea.

**Seton tube**—An implant placed in the eye that provides an alternative route for aqueous fluid drainage.

**Strabismus**—A condition in which the muscles of the eye do not work together, often causing double vision.

**Vitrectomy**—Removal of the vitreous jelly located in the posterior chamber.

who have silicon oil implants for the treatment of retinal detachment.

### Description

A Seton implant is usually inserted under **local anesthesia**, but may be done under **general anesthesia** for an anxious patient or child. Since implantation may be painful for some children, drugs may be given intravenously during surgery.

After anesthesia is administered, the eye is draped and retractors are placed on the eye to hold it in place. An incision is made on the conjunctiva, a thin membrane layer that lies above the sclera (white of the eye). The implant plate is placed under the conjunctiva and sutured to the sclera, carefully avoiding damage to the recti muscles in the area. Incisions may be made in two quadrants of the eye if a double plate implant is inserted.

If the tubing is implanted into the anterior chamber, that portion of the eye is drained of excess fluid. If the tube is placed in the posterior chamber of the eye, all or part of the vitreous is removed. A needle puncture is made at the limbus where the cornea and the sclera meet, and the tubing is passed through this hole into one of the chambers of the eye. This opening is sealed with a donor scleral patch, which may be

autologous (from the patient's own tissue). If a free-flow implant is used, the tubing is ligated with either a disposable suture, or the ligature is positioned such that it can be removed with a minor incision after a few weeks. As an alternative, the non-valved implant may be inserted in two stages. The plate is first implanted, and the tube is attached during a second surgery after the bleb has formed.

### Diagnosis/Preparation

Prior to surgery, the patient's eye is examined with a slit-lamp biomicroscope. It is important that the conjunctiva in which the plate is placed is not scarred; that the cornea is clear; and that there are no attachments of the iris to the lens behind it or to the cornea in front of it. An **ultrasound** of pediatric patients is done to assess the size of the eye because not all implants are small enough to fit into a child's eye.

Antibiotic drops may be given for up to three days prior to surgery. The patient will continue most glaucoma medication until the day of surgery.

**Informed consent** must be given for the procedure. This includes consent for surgery and a list of risks for the Seton tube implant. It is important for the patient to understand that any vision loss acquired prior to surgery cannot be corrected.

## Aftercare

For several weeks postoperatively, the patient is given **topical antibiotics** and steroids. In addition, oral steroids may be given to patients who had ocular inflammation prior to surgery. Some surgeons use atropine to maintain the eye in a temporary dilated state. Glaucoma medication may be continued for a few months due to possible IOP fluctuation during the early post-operative period. Follow-up visits are scheduled for one day after the surgery, weekly during the first month, twice a month during the second month, and again at three months. Patients can resume normal daily activities within a few days. The sutures may cause a foreign body sensation, which decreases as the **stitches** dissolve. This does not usually require treatment.

Aftercare in the surgeon's office involves monitoring for the signs of hypotony and lowered IOP. The treatment for post-operative hypotony is to tighten the tube of a non-valved implant. As the bleb forms, adjustments are made in the tubing ligature to increase flow through the ligature. If the pressure continues to rise, the tube may be blocked, and excess fluid may have to be tapped. Tube blockage may occasionally occur. Hypotony may also be caused by leakage from the conjunctival wound site.

## Risks

This surgery has intraoperative and postoperative risks. During the procedure, an extraocular muscle can be severed. This is particularly true if the implant is placed in the inferior nasal section of the eye. Strabismus and double vision may follow. Also, the cornea may become scarred, hemorrhaging can occur within the eye, and the iris and lens can be damaged by the protruding tube.

Early post-operative complications include hyphema (blood clots in the anterior chamber of the eye), hypotony, tube obstruction, suture rupture with wound leakage, movement of the implanted plate, corneal edema, and detachment of the retina. Because of the position of the implant plate, retinal detachments are difficult to treat successfully if a Seton implant is present. Double vision during the early post-operative period may be due to swelling in the area, and often will resolve as the orbital edema decreases.

In the late post-surgical period, strabismus as well as orbital cellulitis, a condition that can spread to the central nervous system, can develop. Other long-term risks of glaucoma implant surgery include cataract formation, proptosis (bulging of the eye), and phthisis bulbi (a dangerous situation in which the eye is devoid of all fluid).

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Tube implants are performed by ophthalmologists as outpatient procedures in a hospital operating room. The implantation of a Seton tube takes about two hours. An ophthalmologist is a physician with advanced training in the treatment of eye disease. If general anesthesia or extra pain medication is administered, an anesthesiologist may be present during surgery.

Surgical intervention is required for choroidal detachments, strabismus, and if tubing blocks or comes in contact with other structures of the eye, particularly the cornea. If the tube is blocked by blood clots, tissue plasminogen activator may dissolve them. A laser can cut strands of vitreous or iris that may clog the tubing. If bleb enlargement impinges on a muscle, causing strabismus, the implant may be removed and replaced with a smaller type. If the tubing continually rubs on the back or endothelium of the cornea, decomposition of the cornea is possible and a corneal transplant may be required if vision is comprised. In this case, the tubing will have to be relocated to the posterior chamber, and a vitrectomy performed.

Loss of vision is possible with this and all glaucoma surgery. For Seton tube implants, hypotony is the primary cause of vision loss. Other causes include retinal detachment, vitreous bleeding, and macular edema.

## Normal results

Usually the IOP is lower within two weeks of Seton tube placement. At two months, the pressure is stabilized at 16–18 mm/Hg. Glaucoma medication must still be taken. The IOP in 85% of patients with a non-valved implant is lower than 21 mm/Hg without additional medication intervention. Only 50% of patients with a Krupin valve implant have an IOP lower than 21 mm/Hg without added medical treatment.

## Morbidity and mortality rates

For 70–90% of patients, the implant is functional one year after surgery. After three years, 60% remain functional. The failure rate for Seton implants is 4–8% per year, and differ for valved and non-valved implants. For the non-valved implants, the success rate is 90% at one year, but drops to 60% at two years. At least 66% of valved Seton tube implants

## QUESTIONS TO ASK THE DOCTOR

Which implant will be used?

Is a tube implant the best surgical approach for this case?

How many of these procedures has the surgeon performed?

When will it be determined if the surgery has been successful?

What are the risks for this surgery?

Will glaucoma eye drops still be required after surgery?

are effective at one year, but this drops to 34% at six years. Choroidal detachment is a complication in one-third of these patients.

Strabismus is more common with the Krupin valve as opposed to the Ahmed valve, possibly because it is larger.

For high-risk glaucoma patients, the success rate for Seton tube surgery is approximately 50%. The rate of failure increases 10% with each year. High-risk patients include those who are aphakic (have no intraocular lens), have neovascular glaucoma (which develops from uncontrolled diabetes and hypertension), have congenital glaucoma, and who have had other unsuccessful glaucoma surgeries. Although the success rate for neovascular glaucoma is 56% at 18 months, eventually 31% of neovascular glaucoma patients will lose all vision except for light perception.

### Alternatives

Trabeculectomy is another surgical filtration technique used to treat glaucoma. Trabeculectomy surgery is performed by making a flap in the sclera of the eye, which serves as an alternative drainage site for aqueous fluid. Patients who receive this treatment are not as high risk as those undergoing an implant procedure. Overall, they have a lower IOP, but may have more advanced glaucoma. If vascularization of the iris is present, as in neovascular glaucoma, a trabeculectomy is not performed. For patients who do not have neovascular glaucoma, the failure rate for trabeculectomy is similar to that of drainage tube implants.

Cyclodestruction is another alternative to Seton tube implants. Freezing temperatures or lasers are used to destroy the ciliary body, the part of the eye where the aqueous fluid is produced. When compared

to the YAG laser cyclophotocoagulation, tube shunts are twice as successful.

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Martha Reilly, O.D.

## Tube enterostomy

### Definition

Tube enterostomy, or tube feeding, is a form of enteral or intestinal site feeding that employs a stoma or semi-permanent surgically placed tube to the small intestines.



## Purpose

Many patients are unable to take in food by mouth, esophagus, or stomach. A number of conditions can render a person unable to take in nutrition through the normal pathways. Neurological conditions or injuries, injuries to the mouth or throat, obstructions of the stomach, cancer or ulcerative conditions of the gastrointestinal tract, and certain surgical procedures can make it impossible for a person to receive oral nutrition. Tube feeding is indicated for patients unable to ingest adequate nutrition by mouth, but who may have a cleared passage in the esophagus and stomach, and even partial functioning of the gastrointestinal tract. Enteral nutrition procedures that utilize the gastrointestinal tract are preferred over intravenous feeding or parenteral nutrition because they maintain the function of the intestines, provide for immunity to infection, and avoid complications related to intravenous feeding.

Tube enterostomy, a feeding tube placed directly into the intestines or jejunum, is one such enteral procedure. It is used if the need for enteral feeding lasts longer than six weeks, or if it improves the outcomes of drastic surgeries such as removal or resection of the intestines. Recently, it has become an important technique for use in surgery in which a gastroectomy—resection of the intestinal link to the esophagus—occurs. The procedure makes healing easier, and seeks to retain the patient's nutritional status and quality of life after **reconstructive surgery**. Some individuals have a tube enterostomy surgically constructed, and successfully utilize it for a long period of time.

There are a variety of enteral nutritional products, liquid feedings with the nutritional quality of solid food. Patients with normal gastrointestinal function can benefit from these products. Other patients must have nutritional counseling, monitoring, and precise nutritional diets developed by a health care professional.

## Demographics

Tube enterostomy provides temporary enteral nutrition to patients with injuries as well as inflammatory, obstructive, and other intestinal, esophageal, and abdominal conditions. Other uses include patients with pediatric abnormalities, and those who have had surgery for cancerous tumors of the gastroesophageal junction (many of these cases are associated with Barrett's epithelium). Intestinal cancers in the United States have declined since the 1950s. However, this endemic form of gastric cancer is one of the most common causes of **death** from malignant disease,

## KEY TERMS

**Enteral nutritional support**—Nutrition utilizing an intact gastrointestinal tract, but bypassing another organ such as the stomach or esophagus.

**Parenteral nutritional support**—Intravenous nutrition that bypasses the intestines and its contribution to digestion.

**Stoma**—A portal fashioned from the side of the abdomen that allows for ingestion into or drainage out of the intestines or urinary tract.

**Tube feeding**—Feeding or nutrition through a tube placed into the body through the esophagus, nose, stomach, intestines, or via a surgically constructed artificial orifice called a stoma.

with an estimated 798,000 annual cases worldwide; 21,900 in the United States. As gastric cancer has declined, esophageal cancers have increased, requiring surgeries that resect and reconstruct the passage between the esophagus and intestine.

## Description

Tube enterostomy refers to placement via a number of surgical approaches:

- laparoscopy
- esophagostomy (open surgery via the esophagus)
- stomach (gastrostomy or PEG)
- upper intestines or jejunum (jejunostomy)

The appropriate method depends on the clinical prognosis, anticipated duration of feeding, risk of aspirating or inhaling gastric contents, and patient preference. Whether through a standard operation or with laparoscopic surgical techniques, the surgeon fashions a stoma or opening into the esophagus, stomach or intestines, and inserts a tube from the outside through which nutrition will be introduced. These tubes are made of silicone or polyurethane, and contain weighted tips and insertion features that facilitate placement. The surgery is fairly simple to perform, and most patients have good outcomes with stoma placement.

## Diagnosis/Preparation

A number of conditions necessitate tube enterostomy for nutritional support. Many are chronic and require a complete medical evaluation including history, **physical examination**, and extensive imaging

tests. Some conditions are critical or acute, and may emerge from injuries or serious inflammatory conditions in which the patient is not systematically prepared for the surgery. In many cases, the patient undergoing this type of surgery has been ill for a period of time. Sometimes the patient is a small child or adult who accidentally swallowed a caustic substance. Some are elderly patients who have obstructive carcinoma of the esophagus or stomach.

Optimal preparation includes an evaluation of the patient's nutritional status, and his or her potential requirement for blood transfusions and **antibiotics**. Patients who do not have gastrointestinal inflammatory or obstructive conditions are usually required to undergo bowel preparation that flushes the intestines of all material. The bowel preparation reduces the chances of infection.

The patient's acceptance of tube feeding as a substitute for eating is of paramount importance. Health care providers must be sensitive to these problems, and offer early assistance and feedback in the self-care that the tube enterostomy requires.

In preparation for surgery, patients learn that the tube enterostomy will be an artificial orifice placed outside the abdomen through which they will deliver their nutritional support. Patients are taught how to care for the stoma, cleaning and making sure it functions optimally. In addition, patients are prepared for the loss of the function of eating and its place in their lives. They must be made aware that their physical body will be altered, and that this may have social implications and affect their intimate activities.

### Aftercare

Tube enterostomy requires monitoring the patient for infection or bleeding, and educating him or her on the proper use of the enterostomy. According to the type of surgery—minimally invasive or open surgery—it may take several days for the patient to resume normal functioning. Fluid intake and urinary output must be monitored to prevent dehydration.

### Risks

Tube enterostomies are not considered high risk surgeries. Insertions have been completed in over 90% of attempts. Possible complications include diarrhea, skin irritation due to leakage around the stoma, and difficulties with tube placement.

Tube enterostomy is becoming more frequent due to great advances in minimally invasive techniques and new materials used for stoma construction.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Gastrointestinal surgeons and surgical oncologists perform this surgery in general hospital settings.

However, one recent radiograph study of 289 patients who had jejunostomy found that 14% of patients suffered one or more complications, 19% had problems related to the location or function of the tube, and 9% developed thickened small-bowel folds.

### Normal results

Recovery without complications is the norm for this surgery. The greatest challenge is educating the patient on proper stoma usage and types of nutritional support that must be used.

### Morbidity and mortality rates

Some feeding or tube stomas have the likelihood of complications. A review of 1,000 patients indicated that PEG tube placement has mortality in 0.5%, with major complications (stomal leakage, peritonitis [infection in the abdomen], traumatized tissue of the abdominal wall, and gastric [stomach] hemorrhage) in 1% of cases. Wound infection, leaks, tube movement or migration, and fever occurred in 8% of patients. In a review of seven published studies, researchers found that a single intravenous dose of a broad-spectrum antibiotic was very effective in reducing infections with the stoma. Open surgery always carries with it a small percentage of cardiac complications, blood clots, and infections. Many gastric stoma patients have complicated diseases that increase the likelihood of surgical complications.

### Alternatives

Oral routes are always the preferred method of providing nutritional intake. Intravenous fluid intake can be used as an eating substitute, but only for a short period of time. It is the preferred alternative when adequate protein and calories cannot be provided by oral or other enteral routes, or when the gastrointestinal system is not functioning.

## QUESTIONS TO ASK THE DOCTOR

How long will the tube enterostomy remain in place?

How much assistance will be given in adjusting to the stoma and the special diet?

If the condition does not improve, what other surgical alternatives are available?

How long can a person live safely and comfortably with a tube enterostomy?

### Resources

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- United Ostomy Association, Inc. 19772 MacArthur Blvd., Suite 200, Irvine, CA 92612 2405. (800) 826 0826. [www.uoa.org](http://www.uoa.org).

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Tube feeding see **Tube enterostomy**

Tummy tuck see **Abdominoplasty**

## Tumor marker tests

### Definition

Tumor markers are a group of proteins, hormones, enzymes, receptors, and other cellular products that are overexpressed (produced in higher than normal amounts) by malignant cells. Tumor markers are usually normal cellular constituents that are present at normal or very low levels in the blood of healthy persons. If the substance in question is produced by the tumor, its levels will be increased either in the blood or in the tissue of origin.

### Purpose

The majority of tumor markers are used to monitor patients for recurrence of tumors following treatment. In addition, some markers are associated with a more aggressive course and higher relapse rate and have value in staging and prognosis of the cancer. Most tumor markers are not useful for screening because levels found in early malignancy overlap the range of levels found in healthy persons. The levels of most tumor markers are elevated in conditions other than malignancy, and are therefore not useful in establishing a diagnosis.

### Precautions

Tumor markers are sometimes elevated in non-malignant conditions. Not every tumor will cause a rise in the level of its associated marker, especially in the early stages of some cancers. When a marker is used for cancer screening or diagnosis, the physician must confirm a positive test result by using imaging studies, tissue biopsies, and other procedures. False positive results may occur in laboratory tests when the patient has cross-reacting antibodies that interfere with the test.

### Description

Physicians use changes in tumor marker levels to follow the course of a patient's disease, to measure the effect of treatment, and to check for recurrence of certain cancers. Tumor markers have been identified in several types of cancer, including malignant melanoma; multiple myeloma; and bone, breast, colon, gastric, liver, lung, ovarian, pancreatic, prostate, renal, and uterine cancers. Serial measurements of a tumor marker are often an effective means to monitor the course of therapy. Some tumor markers can provide physicians with information used in staging cancers, and some help predict the response to treatment.

## KEY TERMS

**Analyte**—A material or chemical substance subjected to analysis.

**Antitrypsin**—A substance that inhibits the action of trypsin.

**Biopsy**—The removal of living tissue from the body, done in order to establish a diagnosis.

**Glycoprotein**—Any of a group of complex proteins that consist of a carbohydrate combined with a simple protein. Some tumor markers are glycoproteins.

**Immunoassay**—A laboratory method for detecting the presence of a substance by using an antibody that reacts with it.

**Multiple myeloma**—An uncommon disease that occurs more often in men than in women and is associated with anemia, hemorrhage, recurrent infections and weakness. Ordinarily it is regarded as a malignant neoplasm that originates in bone marrow and involves mainly the skeleton.

**Oncogene**—A gene that is capable under certain conditions of triggering the conversion of normal cells into cancer cells.

**Oncologist**—A physician who specializes in the diagnosis and treatment of tumors.

**Overexpression**—Production in abnormally high amounts.

**Serum (plural, sera)**—The clear, pale yellow liquid part of blood that separates from a clot when the blood coagulates.

**Staging**—The classification of cancerous tumors according to the extent of the tumor.

**Substrate**—A substance acted upon by an enzyme.

A decrease in the levels of the tumor marker during treatment indicates that the therapy is having a positive effect on the cancer, while an increase indicates that the cancer is growing and not responding to the therapy.

### *Types of tumor markers*

There are five basic types of tumor markers.

**ENZYMES.** Many enzymes that occur in certain tissues are found in blood plasma at higher levels when the cancer involves that tissue. Enzymes are usually measured by determining the rate at which they convert a substrate to an end product, while most tumor markers of other types are measured by

a test called an immunoassay. Some examples of enzymes whose levels rise in cases of malignant diseases are acid phosphatase, alkaline phosphatase, amylase, creatine kinase, gamma glutamyl transferase, lactate dehydrogenase, and terminal deoxynucleotidyl transferase.

**TISSUE RECEPTORS.** Tissue receptors, which are proteins associated with the cell membrane, are another type of tumor marker. These substances bind to hormones and growth factors, and therefore affect the rate of tumor growth. Some tissue receptors must be measured in tissue samples removed for a biopsy, while others are secreted into the extracellular fluid (fluid outside the cells) and may be measured in the blood. Some important receptor tumor markers are estrogen receptor, progesterone receptor, interleukin-2 receptor, and epidermal growth factor receptor.

**ANTIGENS.** Oncofetal antigens are proteins made by genes that are very active during fetal development but function at a very low level after birth. The genes become activated when a malignant tumor arises and produce large amounts of protein. Antigens comprise the largest class of tumor marker and include the tumor-associated glycoprotein antigens. Important tumor markers in this class are alpha-fetoprotein (AFP), carcinoembryonic antigen (CEA), prostate specific antigen (PSA), cathepsin-D, HER-2/neu, CA-125, CA-19-9, CA-15-3, nuclear matrix protein, and bladder tumor-associated antigen.

**ONCOGENES.** Some tumor markers are the product of oncogenes, which are genes that are active in fetal development and trigger the growth of tumors when they are activated in mature cells. Some important oncogenes are BRAC-1, myc, p53, RB (retinoblastoma) gene (RB), and Ph<sup>1</sup> (Philadelphia chromosome).

**HORMONES.** The fifth type of tumor marker consists of hormones. This group includes hormones that are normally secreted by the tissue in which the malignancy arises as well as those produced by tissues that do not normally make the hormone (ectopic production). Some hormones associated with malignancy are adrenal corticotrophic hormone (ACTH), calcitonin, catecholamines, gastrin, human chorionic gonadotropin (hCG), and prolactin.

### *Tumor markers in clinical use*

Currently, there are over 60 analytes that are used as tumor markers. All of the enzymes and hormones mentioned above have been approved as tumor markers by the Food and Drug Administration (FDA), but most of the others are not; they have been designated for investigation purposes only. The



following list describes the most commonly used tumor markers approved by the FDA for screening, diagnosis, or monitoring of cancer.

- **Alpha-fetoprotein (AFP):** AFP is a glycoprotein produced by the developing fetus, but blood levels of alpha-fetoprotein decline after birth. Healthy adults who are not pregnant rarely have detectable levels of AFP in their blood. The maternal serum AFP test (AFP triple screen or AFP Tetra screen) is primarily used to screen for spina bifida and other open fetal abnormalities, such as an abdominal wall defect. Very rarely a very high level of alpha-fetoprotein may be associated with congenital Finnish nephrosis. Lower than average levels of AFP in maternal serum may increase the risk for fetal Down syndrome or other chromosome abnormalities. In adult males and nonpregnant females, an AFP above 300 ng/L is often associated with cancer, although levels in this range may be seen in nonmalignant liver diseases. Levels above 1000 ng/L are almost always associated with cancer. AFP has been approved by the FDA for the diagnosis and monitoring of patients with non-seminoma testicular cancer. It is elevated in almost all yolk sac tumors and 80% of malignant liver tumors. An elevated AFP level in the maternal circulation during pregnancy warrants further discussion and possible further testing, but usually is not an indication of fetal anomaly, as it can be elevated in normal pregnancies. An elevated level may indicate problems other than fetal anomalies, such as placental problems that may lead to premature delivery or low birth-weight.
- **CA-125:** Measurement of this tumor marker is FDA-approved for the diagnosis and monitoring of women with ovarian cancer. Approximately 75% of persons with ovarian cancer shed CA-125 into the blood and have elevated serum levels. This figure includes approximately 50% of persons with stage I disease and 90% with stage II or higher. Elevated levels of CA-125 are also found in approximately 20% of persons with pancreatic cancer. Other cancers detected by this marker include malignancies of the liver, colon, breast, lung, and digestive tract. Test results, however, are affected by pregnancy and menstruation. Benign diseases detected by the test include endometriosis, ovarian cysts, fibroids, inflammatory bowel disease, cirrhosis, peritonitis, and pancreatitis. CA-125 levels correlate with tumor mass; consequently, this test is used to determine whether recurrence of the cancer has occurred following chemotherapy. Some patients, however, have a recurrence of their cancer without a corresponding increase in the level of CA-125.
- **Carcinoembryonic antigen (CEA):** CEA is a glycoprotein that is part of the normal cell membrane. It is shed into blood serum and reaches very high levels in colorectal cancer. Over 50% of persons with breast, colon, lung, gastric, ovarian, pancreatic, and uterine cancer have elevated levels of CEA. CEA levels in plasma are monitored in patients with tumors that secrete this antigen to determine if second-look surgery should be performed. CEA levels may also be elevated in inflammatory bowel disease (IBD), pancreatitis, and liver disease. Heavy smokers and about 5% of healthy persons have elevated plasma levels of CEA.
- **Prostate specific antigen (PSA):** PSA is a small glycoprotein with protease activity that is specific for prostate tissue. The antigen is present in low levels in all adult males, which means that an elevated level may require additional testing to confirm that cancer is the cause. High levels are seen in prostate cancer, benign prostatic hypertrophy, and inflammation of the prostate. PSA is approved as a screening test for prostatic carcinoma. PSA has been found to be elevated in more than 60% of persons with Stage A and more than 70% with Stage B cancer of the prostate. It has replaced the use of prostatic acid phosphatase for prostate cancer screening because it is far more sensitive. Most PSA is bound to antitrypsins in plasma but some PSA circulates unbound to protein (free PSA). Persons with a borderline total PSA (4–10 ng/L), but who have a low free PSA are more likely to have malignant prostate disease.
- **Estrogen receptor (ER):** ER is a protein found in the nucleus of breast and uterine tissues. The level of ER in the tissue is used to determine whether a person with breast cancer is likely to respond to estrogen therapy with tamoxifen, which binds to the receptors blocking the action of estrogen. Women who are ER-negative have a greater risk of recurrence than women who are ER-positive. Tissue levels are measured using one of two methods. The tissue can be homogenized into a cytosol, and an immunoassay used to measure the concentration of ER receptor protein. Alternatively, the tissue is frozen and thin-sectioned. An immunoperoxidase stain is used to detect and measure the estrogen receptors in the tissue.
- **Progesterone receptor (PR):** PR consists of two proteins, like the estrogen receptor, which are located in the nuclei of both breast and uterine tissues. PR has the same prognostic value as ER, and is measured by similar methods. Tissue that does not express the PR receptors is less likely to bind estrogen analogs used to treat the tumor. Persons who test negative for both

ER and PR have less than a 5% chance of responding to endocrine therapy. Those who test positive for both markers have greater than a 60% chance of tumor shrinkage when treated with hormone therapy.

- **Human chorionic gonadotropin (hCG):** hCG is a glycoprotein produced by cells of the trophoblast and developing placenta. Very high levels are produced by trophoblastic tumors and choriocarcinoma, which is an aggressive tumor that arises from cells that help to attach the fetus to the uterine wall. About 60% of testicular cancers secrete hCG. hCG is also produced less frequently by a number of other tumors. Some malignancies cause an increase in alpha and/or beta hCG subunits in the absence of significant increases in intact hCG. For this reason, separate tests have been developed for alpha and beta hCG, and most laboratories use these assays as tumor marker tests. Most EIA tests for pregnancy are specific for hCG, but detect the whole molecule and are called intact hCG assays.
- **Nuclear matrix protein (NMP22) and bladder tumor-associated analytes (BTA):** NMP22 is a structural nuclear protein that is released into the urine when bladder carcinoma cells die. Approximately 70% of bladder carcinomas are positive for NMP22. BTA is comprised of type IV collagen, fibronectin, laminin, and proteoglycan, which are components of the basement membrane that are released into the urine when bladder tumor cells attach to the basement membrane of the bladder wall. These products can be detected in urine using a mixture of antibodies to the four components. BTA is elevated in about 30% of persons with low-grade bladder tumors and over 60% of persons with high-grade tumors.

## Preparation

Determination of the circulating level of tumor markers requires a blood test performed by a laboratory scientist. A nurse or phlebotomist usually draws the patient's blood; he or she ties a tourniquet above the patient's elbow, locates a vein near the inner elbow, cleanses the skin overlying the vein with an antiseptic solution, and inserts a sterile needle into that vein. The blood is drawn through the needle into an attached vacuum tube. Collection of a blood sample takes only a few minutes.

Tissue samples are collected by a physician at the time of surgical or needle biopsy. A urine sample is collected by the patient, using the midstream void technique.

## Aftercare

Aftercare following a blood test consists of routine care of the area around the puncture site. Pressure is applied for a few seconds and the wound is covered with a bandage. If a bruise or swelling develops around the puncture site, the area is treated with a moist warm compress.

## Risks

The risks associated with drawing blood include dizziness, bruising, swelling, or excessive bleeding from the puncture site. As previously mentioned, the results of blood tests should be interpreted with caution. A single test result may not yield clinically useful information. Several laboratory reports over a period of months may be needed to evaluate treatment and identify recurrence. Positive results must be interpreted cautiously because some tumor markers are increased in nonmalignant diseases and in a small number of apparently healthy persons. In addition false negative results may occur because the tumor does not produce the marker, and because levels seen in healthy persons may overlap those seen in the early stages of cancer. A false positive result occurs when the value is elevated even though cancer is not present. A false negative result occurs when the value is normal but cancer is present.

## Normal results

Reference ranges for tumor markers will vary from one laboratory to another because different antibodies and calibrators are used by various test systems. The values below are representative of normal values or cutoffs for commonly measured tumor markers.

- **Alpha-fetoprotein (AFP):** Less than 15 ng/L in men and nonpregnant women. Levels greater than 1,000 ng/L indicate malignant disease (except in pregnancy).
- **CA125:** Less than 35 U/mL.
- **Carcinoembryonic antigen (CEA):** Less than 3 µg/L for nonsmokers and less than 5 µg/L for smokers.
- **Estrogen receptor:** Less than 6 fmol/mg protein is negative; greater than 10 fmol/mg protein is positive.
- **Human chorionic gonadotropin (HCG):** Less than 20 IU/L for males and non-pregnant females. Greater than 100,00 IU/L indicates trophoblastic tumor.
- **Progesterone receptor:** Less than 6 fmol/mg protein is negative. Greater than 10 fmol/mg protein is positive.
- **Prostate specific antigen (PSA):** Less than 4 ng/L.

## Resources

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American Cancer Society. 1599 Clifton Rd. NE, Atlanta, GA 30329 4251. (800) 227 2345. [www.cancer.org](http://www.cancer.org).

American Society of Clinical Oncology (ASCO). 1900 Duke Street, Suite 200, Alexandria, VA 22314. (703) 299 0150. [www.asco.org](http://www.asco.org).

National Cancer Institute (NCI). NCI Public Inquiries Office, Suite 3036A, 6116 Executive Boulevard, MSC8332, Bethesda, MD 20892 8322. (800) 4 CANCER or (800) 332 8615 (TTY). [www.nci.nih.gov](http://www.nci.nih.gov).

United States Food and Drug Administration (FDA). 5600 Fishers Lane, Rockville, MD 20857 0001. (888) INFO FDA. [www.fda.gov](http://www.fda.gov).

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## Tumor removal

### Definition

A tumor is an abnormal growth in the body that is caused by the uncontrolled division of cells. Benign tumors do not have the potential to spread to other parts of the body (a process called metastasis) and are curable by surgical removal. Malignant or cancerous tumors, however, may metastasize to other parts of the body and will ultimately result in **death** if not successfully treated by surgery and/or other methods.

### Purpose

Surgical removal is one of four main ways that tumors are treated; the other treatment options include chemotherapy, radiation therapy, and biological therapy. There are a number of factors used to determine which methods will best treat a tumor. Because benign tumors do not have the potential to metastasize, they are often treated successfully with surgical removal alone. Malignant tumors, however, are most often treated with a combination of surgery and chemotherapy and/or radiation therapy (in about 55% of cases). In some instances, non-curative surgery may make other treatments more effective. Debulking a cancer—making it smaller by surgical removal of a large part of it—is thought to make radiation and chemotherapy more effective.

Surgery is often used to accurately assess the nature and extent of a cancer. Most cancers cannot be adequately identified without examining a sample of the abnormal tissue under a microscope. Such tissue samples are procured during a surgical procedure. Surgery may also be used to determine exactly how far a tumor has spread.

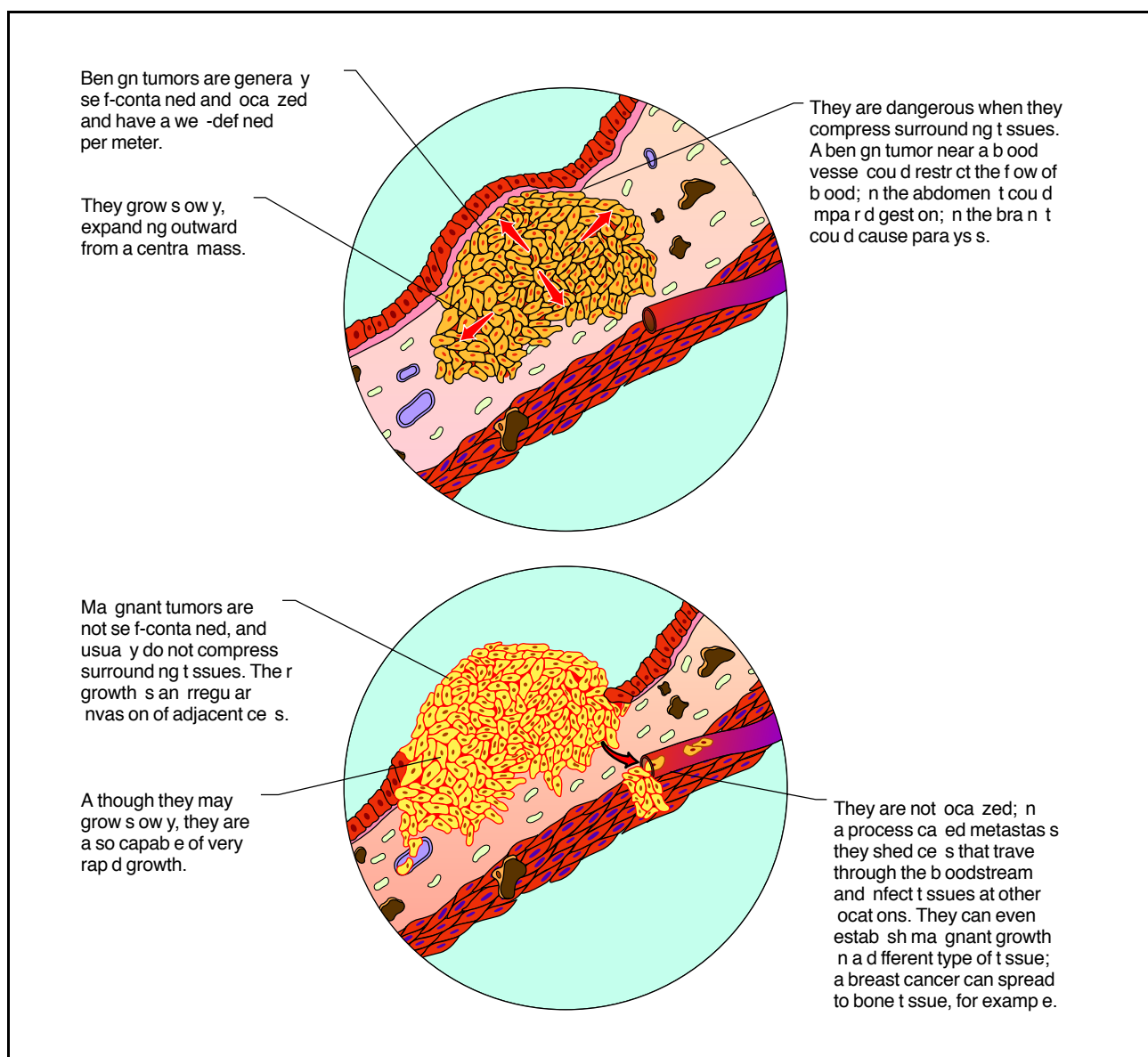
There are a few standard methods of comparing one cancer to another for the purposes of determining appropriate treatments and estimating outcomes. These methods are referred to as staging. The most commonly used method is the TNM system, including:

- “T” stands for tumor, and reflects the size of the tumor.
- “N” represents the spread of the cancer to lymph nodes, largely determined by those nodes removed at surgery that contain cancer cells. Since cancers spread mostly through the lymphatic system, this is a useful measure of a cancer’s ability to disperse.
- “M” refers to metastasis, and indicates if metastases are present and how far they are from the original cancer.

Staging is particularly important with such lymphomas as Hodgkin’s disease, which may appear in many places in the lymphatic system. Surgery is a useful tool for staging such cancers and can increase the chance of a successful cure, since radiation treatment is often curative if all the cancerous sites are located and irradiated.

### Demographics

The American Cancer Society estimates that approximately 1.45 million cases of cancer are diagnosed in the United States each year. Seventy-eight



**A comparison of benign (top of illustration) and malignant tumor characteristics.** (Illustration by Hans & Cassidy, Inc. Cengage Learning, Gale.)

percent of cancers are diagnosed in men and women over the age of 55, although cancer may affect individuals of any age. Men develop cancer more often than women; one in two men will be diagnosed with cancer during his lifetime, compared to one in three women. Cancer affects individuals of all races and ethnicities, although incidence may differ among these groups by cancer type.

### Description

Surgery may be used to remove tumors for diagnostic or therapeutic purposes.

### Diagnostic tumor removal

A biopsy is a medical procedure that obtains a small piece of tissue for diagnostic testing. The sample is examined under a microscope by a doctor who specializes in the effects of disease on body tissues (a pathologist) to detect any abnormalities. A definitive diagnosis of cancer cannot be made unless a sample of the abnormal tissue is examined histologically (under a microscope).

There are four main biopsy techniques used to diagnose cancer, including:



## KEY TERMS

**Aspiration**—A technique for obtaining a piece of tissue for biopsy by using suction applied through a needle attached to a syringe.

**Biopsy**—The removal of living tissue from the body, done in order to establish a diagnosis.

**Debulking**—Surgical removal of a major portion of a tumor so that there is less of the cancer left for later treatment by chemotherapy or radiation.

**Mammogram**—A set of x rays taken of the front and side of the breast; used to diagnose various abnormalities of the breast.

**Metastasis (plural, metastases)**—A growth of cancer cells at a site in the body distant from the primary tumor.

**Oncologist**—A physician who specializes in the diagnosis and treatment of tumors.

**Palliative**—Offering relief of symptoms, but not a cure.

**Pap test**—The common term for the Papanicolaou test, a simple smear method of examining stained cells to detect cancer of the cervix.

**Staging**—The classification of cancerous tumors according to the extent of the tumor.

- **Aspiration biopsy.** A needle is inserted into the tumor and a sample is withdrawn. This procedure may be performed under local anesthesia or with no anesthesia at all.
- **Needle biopsy.** A special cutting needle is inserted into the core of the tumor and a core sample is cut out. Local anesthesia is most often administered.
- **Incisional biopsy.** A portion of a large tumor is removed, usually under local anesthesia in an outpatient setting.
- **Excisional biopsy.** An entire cancerous lesion is removed along with surrounding normal tissue (called a clear margin). Local or general anesthesia may be used.

### *Therapeutic tumor removal*

Once surgical removal has been decided, a surgical oncologist will remove the entire tumor, taking with it a large section of the surrounding normal tissue. The healthy tissue is removed to minimize the risk that abnormal tissue is left behind. Tumors may be removed by cutting with steel instruments, by the use

of a laser beam, by radiofrequency ablation (the use of radiofrequency energy to destroy tissue), by cryoablation (the use of extreme cold to freeze and thus destroy the tumor), or by injecting alcohol into the tumor.

When surgical removal of a tumor is unacceptable as a sole treatment, a portion of the tumor is removed to debulk the mass; this process is called cytoreduction. Cytoreductive surgery aids radiation and chemotherapy treatments by increasing the sensitivity of the tumor and decreasing the number of necessary treatment cycles.

Certain types of skin tumors can be removed by a technique called Mohs micrographic surgery, developed in the late 1930s by Dr. Frederick E. Mohs. The Mohs method involves four steps: surgical removal of the tumor; making a slide of the removed tissue and examining it for cancer cells (called mapping the tissue); interpreting the microscope slides and removing more tissue if necessary until no more cancer cells are found; and performing **reconstructive surgery** to cover the wound.

A newer technique for removing some tumors of the spinal cord involves the use of a suction tip rather than a scalpel. The newer technique appears to have a wider margin of safety when working around the delicate structures of the central nervous system.

In some instances, the purpose of tumor removal is not to cure the cancer, but to relieve the symptoms of a patient who cannot be cured. This approach is called palliative surgery. For example, a patient with advanced cancer may have a tumor causing significant pain or bleeding; in such a case, the tumor may be removed to ease the patient's pain or other symptoms even though a cure is not possible.

### *Seeding*

The surgical removal of malignant tumors demands special considerations. There is a danger of spreading cancerous cells during the process of removing abnormal tissue (called seeding). Presuming that cancer cells can implant elsewhere in the body, the surgeon must minimize the dissemination of cells throughout the operating field or into the bloodstream.

Special techniques called block resection and no-touch are used. Block resection involves taking the entire specimen out as a single piece. The no-touch technique involves removing a specimen by handling only the normal tissue surrounding it; the cancer itself is never touched. These approaches prevent the spread of cancer cells into the general circulation. The surgeon takes great care to clamp off the blood supply

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Tumors are usually removed by a general surgeon or surgical oncologist. The procedure is frequently done in a hospital setting, but specialized outpatient facilities may sometimes be used.

first, preventing cells from leaving by that route later in the surgery.

### Diagnosis/Preparation

A tumor may first be palpated (felt) by the patient or by a healthcare professional during a **physical examination**. A tumor may be visible on the skin or protrude outward from the body. Still other tumors are not evident until their presence begins to cause such symptoms as weight loss, fatigue, or pain. In some instances, tumors are located during routine tests (e.g., a yearly mammogram or Pap smear).

### Aftercare

Retesting and periodical examinations are necessary to ensure that a tumor has not returned or metastasized after total removal.

### Risks

Each tumor removal surgery carries certain risks that are inherent to the procedure. There is always a risk of misdiagnosing a cancer if an inadequate sample was procured during biopsy, or if the tumor was not properly located. There is a chance of infection of the surgical site, excessive bleeding, or injury to adjacent tissues. The possibility of metastasis and seeding are risks that have to be considered in consultation with an oncologist.

### Normal results

The results of a tumor removal procedure depend on the type of tumor and the purpose of the treatment. Most benign tumors can be removed successfully with no risk of the abnormal cells spreading to other parts of the body and little risk of the tumor returning. Malignant tumors are considered successfully removed if the entire tumor can be removed, if a clear margin of healthy tissue is removed with the tumor, and if there is no evidence of metastasis. The normal results of

## QUESTIONS TO ASK THE DOCTOR

- What type of tumor do I have and where is it located?
- What procedure will be used to remove the tumor?
- Is there evidence that the tumor has metastasized?
- What diagnostic tests will be performed prior to tumor removal?
- What method of anesthesia/pain relief will be used during the procedure?

palliative tumor removal are a reduction in the patient's symptoms with no impact on length of survival.

### Morbidity and mortality rates

The recurrence rates of benign and malignant tumors after removal depend on the type of tumor and its location. The rate of complications associated with tumor removal surgery differs by procedure, but is generally very low.

### Alternatives

If a benign tumor shows no indication of harming nearby tissues and is not causing the patient any symptoms, surgery may not be required to remove it. Chemotherapy, radiation therapy, and biological therapy are treatments that may be used alone or in conjunction with surgery.

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TURP see **Transurethral resection of the prostate**

Tylenol see **Acetaminophen**

## Tympanoplasty

### Definition

Tympanoplasty, also called eardrum repair, refers to surgery performed to reconstruct a perforated tympanic membrane (eardrum) or the small bones of the middle ear. Eardrum perforation may result from



**Yellowish discharge from the ear of an adult with past tympanoplasty.** (Pulse Picture Library/CMP Images/Phototake. Reproduced by permission.)

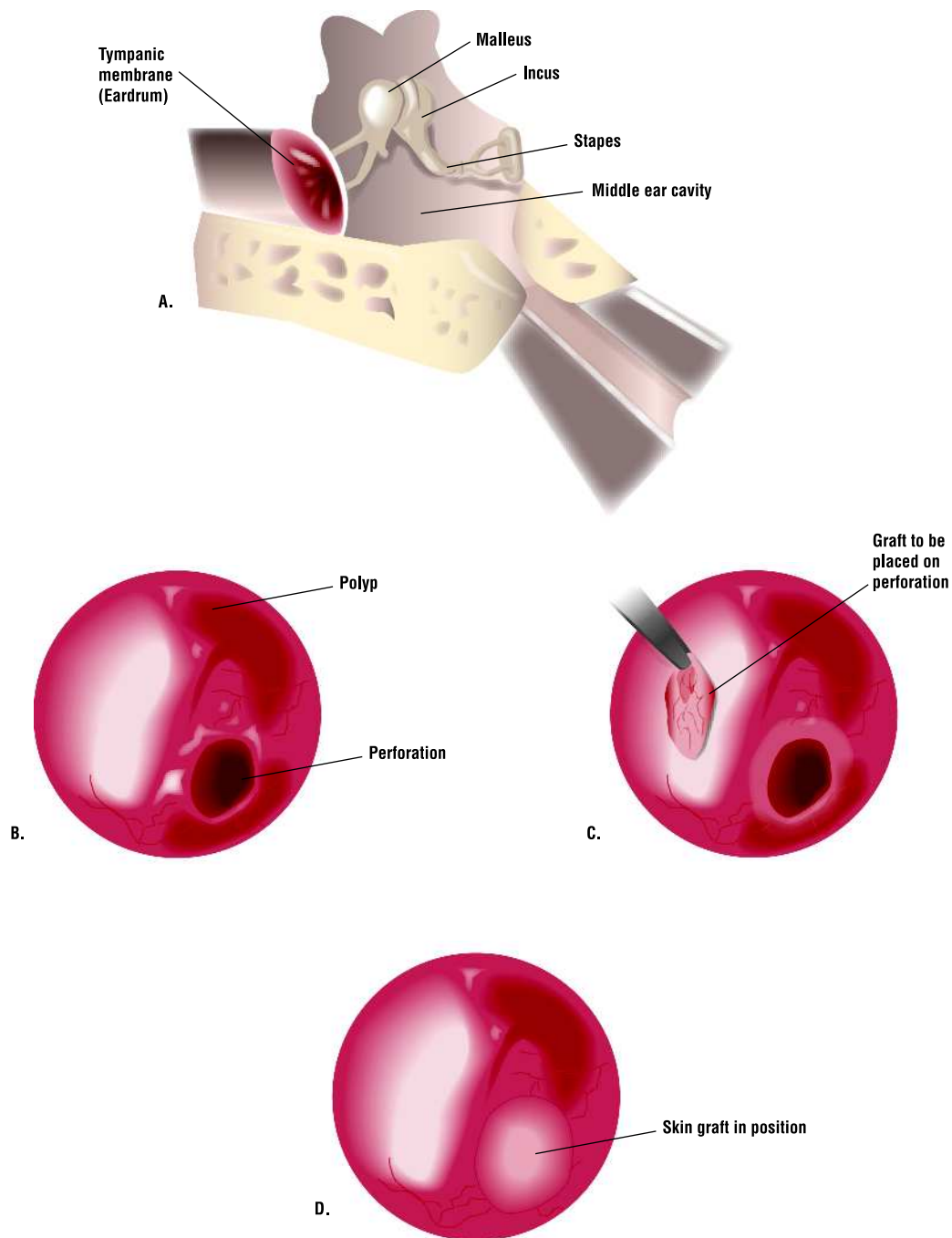
chronic infection or, less commonly, from trauma to the eardrum.

### Purpose

The tympanic membrane of the ear is a three-layer structure. The outer and inner layers consist of epithelium cells. Perforations occur as a result of defects in the middle layer, which contains elastic collagen fibers. Small perforations usually heal spontaneously. However, if the defect is relatively large, or if there is a poor blood supply or an infection during the healing process, spontaneous repair may be hindered. Eardrums may also be perforated as a result of trauma, such as an object in the ear, a slap on the ear, or an explosion.

The purpose of tympanoplasty is to repair the perforated eardrum, and sometimes the middle ear bones (ossicles) that consist of the incus, malleus, and stapes. Tympanic membrane grafting may be required. If needed, grafts are usually taken from a vein or fascia

## Tympanoplasty



The tympanic membrane, or ear drum, may need surgical repair when punctured (A). During a type I tympanoplasty, a perforation in the eardrum is visualized (B). A tissue graft is placed over the perforation (C) and held in place by the existing eardrum (D) (Illustration by GGS Information Services. Cengage Learning, Gale.)



(muscle sheath) tissue on the lobe of the ear. Synthetic materials may be used if patients have had previous surgeries and have limited graft availability.

## Demographics

In the United States, ear disorders leading to hearing loss affect all ages. Over 60% of the population with hearing loss is under the age of 65, although nearly 25% of those above age 65 have a hearing loss that is considered significant. Causes include: birth defect (4.4%), ear infection (12.2%), ear injury (4.9%), damage due to excessive noise levels (33.7%), advanced age (28%), and other problems (16.8%).

## Description

There are five basic types of tympanoplasty procedures:

- Type I tympanoplasty is called myringoplasty and involves the restoration of the perforated eardrum by grafting.
- Type II tympanoplasty is used for tympanic membrane perforations with erosion of the malleus. It involves grafting onto the incus or the remains of the malleus.
- Type III tympanoplasty is indicated for destruction of two ossicles, with the stapes still intact and mobile. It involves placing a graft onto the stapes, and providing protection for the assembly.
- Type IV tympanoplasty is used for ossicular destruction, which includes all or part of the stapes arch. It involves placing a graft onto or around a mobile stapes footplate.
- Type V tympanoplasty is used when the footplate of the stapes is fixed.

Depending on its type, tympanoplasty can be performed under local or **general anesthesia**. In small perforations of the eardrum, Type I tympanoplasty can be easily performed under **local anesthesia** with intravenous sedation. An incision is made into the ear canal and the remaining eardrum is elevated away from the bony ear canal, and lifted forward. The surgeon uses an operating microscope to enlarge the view of the ear structures. If the perforation is very large or the hole is far forward and away from the view of the surgeon, it may be necessary to perform an incision behind the ear. This elevates the entire outer ear forward, providing access to the perforation. Once the hole is fully exposed, the perforated remnant is rotated forward, and the bones of hearing are inspected. If scar tissue is present, it is removed either with micro hooks or laser.

## KEY TERMS

**Audiogram**—A test of hearing at a range of sound frequencies.

**Epithelium**—The covering of internal and external surfaces of the body, including the lining of vessels and other small cavities. It consists of cells joined by small amounts of cementing substances.

**Fistula test**—Compression or rarefaction of the air in the external auditory canal.

**Mastoid process**—The nipple-like projection of part of the temporal bone (the large irregular bone situated in the base and side of the skull).

**Mastoidectomy**—Hollowing out the mastoid process by curetting, gouging, drilling, or otherwise removing the bony partitions forming the mastoid cells.

**Myringoplasty**—Surgical restoration of a perforated tympanic membrane by grafting.

**Ossicles**—Small bones of the middle ear, called stapes, malleus, and incus.

**Ossiculoplasty**—Surgical insertion of an implant to replace one or more of the ear ossicles. Also called ossicular replacement.

**Otoscopy**—Examination of the ear with an otoscope, an instrument designed to evaluate the condition of the ear.

**Tinnitus**—Noises or ringing in the ear.

Tissue is then taken either from the back of the ear, the tragus (small cartilaginous lobe of skin in front of the ear), or from a vein. The tissues are thinned and dried. An absorbable gelatin sponge is placed under the eardrum to support the graft. The graft is then inserted underneath the remaining eardrum remnant, which is folded back onto the perforation to provide closure. Very thin sheeting is usually placed against the top of the graft to prevent it from sliding out of the ear when the patient sneezes.

If it was opened from behind, the ear is then stitched together. Usually, the **stitches** are buried in the skin and do not have to be removed later. A sterile patch is placed on the outside of the ear canal and the patient returns to the **recovery room**.

## Diagnosis/Preparation

The examining physician performs a complete physical with diagnostic testing of the ear, which includes an

audiogram and history of the hearing loss, as well as any vertigo or facial weakness. A microscopic exam is also performed. Otoscopy is used to assess the mobility of the tympanic membrane and the malleus. A fistula test can be performed if there is a history of dizziness or a marginal perforation of the eardrum.

Preparation for surgery depends upon the type of tympanoplasty. For all procedures, however; blood and urine studies, and hearing tests are conducted prior to surgery.

### Aftercare

Generally, the patient can return home within two to three hours. **Antibiotics** are given, along with a mild pain reliever. After 10 days, the packing is removed and the ear is evaluated to see if the graft was successful. Water is kept away from the ear, and nose blowing is discouraged. If there are allergies or a cold, antibiotics and a decongestant are usually prescribed. Most patients can return to work after five or six days, or two to three weeks if they perform heavy physical labor. After three weeks, all packing is completely removed under the operating microscope. It is then determined whether or not the graft has been completely successful.

**Postoperative care** is also designed to keep the patient comfortable. Infection is generally prevented by soaking the ear canal with antibiotics. To heal, the graft must be kept free from infection, and must not experience shearing forces or excessive tension. Activities that change the tympanic pressure are forbidden, such as sneezing with the mouth shut, using a straw to drink, or heavy nose blowing. A complete hearing test is performed four to six weeks after the operation.

### Risks

Possible complications include failure of the graft to heal, causing recurrent eardrum perforation; narrowing (stenosis) of the ear canal; scarring or adhesions in the middle ear; perilymph fistula and hearing loss; erosion or extrusion of the prosthesis; dislocation of the prosthesis; and facial nerve injury. Other problems such as recurrence of cholesteatoma, may or may not result from the surgery.

Tinnitus (noises in the ear), particularly echo-type noises, may be present as a result of the perforation itself. Usually, with improvement in hearing and closure of the eardrum, the tinnitus resolves. In some cases, however, it may worsen after the operation. It is rare for the tinnitus to be permanent after surgery.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Tympanoplasty is usually performed on an outpatient basis by an otolaryngologist, a physician specialized in the diagnosis and treatment of disorders and diseases of the ears, nose, and throat. For most adults, Type I tympanoplasty is performed in the office of the otolaryngologist with topical anesthesia at the tympanic membrane site, and subcutaneous local anesthesia injection at the graft donor site. An overnight stay is recommended if the tympanoplasty involves ossicular replacement.

### Normal results

Tympanoplasty is successful in over 90% of cases. In most cases, the operation relieves pain and infection symptoms completely. Hearing loss is minor.

### Morbidity and mortality rates

There can be imbalance and dizziness immediately after this procedure. Dizziness, however, is uncommon in tympanoplasties that only involve the eardrum. Besides failure of the graft, there may be further hearing loss due to unexplained factors during the healing process. This occurs in less than 5% of patients. A total hearing loss from tympanoplasty surgery is rare, occurring in less than 1% of operations. Mild postoperative dizziness and imbalance can persist for about a week after surgery. If the ear becomes infected after surgery, the risk of dizziness increases. Generally, imbalance and dizziness completely disappears after a week or two.

### Alternatives

Myringoplasty is another operative procedure used in the reconstruction of a perforation of the tympanic membrane. It is performed when the middle ear space, its mucosa, and the ossicular chain are free of active infection. Unlike tympanoplasty, there is no direct inspection of the middle ear during this procedure.

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- Are there any other options aside from tympanoplasty?
- How will the surgery impact hearing?
- How long will it take to recover from the surgery?
- What are the possible complications?
- How many tympanoplasty surgeries does the surgeon perform each year?
- How successful is tympanoplasty in restoring normal hearing?

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## Type and screen

### Definition

Blood typing is a laboratory test that identifies blood group antigens (substances that stimulate an immune response) belonging to the ABO blood group system. The test classifies blood into four groups designated A, B, AB, and O. Antibody screening is a test to detect atypical antibodies in the serum that may have been formed as a result of **transfusion** or pregnancy. An antibody is a protein produced by lymphocytes (nongranular white blood cells) that binds to an antigen, facilitating its removal by phagocytosis (or engulfing by macrophages) or lysis (cell rupture or decomposition). The type and screen (T&S) is performed on persons who may need a transfusion of blood products. These tests are followed by the compatibility test (cross-match). This test insures that no antibodies are detected in the recipient's serum that will react with the donor's red blood cells.

### Purpose

Blood typing and screening are most commonly performed to ensure that a person who needs a transfusion will receive blood that matches (is compatible with) his or her own; and that clinically significant antibodies are identified if present. People must receive blood of the same blood type; otherwise, a severe transfusion reaction may result.

### Prenatal care

Parents who are expecting a baby have their blood typed to diagnose and prevent hemolytic disease of the newborn (HDN), a type of anemia also known as erythroblastosis fetalis. Babies who have a blood type different from their mother's are at risk for developing this disease.

### Determination of paternity

A child inherits factors or genes from each parent that determine his or her blood type. This fact makes blood typing useful in paternity testing. The blood

## KEY TERMS

**ABO blood type**—Blood type based on the presence or absence of the A and B antigens on the red blood cells. There are four types: A, B, AB, and O.

**Acute hemolytic transfusion reaction (AHTR)**—A severe transfusion reaction with abrupt onset, most often caused by ABO incompatibility. Symptoms include difficulty breathing, fever and chills, pain, and sometimes shock.

**Antibody**—A protein produced by B-lymphocytes that binds to an antigen facilitating its removal by phagocytosis or lysis.

**Antigen**—Any substance that stimulates the production of antibodies and combines specifically with them.

**Autologous donation**—Donation of the patient's own blood, made several weeks before elective surgery.

**Blood bank**—A laboratory that specializes in blood typing, antibody identification, and transfusion services.

**Blood type**—Any of various classes into which human blood can be divided according to immunological compatibility based on the presence or absence of certain antigens on the red blood cells. Blood types are sometimes called blood groups.

**Cross-match**—A laboratory test done to confirm that blood from a donor and blood from the recipient are compatible. Serum from each is mixed with red blood cells from the other and observed for hemagglutination.

**Ectopic pregnancy**—The implantation of a fertilized egg in a woman's fallopian tube instead of the uterus.

**Gene**—A piece of DNA, located on a chromosome, that determines how such traits as blood type are inherited and expressed.

**Hemagglutination**—The clumping of red blood cells due to blood type incompatibility.

**Hematocrit**—The proportion of the volume of a blood sample that consists of red blood cells. It is expressed as a percentage.

**Indirect Coombs' test**—A test used to screen for unexpected antibodies against red blood cells. The patient's serum is mixed with reagent red blood cells, incubated, washed, tested with antihuman globulin, and observed for clumping.

**Lysis**—Destruction or decomposition.

**Pathologist**—A doctor who specializes in the study of diseases. The ABO blood groups were discovered by an Austrian pathologist.

**Rh blood type**—In general, refers to the blood type based on the presence or absence of the D antigen on the red blood cells. There are, however, other antigens in the Rh system.

**Serum (plural, sera)**—The clear, pale yellow liquid that separates from a clot when blood coagulates.

**Tourniquet**—A thin piece of tubing or other device used to stop bleeding or control circulation by compressing the blood vessels in an arm or leg. Health care professionals apply a tourniquet before drawing blood.

**Transfusion**—The therapeutic introduction of blood or a blood component into a patient's bloodstream.

types of the child, mother, and alleged father are compared to determine paternity.

### *Forensic investigations*

Legal investigations may require typing of blood or such other body fluids as semen or saliva to identify criminal suspects. In some cases typing is used to identify the victims of crime or major disasters.

### Description

Blood typing and screening tests are performed in a blood bank laboratory by technologists trained in blood bank and transfusion services. The tests are performed on blood after it has been separated into cells and serum (the yellow liquid left after the blood

cells are removed). Costs for both tests are covered by insurance when the tests are determined to be medically necessary.

Blood bank laboratories are usually located in blood center facilities, such as those operated by the American Red Cross, that collect, process, and supply blood that is donated. Blood bank laboratories are also found in most hospitals and other facilities that prepare blood for transfusion. These laboratories are regulated by the United States Food and Drug Administration (FDA) and are inspected and accredited by a professional association such as the American Association of Blood Banks (AABB).

Blood typing and screening tests are based on the reaction between antigens and antibodies. An antigen



can be anything that triggers the body's immune response. The body produces a special protein called an antibody that has a uniquely shaped site that combines with the antigen to neutralize it. A person's body normally does not produce antibodies against its own antigens.

The antigens found on the surface of red blood cells are important because they determine a person's blood type. When red blood cells having a certain blood type antigen are mixed with serum containing antibodies against that antigen, the antibodies combine with and stick to the antigen. In a test tube, this reaction is visible as clumping or aggregating.

Although there are over 600 known red blood cell antigens organized into 22 blood group systems, routine blood typing is usually concerned with only two systems: the ABO and Rh blood group systems. Antibody screening helps to identify antibodies against several other groups of red blood cell antigens.

### *Blood typing*

**THE ABO BLOOD GROUP SYSTEM.** In 1901, Karl Landsteiner, an Austrian pathologist, randomly combined the serum and red blood cells of his colleagues. From the reactions he observed in test tubes, he developed the ABO blood group system, which earned him the 1930 Nobel Prize in Medicine. A person's ABO blood type—A, B, AB, or O—is based on the presence or absence of the A and B antigens on his red blood cells. The A blood type has only the A antigen and the B blood type has only the B antigen. The AB blood type has both A and B antigens, and the O blood type has neither the A nor the B antigen.

By the time a person is six months old, he or she will have developed antibodies against the antigens that his or her red blood cells lack. That is, a person with A blood type will have anti-B antibodies, and a person with B blood type will have anti-A antibodies. A person with AB blood type will have neither antibody, but a person with O blood type will have both anti-A and anti-B antibodies. Although the distribution of each of the four ABO blood types varies among racial groups, O is the most common and AB is the least common in all groups.

**FORWARD AND REVERSE TYPING.** ABO typing is the first test done on blood when it is tested for transfusion. A person must receive ABO-matched blood because ABO incompatibilities are the major cause of fatal transfusion reactions. To guard against these incompatibilities, typing is done in two steps. In the first step, called forward typing, the patient's blood is mixed with serum that contains antibodies against

type A blood, then with serum that contains antibodies against type B blood. A determination of the blood type is based on whether or not the blood clots in the presence of these sera.

In reverse typing, the patient's blood serum is mixed with blood that is known to be type A and type B. Again, the presence of clotting is used to determine the type.

An ABO incompatibility between a pregnant woman and her baby is a common cause of HDN but seldom requires treatment. This is because the majority of ABO antibodies are IgM, which are too large to cross the placenta. It is the IgG component that may cause HDN, and this is most often present in the plasma of group O mothers.

Paternity testing compares the ABO blood types of the child, mother, and alleged father. The alleged father cannot be the biological father if the child's blood type requires a gene that neither he nor the mother have. For example, a child with blood type B whose mother has blood type O requires a father with either AB or B blood type; a man with blood type O cannot be the biological father.

In some people, ABO antigens can be detected in body fluids other than blood, such as saliva, sweat, or semen. People whose body fluids contain detectable amounts of antigens are known as secretors. ABO typing of these fluids provides clues in legal investigations.

**THE RH BLOOD GROUP SYSTEM.** The Rh, or Rhesus, system was first detected in 1940 by Landsteiner and Wiener when they injected blood from rhesus monkeys into guinea pigs and rabbits. More than 50 antigens have since been discovered that belong to this system, making it the most complex red blood cell antigen system.

In routine blood typing and cross-matching tests, only one of these 50 antigens, the D antigen, also known as the Rh factor or Rh<sub>0</sub>[D], is tested for. If the D antigen is present, that person is Rh-positive; if the D antigen is absent, that person is Rh-negative.

Other important antigens in the Rh system are C, c, E, and e. These antigens are not usually tested for in routine blood typing tests. Testing for the presence of these antigens, however, is useful in paternity testing, and in cases in which a technologist screens blood to identify unexpected Rh antibodies or find matching blood for a person with antibodies to one or more of these antigens.

Unlike the ABO system, antibodies to Rh antigens don't develop naturally. They develop only as an immune response after a transfusion or during

pregnancy. The incidence of the Rh blood types varies between racial groups, but not as widely as the ABO blood types: 85% of whites and 90% of blacks are Rh-positive; 15% of whites and 10% of blacks are Rh-negative.

The distribution of ABO and Rh blood groups in the overall United States population is as follows:

- O Rh-positive, 38%
- O Rh-negative, 7%
- A Rh-positive, 34%
- A Rh-negative, 6%
- B Rh-positive, 9%
- B Rh-negative, 2%
- AB Rh-positive, 3%
- AB Rh-negative, 1%

In transfusions, the Rh system is next in importance after the ABO system. Most Rh-negative people who receive Rh-positive blood will develop anti-D antibodies. A later transfusion of Rh-positive blood may result in a severe or fatal transfusion reaction.

Rh incompatibility is the most common and severe cause of HDN. This incompatibility may occur when an Rh-negative mother and an Rh-positive father have an Rh-positive baby. Cells from the baby can cross the placenta and enter the mother's bloodstream, causing the mother to make anti-D antibodies. Unlike ABO antibodies, the structure of anti-D antibodies makes it likely that they will cross the placenta and enter the baby's bloodstream. There, they can destroy the baby's red blood cells, causing a severe or fatal anemia.

The first step in preventing HDN is to find out the Rh types of the expectant parents. If the mother is Rh-negative and the father is Rh-positive, the baby is at risk for developing HDN. The next step is performing an antibody screen of the mother's serum to make sure she doesn't already have anti-D antibodies from a previous pregnancy or transfusion. Finally, the Rh-negative mother is given an injection of Rh immunoglobulin (RhIg) at 28 weeks of gestation and again after delivery, if the baby is Rh positive. The RhIg attaches to any Rh-positive cells from the baby in the mother's bloodstream, preventing them from triggering anti-D antibody production in the mother. An Rh-negative woman should also receive RhIg following a miscarriage, abortion, or ectopic pregnancy.

**OTHER BLOOD GROUP SYSTEMS.** Several other blood group systems may be involved in HDN and transfusion reactions, although they are much less common than ABO and Rh incompatibilities. Some of the other groups are the Duffy, Kell, Kidd, MNS,

and P systems. Tests for antigens from these systems are not included in routine blood typing, but they are commonly used in paternity testing.

Like Rh antibodies, antibodies in these systems do not develop naturally, but as an immune response after transfusion or during pregnancy. An antibody screening test is done before a cross-match to check for unexpected antibodies to antigens in these systems. A person's serum is mixed in a test tube with commercially prepared cells containing antigens from these systems. If hemagglutination, or clumping, occurs, the antibody is identified.

### *Antibody screening*

Antibody screening is done to look for unexpected antibodies to other blood groups, such as certain Rh (e.g. E, e, C, c), Duffy, MNS, Kell, Kidd, and P system antigens. The recipient's serum is mixed with screening reagent red blood cells. The screening reagent red blood cells are cells with known antigens. This test is sometimes called an indirect antiglobulin or Coombs test. If an antibody to an antigen is present, the mixture will cause agglutination (clumping) of the red blood cells or cause hemolysis (breaking of the red cell membrane). If an antibody to one of these antigens is found, only blood without that antigen will be compatible in a cross-match. This sequence must be repeated before each transfusion a person receives.

### *Testing for infectious disease markers*

As of 2003, pretransfusion testing includes analyzing blood for the following infectious disease markers:

- Hepatitis B surface antigen (HBsAg). This test detects the outer envelope of the hepatitis B virus.
- Antibodies to the core of the hepatitis B virus (Anti-HBc). This test detects an antibody to the hepatitis B virus that is produced during and after an infection.
- Antibodies to the hepatitis C virus (Anti-HCV).
- Antibodies to human immunodeficiency virus, types 1 and 2 (Anti-HIV-1, -2).
- HIV-1 p24 antigen. This test screens for antigens of HIV-1. The advantage of this test is that it can detect HIV-1 infection a week earlier than the antibody test.
- Antibodies to human T-lymphotropic virus, types I and II (Anti-HTLV-I, -II). In the United States, HTLV infection is most common among intravenous drug users.
- Syphilis. This test is performed to detect evidence of infection with the spirochete *Treponema pallidum*.

- Nucleic acid amplification testing (NAT). NAT uses a new form of blood testing technology that directly detects the genetic material of the HCV and HIV viruses.
- Confirmatory tests. These are done to screen out false positives.

### *Cross-matching*

Cross-matching is the final step in pretransfusion testing. It is commonly referred to as compatibility testing, or “type and cross.” Before blood from a donor and the recipient are cross-matched, both are ABO and Rh typed. To begin the cross-match, a unit of blood from a donor with the same ABO and Rh type as the recipient is selected. Serum from the patient is mixed with red blood cells from the donor. The cross-match can be performed either as a short (5–10 min) incubation intended only to verify ABO compatibility or as a long (45 min) incubation with an antihuman globulin test intended to verify compatibility for all other red cell antigens. If clumping occurs, the blood is not compatible; if clumping does not occur, the blood is compatible. If an unexpected antibody is found in either the patient or the donor, the blood bank does further testing to ensure that the blood is compatible.

In an emergency, when there is not enough time for blood typing and cross-matching, O red blood cells may be given, preferably Rh-negative. O-type blood is called the universal donor because it has no ABO antigens for a patient’s antibodies to combine with. In contrast, AB blood type is called the universal recipient because it has no ABO antibodies to combine with the antigens on transfused red blood cells. If there is time for blood typing, red blood cells of the recipient type (type-specific cells) are given. In either case, the cross-match is continued even though the transfusion has begun.

### *Autologous donation*

The practice of collecting a patient’s own blood prior to **elective surgery** for later transfusion is called autologous donation. Since the safest blood for transfusion is the patient’s own, autologous donation is particularly useful for patients with rare blood types. Two to four units of blood are collected several weeks before surgery, and the patient is given iron supplements to build up his or her hemoglobin levels.

### **Preparation**

To collect the 10 mL of blood needed for these tests, a healthcare worker ties a tourniquet above the

patient’s elbow, locates a vein near the inner elbow, cleans the skin overlying the vein, and inserts a needle into that vein. The blood is drawn through the needle into an attached vacuum tube. Collection of the sample takes only a few minutes.

Blood typing and screening must be done three days or less before a transfusion. A person does not need to change diet, medications, or activities before these tests. Patients should tell their health care provider if they have received a blood transfusion or a plasma substitute during the last three months, or have had a radiology procedure using intravenous contrast media. These can give false clumping reactions in both typing and cross-matching tests.

### **Aftercare**

The possible side effects of any blood collection are discomfort, bruising, or excessive bleeding at the site where the needle punctured the skin, as well as dizziness or fainting. Bruising and bleeding is reduced if pressure is applied with a finger to the puncture site until the bleeding stops. Discomfort can be treated with warm packs to the puncture site.

### **Risks**

Aside from the rare event of infection or bleeding, there are no risks from blood collection. Blood transfusions, however, always have the risk of an unexpected transfusion reaction. These complications may include an acute hemolytic transfusion reaction (AHTR), which is most commonly caused by ABO incompatibility. The patient may complain of pain, difficult breathing, fever and chills, facial flushing, and nausea. Signs of shock may appear, including a drop in blood pressure and a rapid but weak pulse. If AHTR is suspected, the transfusion should be stopped at once.

Other milder transfusion reactions include a delayed hemolytic transfusion reaction, which may occur one to two weeks after the transfusion. It consists of a slight fever and a falling **hematocrit**, and is usually self-limited. Patients may also have allergic reactions to unknown components in donor blood.

### **Normal results**

The blood type is labeled as A+, A–, B+, B–, O+, O–, AB+, or AB–, based on both the ABO and Rh systems. If antibody screening is negative, only a cross-match is necessary. If the antibody screen is positive, then blood that is negative for those antigens must be identified. The desired result of a cross-match is that compatible donor blood is found. Compatibility

testing procedures are designed to provide the safest blood product possible for the recipient, but a compatible cross-match is no guarantee that an unexpected adverse reaction will not appear during the transfusion.

Except in an emergency, a person cannot receive a transfusion without a compatible cross-match result. In rare cases, the least incompatible blood has to be given.

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- American Association of Blood Banks (AABB). 8101 Glenbrook Road, Bethesda, MD 20814. (301) 907 6977. [www.aabb.org](http://www.aabb.org).
- American College of Obstetricians and Gynecologists. 409 12th Street SW, Washington, DC 20024 2188. (202) 638 5577. [www.acog.org](http://www.acog.org).
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Mark A. Best







UGI see **Upper GI exam**

Ulcer surgery see **Vagotomy**

Ultrasonic lithotripsy see **Lithotripsy**

## Ultrasound

### Definition

Medical ultrasound imaging involves the use of high frequency sound waves to produce pictures of different parts of the inside of the body. This medical procedure is painless, safe, and non-invasive. Ultrasound imaging is not an X-ray as it uses sound waves and not ionizing radiation. Ultrasound images are unlike x-rays also in that they are done in “real time” and not just a picture taken at a single moment. Therefore, ultrasound imaging can help to show movement inside of body organs as well as the structure of the organs. Most people are familiar with ultrasound imaging being used during pregnancy to look safely and carefully at the developing fetus. There are also many other uses in medicine for ultrasound imaging.

The following are some other uses for medical ultrasound imaging:

- Cardiac ultrasound is used to diagnose problems with the heart and major blood vessels surrounding the heart.
- Ultrasound imaging in gynecology is used to diagnose problems with the female reproductive tract including being used to diagnose problems associated with infertility. Ultrasound is also used to monitor infertility treatments.
- Ultrasound imaging is used to look for problems with other internal organs, such as the gallbladder, bladder, testicles, liver, spleen, kidneys, and pancreas.
- Ultrasound imaging is also used to look for problems with glands, such as the thyroid.
- Vascular ultrasound imaging is used to watch the blood flow in blood vessels or blood flow to tumors. Ultrasound doppler imaging and color flow mapping can show the flow of blood.
- Ultrasound imaging is also used during medical procedures such as needle biopsies or egg retrieval during in vitro fertilization.

### Purpose

The purpose of ultrasound imaging in medicine is to help the physician diagnose, monitor and treat medical conditions.

### Precautions

The greatest precaution that should be taken when using ultrasound imaging to diagnose medical problems is the over and under diagnosing of problems by staff that is not properly trained, using poor equipment or not adequately supervised. This is especially true in the obstetrical setting where it is important to have properly trained ultrasound technicians (sonographers) to perform routine and advanced diagnostic ultrasound on a pregnant woman. The Society of Diagnostic Medical Sonography and the American Institute for Ultrasound in Medicine are great resources for helping to find certified sonographers from accredited programs.

### Description

Ultrasound imaging is performed by using a transducer, which is a small device that the technician holds in his/her hand and is attached to a cord that connects to the ultrasound machine. The ultrasound machine has a keyboard, a computer, and a display screen. The patient is usually lying down on an examination table and clear gel (cold or warm) is applied to the area of the body that is to be imaged or scanned so that the transducer makes easy contact with the body and can easily be slid back and forth during the ultrasound. As the transducer is moved over that part of the

body, it sends out high frequency sound waves, looks for the returning echo and instantly puts that image up onto the screen. An ultrasound examination is usually painless, however, on occasion, discomfort from the pressure being pressed on the body may occur, especially if the patient's bladder is full, or if the area being scanned is injured or tender. Sometimes ultrasound imaging is performed by using an ultrasound probe that is inserted into an area of the body, such as the vagina. Vaginal ultrasounds are used to scan for early pregnancy or to look carefully at the ovaries or guide the physician during procedures such as egg retrieval for in vitro fertilization. This ultrasound is not usually painful, but to some may be uncomfortable.

### Preparation

Preparation for an ultrasound examination depends upon the area of the body that is to be scanned. For example during pregnancy, a patient may be instructed to drink water and not to empty her bladder prior to the ultrasound examination to help with visualization during the ultrasound. Other procedures may require no eating or drinking prior to the ultrasound examination. Comfortable, loose clothing should be worn, although a gown may be provided to be worn for the ultrasound examination. It is important to ask for and follow the instructions that are given prior to the ultrasound examination so that the procedure does not need to be rescheduled.

### Aftercare

After the ultrasound, the gel is wiped off and the patient is usually able to return to normal activity. Usually, after the examination, the technician has the images reviewed by the physician and the physician may then speak to the patient at that time. Otherwise, the results are called to the patient or discussed at a later visit. On occasion, especially during pregnancy, the technician or physician will discuss the results of the ultrasound while the ultrasound is being performed. If an ultrasound examination shows abnormal results, those results may need to be followed-up with other tests or consultations to discuss possible treatment.

### Risks

For routine diagnostic ultrasound imaging, there are no known risks to humans and therefore, if necessary it is safe to repeat the procedure as often as needed to monitor a particular health concern or treatment. For over 30 years, diagnostic ultrasound imaging has been used on pregnant women. A multitude of studies on the effects of ultrasound use during

pregnancy have been reported and although there have been a number of small studies citing possible hearing problems, low birth-weight and left handedness, these studies have not been verified by larger studies. Overall, there has been no evidence that ultrasound is harmful to a developing fetus, however, the medical community should be diligent about preventing unnecessary use of ultrasound in pregnancy.

### Resources

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American Institute of Ultrasound in Medicine, 14750 Sweitzer Lane, Suite 100, Laurel, MD 20707. (301)498 4100. <http://www.aium.org/>.

Society of Diagnostic Medical Sonography, 2745 Dallas Parkway Suite 350, Plano, TX 75093. (214) 473 8057. <http://www.sdms.org/>.

#### OTHER

Medline Plus, a service of the National Library of Medicine and the National Institutes of Health, 8600 Rockville Pike, Bethesda, MD 20894. <http://www.nlm.nih.gov/medlineplus/ency/article/003336.htm>

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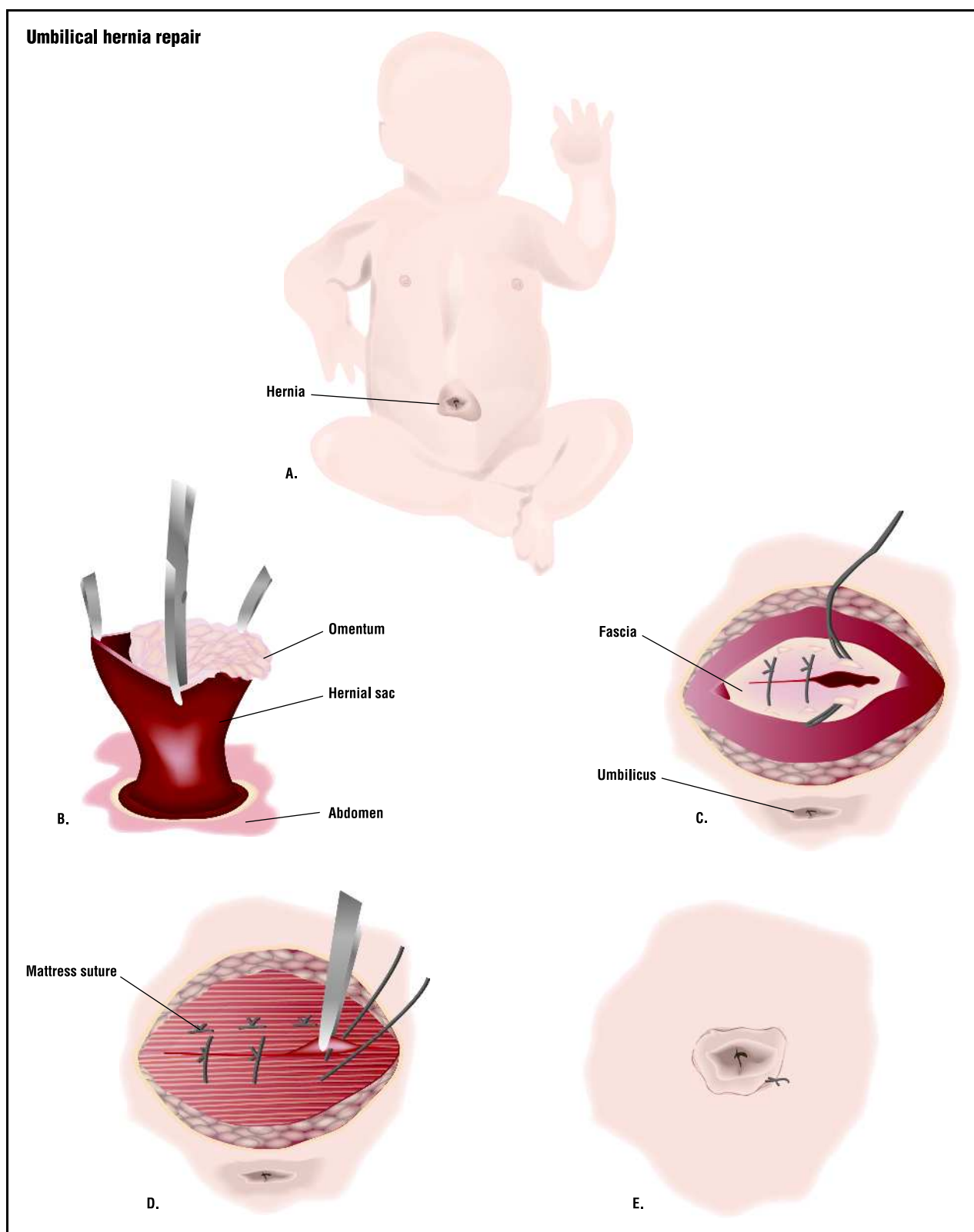
## Umbilical hernia repair

### Definition

An umbilical hernia repair is a surgical procedure performed to fix a weakness in the abdominal wall or to close an opening near the umbilicus (navel) that has allowed abdominal contents to protrude. The abdominal contents may or may not be contained within a membrane or sac. The medical name for a hernia repair is herniorraphy.

### Purpose

Umbilical hernias are usually repaired either to relieve discomfort or to prevent complications. It is not always necessary to fix an umbilical hernia. If the person is not in pain, the hernia is often not repaired. Complications may develop if pressure inside the abdomen resulting from daily activity pushes the abdominal contents further through the opening. They may then become twisted or strangulated. Strangulation is a condition in which the circulation to a section of the intestine



Baby with an umbilical hernia (A). To repair, the hernia is cut open (B), and the contents replaced in the abdomen. Connecting tissues, or fascia, are sutured closed (D), and the skin is repaired (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)



(or other part of the body) is cut off by compression or constriction; it can cause extreme pain. If the strangulation persists, the tissue can die from lack of blood supply and lead to an infection.

## Demographics

An umbilical hernia can occur in both men and women, and can occur at any age, although it is often present at birth. Umbilical hernias are found in about 20% of newborns, especially in premature infants. Umbilical hernias are more common in male than in female infants; with regard to race, they are eight times more common in African Americans than in Caucasians or Hispanics. While umbilical hernia is not a genetically determined condition, it tends to run in families. In the adult population, umbilical hernias are more common in overweight persons with weak abdominal muscles, and in women who are either pregnant or have borne many children. People with liver disease or fluid in the abdominal cavity are also at higher risk of developing an umbilical hernia.

## Description

Repair of an abdominal hernia involves a cut, or incision, in the umbilical area. Most herniorrhaphies take about two hours to complete. After the patient has been given a sedative, the anesthesiologist will administer a local, spinal, or general anesthetic. The type of anesthesia used depends on the patient's age, general health, and complexity of the procedure. The incision is usually made underneath the belly button. The herniated tissues are isolated and pushed back inside the abdominal cavity. A hernia repair may be done using traditional open surgery or with a laparoscope. A laparoscopic procedure is performed through a few very small incisions. The hole in the abdominal wall may be closed with sutures, or by the use of a fine sterile **surgical mesh**. The mesh provides additional strength. Some surgeons may choose to use the mesh when repairing a larger hernia. A hernia repair done with a mesh insert is called a tension-free procedure because the surgeon does not have to put tension on the layer of muscle tissue in order to bring the edges of the hole together.

## Diagnosis/Preparation

### Diagnosis

In children, umbilical hernias are often diagnosed at birth, usually when the doctor feels a lump in the area around the belly button. The hernia may also be diagnosed if the child is crying from pain, because the

## KEY TERMS

**Abdominal distension**—Swelling of the abdominal cavity, which creates painful pressure on the internal organs.

**Hernia**—The protrusion of a loop or piece of tissue through an incision or abnormal opening in other tissues.

**Herniorraphy**—The medical name for a hernia repair procedure.

**Incarceration**—The abnormal confinement of a section of the intestine or other body tissues. An umbilical hernia may lead to incarceration of part of the intestine.

**Intra-abdominal pressure**—Pressure that occurs within the abdominal cavity. Pressure in this area builds up with coughing, crying, and the pressure exerted when bearing down with a bowel movement.

**Strangulation**—A condition in which a vessel, section of the intestine, or other body part is compressed or constricted to the point that blood cannot circulate.

**Umbilicus**—The area where the umbilical cord was attached; also known as the navel or belly button.

crying will increase the pressure inside the abdomen and make the hernia more noticeable.

Umbilical hernias in adults occur more often in pregnant women and obese persons with weak stomach muscles. They may develop gradually without producing any discomfort, but the patient may see a bulge in the abdomen while bathing or getting dressed. Other patients consult their doctor because they have felt the tissues in the abdomen suddenly give way when they are having a bowel movement. In an office examination, the patient may be asked to lie down, lift the head, and cough. This action increases pressure inside the abdomen and causes the hernia to bulge outward.

A hernia that has become incarcerated or strangulated is a medical emergency. Its symptoms include:

- nausea
- vomiting
- abdominal swelling or distension
- pale complexion
- weakness or dizziness
- extreme pain

When a hernia is present at birth, some surgeons may opt for a “wait and see” approach, as umbilical hernias in children often close by themselves with time. If the hernia has not closed by the time the child is three or four years old, then surgery is usually considered. If the hernia is very large, surgery may be recommended.

Repair of an umbilical hernia in an adult is usually considered **elective surgery**. The patient’s surgeon may recommend the procedure, however, on the grounds that hernias in adults do not close by themselves and tend to grow larger over time.

### Preparation

Adults scheduled for a herniorrhaphy are given standard blood tests and a **urinalysis**. They should not eat breakfast on the morning of the procedure, and they should wear loose-fitting, comfortable clothing that they can easily pull on after the surgery without straining their abdomen.

### Aftercare

Aftercare will depend in part on the invasiveness of the surgery, whether laparoscopic or open; the type of anesthesia; the patient’s age; and his or her general medical condition. Immediately after the procedure, the person will be taken to the recovery area of the surgical center, where nurses will monitor the patient for signs of excessive bleeding, infection, uncontrolled pain, or shock. Hernia repairs are usually performed on an outpatient basis, which means that the patient can expect to go home within a few hours of the surgery. Adult patients, however, should arrange to have a friend or relative drive them home. If possible, someone should stay with them for the first night.

The nurses will provide the patient with instructions on **incision care**. The specific instructions will depend on the type of surgery and the way in which the incision was closed. Sometimes a see-through dressing is placed on the wound that the patient can remove about three days after the procedure. It may be necessary to keep the dressing dry until some healing has taken place. Very small incisions may be closed with Steri-strips rather than sutures.

### Risks

There are surgical and anesthesia-related risks with all surgical procedures. The primary surgical risks include bleeding and infection. Anesthesia-related risks include reactions to the specific anesthetic agents that are used; interactions with over-the-counter and herbal preparations; and respiratory problems. The

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

This procedure is performed by a general surgeon or a pediatric surgeon. It is usually performed on an outpatient, or ambulatory, basis in a hospital. After a few hours of recovery in the surgical center, the patient is able to return home.

greatest risk associated with umbilical hernia is missing the diagnosis. Additional risks include the formation of scar tissue and recurrence of the hernia.

### Normal results

Umbilical hernia repair is usually considered an uncomplicated procedure with a relatively short recovery period. A study reported in the December 2002 issue of the *American Journal of Surgery* found that patients who had laparoscopic surgery with the use of a surgical mesh had fewer complications and recurrences of a hernia than those with the traditional open surgery. However, laparoscopic surgery took somewhat longer to perform, possibly because the laparoscopic approach is often used for larger repairs.

### Morbidity and mortality rates

In general, there are few complications with hernia repair in children. The most serious complication is surgical injury to the bladder or intestine; fortunately, this complication is very rare—about one in 1,000 patients. The recurrence rate is between 1% and 5%; recurrence is more likely in patients with very large hernias. The rate of infection is less than 1%. In the adult population, a November 2001 study reported in the *American Journal of Surgery* found a 5% mortality in elderly patients undergoing emergency hernia repairs.

### Alternatives

There are no medical or surgical alternatives to an umbilical hernia repair other than watchful waiting. Since umbilical hernias present at birth often close on their own, intervention can often be delayed until the child is several years old. There is some risk that the hernia will enlarge, however, which increases the risk of incarceration or strangulation.

## QUESTIONS TO ASK THE DOCTOR

- How soon can my child return to normal activities?
- How soon can I return to work and my other normal activities?
- When can I drive?
- What should I do to take care of the incision?
- How many times have you performed this surgery?
- What kinds of complications are there to this procedure?
- What kinds of complications have your patients experienced?

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American Academy of Family Physicians. 11400 Tomahawk Creek Parkway, Leawood, KS 66211-2672. (913) 906-6000. E mail: fp@aafp.org. www.aafp.org.

American Academy of Pediatrics. 141 Northwest Point Boulevard, Elk Grove Village, IL 60007-1098. (847) 434-4000. Fax: (847) 434-8000. E mail: kidsdoc@aap.org. www.aap.org.

American College of Surgeons. 633 North St. Clair Street, Chicago, IL 60611-3231. (312) 202-5000. Fax: (312) 202-5001. www.facs.org.

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Esther Csapo Rastegari, R.N., B.S.N., Ed.M.

Undescended testicle repair see **Orchiopexy**

## Upper GI exam

### Definition

An upper GI examination is a fluoroscopic examination (a type of x-ray imaging) of the upper gastrointestinal tract, including the pharynx (throat), esophagus, stomach, and upper small intestine (duodenum). An x-ray examination that evaluates only the pharynx and esophagus is called a barium swallow.

### Purpose

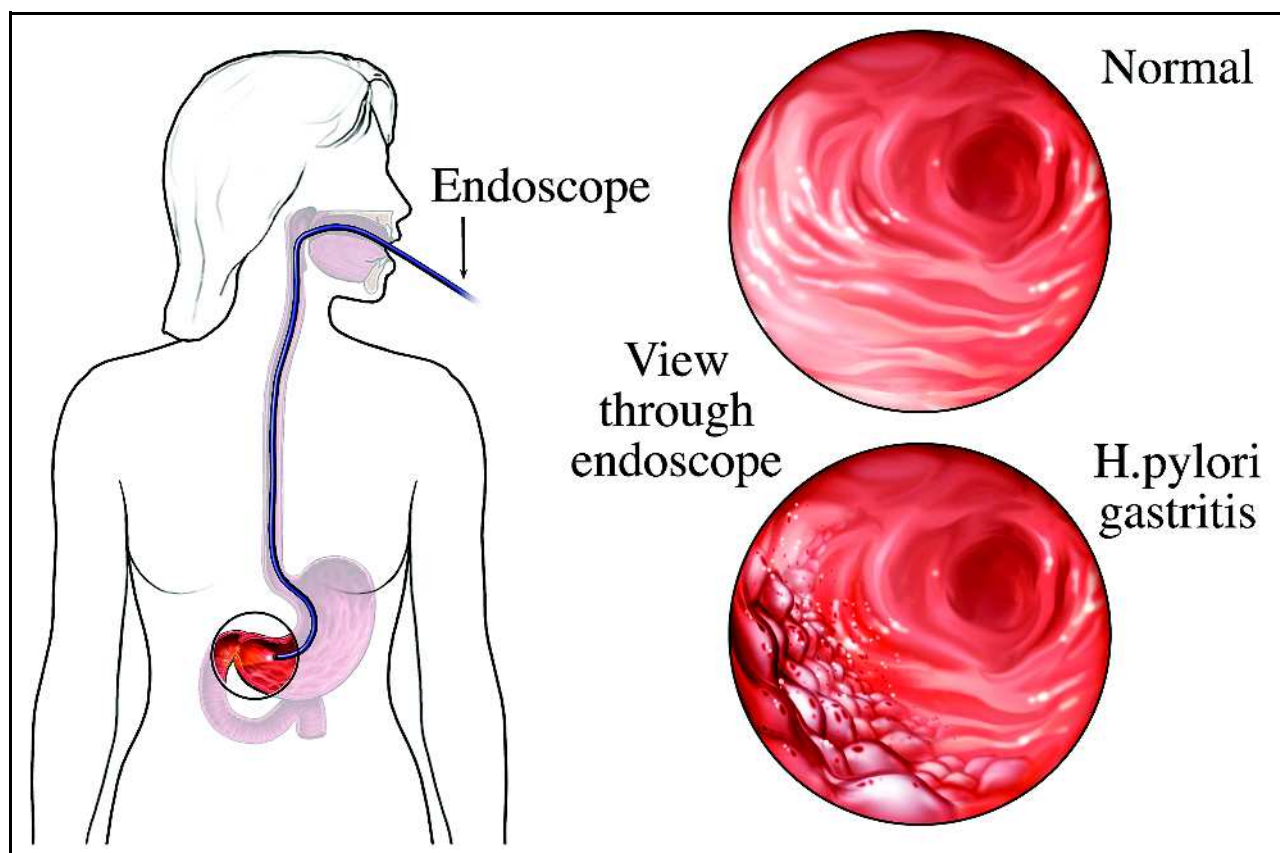
An upper GI series is frequently requested when a patient experiences unexplained symptoms of abdominal pain, difficulty in swallowing (dysphagia), regurgitation (reflux), diarrhea, unexplained vomiting, blood in the stool, or unexplained weight loss. It is used to help diagnose disorders and diseases of, or related to, the upper gastrointestinal tract. Some of these conditions are: **hiatal hernia**, diverticula, tumors, obstruction, gastroesophageal reflux disease (GERD), pulmonary aspiration, and inflammation (e.g., ulcers, enteritis, and Crohn's disease).

Glucagon, a medication sometimes given prior to an upper GI procedure, may cause nausea and dizziness. It is used to relax the natural movements of the stomach, which will enhance the overall study.

### Description

An upper GI series takes place in a hospital or clinic setting, and is performed by an x-ray technologist and a radiologist. Before the test begins, the patient is sometimes given a glucagon injection, a medication that slows stomach and bowel activity, to provide the radiologist with a clear picture of the gastrointestinal tract. In order to further improve the upper GI picture clarity, the patient may be given a cup of fizzing baking soda crystals to swallow, which distends the esophagus and stomach by producing gas. This procedure is called a double-contrast or air-contrast upper GI.

Once these preparatory steps are complete, the patient stands against an upright x-ray table, and a fluoroscopic screen is placed in front of him or her. The patient will be asked to drink from a cup of flavored barium sulfate, a thick and chalky-tasting liquid, while the radiologist views the esophagus, stomach, and duodenum on the fluoroscopic screen. The patient will be asked to change positions frequently to coat the entire surface of the gastrointestinal tract with barium, move overlapping loops of bowel to isolate each segment, and provide multiple



**Illustration of endoscope placement in upper GI tract.** (Nucleus Medical Art, Inc./Phototake. Reproduced by permission.)

views of each segment. The technician or radiologist may press on the patient's abdomen to spread the barium throughout the folds within the lining of the stomach. The x-ray table will also be moved several times throughout the procedure. The radiologist will ask the patient to hold his or her breath periodically while exposures are taken. After the radiologist completes his or her portion of the exam, the technologist takes three to six additional films of the GI tract. The entire procedure takes approximately 15–30 minutes.

In addition to the standard upper GI series, a physician may request a detailed small bowel follow-through (SBFT), which is a timed series of films. After the preliminary upper GI series is complete, the patient will drink additional barium sulfate, and will be escorted to a waiting area while the barium moves through the small intestines. X rays are initially taken at 15-minute intervals until the barium reaches the colon (the only way to be sure the terminal ileum is fully seen is to see the colon or ileocecal valve). The interval may be increased to 30 minutes, or even one hour if the barium passes slowly. Then the radiologist

will obtain additional views of the terminal ileum (the most distal segment of the small bowel, just before the colon). This procedure can take from one to four hours.

Esophageal radiography, also called a barium esophagram or a barium swallow, is a study of the esophagus only, and is usually performed as part of the upper GI series (sometimes only a barium swallow is done). It is commonly used to diagnose the cause of difficulty in swallowing (dysphagia), and to detect a hiatal hernia. The patient drinks a barium sulfate liquid, and sometimes eats barium-coated food while the radiologist examines the swallowing mechanism on a fluoroscopic screen. The test takes approximately 30 minutes.

### Preparation

Patients must not eat, drink, chew gum, or smoke for eight hours prior to undergoing an upper GI examination. Longer dietary restrictions may be required, depending on the type and diagnostic purpose of the test. Patients undergoing a small-bowel



## KEY TERMS

**Contrast medium**—Any substance that is swallowed or injected in order to increase the visibility of body structures or fluids.

**Crohn's disease**—A chronic, inflammatory bowel disease usually affecting the ileum, colon, or both.

**Diverticula (singular, diverticulum)**—Pouch-like herniations through the muscular wall of an organ such as the stomach, small intestine, or colon.

**Enteritis**—Inflammation of the mucosal lining of the small intestine.

**Gastroesophageal reflux disease (GERD)**—A painful, chronic condition in which stomach acid flows back into the esophagus causing heartburn and, in time, erosion of the esophageal lining.

**Hiatal hernia**—Protrusion of the stomach up through the diaphragm.

follow-through exam may be asked to take **laxatives** the day before the test. Patients are required to wear a hospital gown, or similar attire, and to remove all jewelry, to provide the camera with an unobstructed view of the abdomen.

## Aftercare

No special aftercare treatment or regimen is required for an upper GI series. The patient may eat and drink as soon as the test is completed. The barium sulfate may make the patient's stool white for several days, and can cause constipation; therefore, patients are encouraged to drink plenty of water to eliminate it from their system.

## Risks

Because the upper GI series is an x-ray procedure, it does involve minor exposure to ionizing radiation. Unless the patient is pregnant, or multiple radiological or fluoroscopic studies are required, the small dose of radiation incurred during a single procedure poses little risk. However, multiple studies requiring fluoroscopic exposure that are conducted in a short time period have been known, on very rare occasions, to cause skin **death** (necrosis) in some individuals. This risk can be minimized by careful monitoring and documentation of cumulative radiation doses.

Some patients find the barium liquid unpleasant to the taste or difficult to swallow. The radiologist may be able to provide a strawberry- or chocolate-flavored

version. In addition, some patients feel gassy, bloated, or nauseated while they are being tilted on the examination table or having their abdomen pressed.

A few patients are allergic to barium and other contrast materials. Patients should inform the radiologist of any known allergies.

## Normal results

A normal upper GI series shows a healthy, normally functioning, and unobstructed digestive tract. Hiatal hernia, obstructions, inflammation (including ulcers or polyps of the esophagus, stomach, or small intestine), or irregularities in the swallowing mechanism are just a few of the possible abnormalities that may appear on an upper GI series. Additionally, abnormal peristalsis, or digestive movements of the esophagus, stomach, and small intestine can often be visualized on the fluoroscopic part of the exam, and in the interpretation of the SBFT.

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## Ureteral stenting

### Definition

A ureteral stent is a thin, flexible tube threaded into the ureter to help urine drain from the kidney to the bladder or to an external collection system.

### Purpose

Urine is normally carried from the kidneys to the bladder via a pair of long, narrow tubes called ureters (each kidney is connected to one ureter). A ureter may become obstructed as a result of a number of conditions including kidney stones, tumors, blood clots, postsurgical swelling, or infection. A ureteral stent is placed in the ureter to restore the flow of urine to the bladder. Ureteral stents may be used in patients with active kidney infection or with diseased bladders (e.g., as a result of cancer or radiation therapy). Alternatively, ureteral stents may be used during or after urinary tract surgical procedures to provide a mold around which healing can occur, to divert the urinary flow away from areas of leakage, to manipulate kidney stones or prevent stone migration prior to treatment, or to make the ureters more easily identifiable during difficult surgical procedures. The stent may remain in place on a short-term (days to weeks) or long-term (weeks to months) basis.

### Demographics

Chronic blockage of a ureter affects approximately five individuals out of every 1,000; acute blockage affects one out of every 1,000. Bilateral obstruction (blockage to both ureters) is more rare; chronic blockage affects one individual per 1,000 people, and acute blockage affects five per 10,000.

### Description

The size, shape, and material of the ureteral stent to be used depends on the patient's anatomy and the reason why the stent is required. Most stents are 5–12 inches (12–30 cm) in length, and have a diameter of 0.06–0.2 inches (1.5–6 mm). One or both ends of the

## KEY TERMS

**Acute**—A condition that has a short but severe course.

**Chronic**—A condition that is persistent or recurs frequently.

**Cystoscopy**—Examination or treatment of the interior of the urinary bladder by looking through a special instrument with reflected light.

**Kidney stones**—Small, solid masses that form in the kidney.

**Urethra**—The tube through which urine travels from the bladder to the outside of the body.

stent may be coiled (called a pigtail stent) to prevent it from moving out of place; an open-ended stent is better suited for patients who require temporary drainage. In some instances, one end of the stent has a thread attached to it that extends through the bladder and urethra to the outside of the body; this aids in stent removal. The stent material must be flexible, durable, non-reactive, and radiopaque (visible on an x ray).

The patient is usually placed under **general anesthesia** for stent insertion; this ensures the physician that the patient will remain relaxed and will not move during the procedure. A cystoscope (a thin, telescope-like instrument) is inserted into the urethra to the bladder, and the opening to the ureter to be stented is identified. In some instances, a guide wire is inserted into the ureter under the aid of a fluoroscope (an imaging device that uses x rays to visualize structures on a fluorescent screen). The guide wire provides a path for the placement of the stent, which is advanced over the wire. Once the stent is in place, the guide wire and cystoscope are removed. Patients who fail this method of ureteral stenting may have the stent placed percutaneously (through the skin), into the kidney, and subsequently into the ureter.

A stent that has an attached thread may be pulled out by a physician in an office setting. **Cystoscopy** may also be used to remove a stent.

### Diagnosis/Preparation

A number of different technologies aid in the diagnosis of ureteral obstruction. These include:

- cystoscopy (a procedure in which a thin, tubular instrument is used to visualize the interior of the bladder)
- ultrasonography (an imaging technique that uses high-frequency sound waves to visualize structures inside the body)

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Ureteral stenting is typically performed in a hospital by an interventional radiologist (a physician who specializes in the treatment of medical disorders using specialized imaging techniques) or a urologist (a physician who specializes in the diagnosis and treatment of diseases of the urinary tract and genital organs).

- computed tomography (an imaging technique that uses x rays to produce two-dimensional cross-sections on a viewing screen)
- pyelography (x rays taken of the urinary tract after a contrast dye has been injected into a vein or into the kidney, ureter, or bladder)

Prior to ureteral stenting, the procedure should be thoroughly explained by a medical professional. No food or drink is permitted after midnight the night before surgery. The patient wears a hospital gown during the procedure. If the stent insertion is performed with the aid of a cystoscope, the patient will assume a position that is typically used in a gynecological exam (lying on the back, with the legs flexed and supported by stirrups).

### Aftercare

Stents must be periodically replaced to prevent fractures within the catheter wall or build-up of encrustation. Stent replacement is recommended approximately every six months; more often in patients who form stones.

### Risks

Complications associated with ureteral stenting include:

- bleeding (usually minor and easily treated, but occasionally requiring transfusion)
- catheter migration or dislodgement (may require readjustment)
- coiling of the stent within the ureter (may cause lower abdominal pain or flank pain on urination, urinary frequency, or blood in the urine)
- introduction or worsening of infection
- penetration of adjacent organs (e.g., bowel, gallbladder, or lungs)

### Normal results

Normally, a ureteral stent re-establishes the flow of urine from the kidney to the bladder. Postoperative

## QUESTIONS TO ASK THE DOCTOR

- Why is ureteral stenting recommended?
- What diagnostic tests will be performed prior to the stenting procedure?
- What technique will be used to place the stent?
- What type of stent will be used, and when will it be removed?
- Are there any alternatives to ureteral stenting?

urine flow will be monitored to ensure the stent has not been dislodged or obstructed.

### Morbidity and mortality rates

Serious complications occur in approximately 4% of patients undergoing ureteral stenting, with minor complications in another 10%.

### Alternatives

If a ureter is obstructed and ureteral stenting is not possible, a **nephrostomy** may be performed. During this procedure, a tube is placed through the skin on the patient's back, into the area of the kidney that collects urine. The tube may be connected to an external drainage bag. In other cases, the tube is connected directly from the kidney to the bladder.

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## Ureterosigmoidoscopy

### Definition

Ureterosigmoidoscopy is a surgical procedure that treats urinary incontinence by joining the ureters to the lower colon, thereby allowing urine to evacuate through the rectum.

### Purpose

The surgery is indicated when there is resection (surgical removal), malformation, or injury to the bladder. The bladder disposes of wastes passed to it from the kidneys, which is the organ that does most of the blood filtering and retention of needed glucose, salts, and minerals.

Wastes from the kidneys drip through the ureters to the bladder, and on to the urethra where they are expelled via urination. Waste from the kidneys is slowed or impaired when the bladder is diseased because of ulcerative, inflammatory, or malignant conditions; is malformed; or if it has been removed. In these cases, the kidney is unable to get rid of the wastes, resulting in hydronephrosis (distention of the kidneys). Over time, this leads to kidney deterioration. Saving the kidneys by bladder diversion is as important as restoring urinary continence.

The surgical techniques for urinary and fecal diversion fall into two categories: continent diversion and conduit diversion. In continent diversion, an internal reservoir for urine or feces is created, allowing natural evacuation from the body. In urinary and fecal conduit diversion, a section of existing tissue is altered to serve as a passageway to an external reservoir or ostomy. Both continent and conduit diversions reproduce bladder or colon function that was impaired due to surgery, obstruction, or a neurogenically (nerve dysfunction) created condition. Both the continent and conduit diversion methods have been used for years, with advancements in minimally invasive surgical techniques and biochemical improvements in conduit materials and ostomy appliances.

Catheterization was the original solution for urinary incontinence, especially when major organ failure or removal was involved. But catheterization was found to have major residual back flow of urine into the kidneys over the long term. With the advent of surgical anastomosis—the grafting of vascularizing tissue for the repair and expansion of organ function—and with the ability to include flap-type valves to prevent back-up into the kidneys, major continent restoring procedures have become routine in **urologic**

### KEY TERMS

**Bladder exstrophy**—One of many bladder and urinary congenital abnormalities. Occurs when the wall of the bladder fails to close in embryonic development and remains exposed to the abdominal wall.

**Conduit diversion**—A surgical procedure that restores urinary and fecal continence by diverting these functions through a constructed conduit leading to an external waste reservoir (ostomy).

**Cystectomy**—The surgical resection of part or all of the bladder.

**Urinary continent diversion**—A surgical procedure that restores urinary continence by diverting urinary function around the bladder and into the intestines, thereby allowing for natural evacuation through the rectum or an implanted artificial sphincter.

**surgery.** Catheterization has been replaced as a permanent remedy for persistent incontinence. Continent surgical procedures developed since the 1980s offer the possibility of safely retaining natural evacuation functions in both colonic (intestinal) and urinary systems.

Quality of life issues associated with urinary diversion are increasingly important to patients and, along with medical requirements, put an optimal threshold on the requirements for the surgical procedure. The bladder substitute or created reservoir must offer the following advantages:

- maintain continence
- maintain sterile urine
- empty completely
- protect the kidneys
- prevent absorption of waste products
- maintain quality of life

Ureterosigmoidoscopy is one of the earliest continent diversions for a resected bladder, bladder abnormalities, and dysfunction. It is one of the more difficult surgeries, and has significant complications. Ureterosigmoidoscopy does have a major benefit; it allows the natural expelling of wastes without the construction of a stoma—an artificial conduit—by using the rectum as a urinary reservoir. When evacuation occurs, the urine is passed along with the fecal matter.



Ureterosigmoidoscopy is a single procedure, but there are additional refinements that allow rectal voiding of urine. A procedure known as the Mainz II pouch has undergone many refinements in attempts to lessen the complications that have traditionally accompanied uretersigmoidoscopy. This surgery is indicated for significant and serious conditions of the urinary tract including:

- Cancer or ulceration of the bladder that necessitates a radical cystectomy or removal of the bladder, primarily occurring in adults, particularly those of advanced age.
- Various congenital abnormalities of the bladder in infants, especially eversion of part or all of the bladder. Eversion (or exstrophy) is a malformation of the bladder in which the wall adjacent to the abdomen fails to close. In some children, the bladder plate may be too small to fashion a closure.

### Demographics

Bladder cancer affects over 50,000 people annually in the United States. The average age at diagnosis is 68 years. It accounts for approximately 10,000 deaths per year. Bladder cancer is the fifth leading cause of cancer deaths among men older than 75 years. Male bladder cancer is three times more prevalent than female bladder cancer.

In the United States, radical **cystectomy** (total removal of the bladder) is the standard treatment for muscle-invading bladder cancer. The operation usually involves removal of the bladder (with oncology staging) and pelvic lymph node, and prostate and seminal conduits with a form of urinary diversion. Ureterosigmoidoscopy is one option that restores continence.

Pediatric ureterosigmoidoscopy is performed primarily for bladder abnormalities occurring at birth. Classic bladder exstrophy occurs in 3.3 per 100,000 births, with a male to female ratio of 3:1 (6:1 in some studies).

### Description

The most basic ureterosigmoidoscopy modification is the Mainz II pouch. There is a 2.4 in (6 cm) cut along antimesenteric border of the colon, both on the proximal and distal sides of the rectum/sigmoid colon junction. The ureters are drawn down into the colon. A special flap technique is applied by folding the colon to stop urine from refluxing back to the kidneys. After the colon is closed, the result is a small rectosigmoid reservoir that holds urine without refluxing it back to the upper urinary tract. Some variations of the Mainz

II pouch include the construction of a valve, as in the Kock pouch, that confines urine to the distal segment of the colon.

Ureterosigmoidoscopy is typically performed in patients with complex medical problems, often those who have had numerous surgeries. Ureterosigmoidoscopy as a continent diversion technique relies heavily upon an intact and functional rectal sphincter. The treatment of pediatric urinary incontinence due to bladder eversion or other anatomical anomalies is a technical challenge, and is not always the first choice of surgeons. In Europe, early urinary diversion with ureterosigmoidoscopy is used widely for most exstrophy patients. Its main advantage is the possibility for spontaneous emptying by evacuation of urine and stool.

### Diagnosis/Preparation

A number of tests are performed as part of the pre-surgery diagnostic workup for bladder conditions such as cancer, ulcerative or inflammatory disease, or pediatric abnormalities. Tests may include:

- cystoscopy (bladder inspection with a laparoscope)
- CT scan
- liver function
- renal function
- rectal sphincter function evaluation (The rectal sphincter will be a critical ingredient in urination after the surgery, and it is important to determine its ability to function. Adult patients are often asked to have an oatmeal enema and sit upright for a period of time to test sphincter function.)

In adult patients, a discussion of continent diversion is conducted early in the diagnostic process. Patients are asked to consider the possibility of a conduit urinary diversion if the ureterosigmoidoscopy proves impossible to complete. Educational sessions on specific conduit alternatives take place prior to surgery. Topics include options for placement of a stoma, and appliances that may be a part of the daily voiding routine after surgery. Many doctors provide a stomal therapist to consult with the patient.

### Aftercare

After surgery, patients may remain in the hospital for a few days to undergo blood, renal, and liver tests, and monitoring for fever or other surgical complications. In pediatric patients, a cast keeps the legs abducted (apart) and slightly elevated for three weeks. Bladder and kidneys are fully drained via multiple catheters during the first few weeks after surgery. **Antibiotics** are continued after surgery. Permanent

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Uretersigmoidoscopy is usually performed by a urological surgeon with advanced training in urinary continent surgeries, often in consultation with a neonatalist (in newborn patients) or an oncological surgeon. The surgery takes place in a general hospital.

follow-up with the urologist is essential for proper monitoring of kidney function.

### Normal results

Good results have been reported, especially in children; however, uretersigmoidoscopy offers some severe morbid complications. Post-surgical bladder function and continence rates are very high. However, many newly created reservoirs do not function normally; some deteriorate over time, creating a need for more than one diversion surgery. Many patients have difficulty voiding after surgery. Five-year survival rates for bladder surgery patients are 50–80%, depending on the grade, depth of bladder penetration, and nodal status.

### Morbidity and mortality rates

The continence success rate with uretersigmoidoscopy and its variants is higher than 95% for exstrophy; however, long-term malignancy rates are quite high. Adenocarcinoma is the most common of these malignancies, and may be caused by chronic irritation and inflammation of exposed mucosa of the exstrophic bladder. In one series of studies, adenocarcinoma was reported in more than 10% of patients. However, the malignancy is actually higher in untreated patients whose bladders are left exposed for years before surgery.

Upper urinary tract deterioration is a potential complication, caused by reflux of urine back to the kidneys, resulting in febrile infections.

### Alternatives

Other options include construction of a full neo-bladder in certain carefully defined circumstances, and bladder enhancement for congenitally shortened or abnormal bladders. Surgical bladder resection is often followed by continent operations using other

## QUESTIONS TO ASK THE DOCTOR

How many times has the surgeon performed this operation?

Is conduit surgery the best route for protecting renal function?

What is the surgeon's complication rate?

parts of the colon, and by various conduit surgeries that utilize an external ostomy appliance.

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## Ureterostomy, cutaneous

### Definition

A cutaneous ureterostomy, also called ureterocutaneostomy, is a surgical procedure that detaches one or both ureters from the bladder, and brings them to

the surface of the abdomen with the formation of an opening (stoma) to allow passage of urine.

### Purpose

The bladder is the membranous pouch that serves as a reservoir for urine. Contraction of the bladder results in urination. A ureterostomy is performed to divert the flow of urine away from the bladder when the bladder is not functioning or has been removed. The following conditions may result in a need for ureterostomy.

- bladder cancer
- spinal cord injury
- malfunction of the bladder
- birth defects, such as spina bifida

### Demographics

Bladder disorders afflict millions of people in the United States. According to the American Cancer Society (ACS), there were 54,200 new cases of bladder cancer in 1999, with approximately 12,100 deaths from the disease. Bladder cancer incidence is steadily rising, and by 2010 it is projected to increase by 28% for both men and women.

### Description

Urostomy is the generic name for any surgical procedure that diverts the passage of urine by re-directing the ureters (fibromuscular tubes that carry the urine from the kidney to the bladder). There are two basic types of urostomies. The first features the creation of a passage called an “ileal conduit.” In this procedure, the ureters are detached from the bladder and joined to a short length of the small intestine (ileum). The other type of urostomy is cutaneous ureterostomy. With this technique, the surgeon detaches the ureters from the bladder and brings one or both to the surface of the abdomen. The hole created in the abdomen is called a stoma, a reddish, moist abdominal protrusion. The stoma is not painful; it has no sensation. Since it has no muscles to regulate urination, urine collects in a bag.

There are four common types of ureterostomies:

- Single ureterostomy. This procedure brings only one ureter to the surface of the abdomen.
- Bilateral ureterostomy. This procedure brings the two ureters to the surface of the abdomen, one on each side.

## KEY TERMS

**Anastomosis**—An opening created by surgical, traumatic, or pathological means between two separate spaces or organs.

**Cecum**—The pouch-like start of the large intestine (colon) at the end of the small intestine.

**Gastrointestinal (GI) tract**—The entire length of the digestive tract, from the stomach to the rectum.

**Ileum**—The last portion of the small intestine that communicates with the large intestine.

**Large intestine**—Also called the colon, this structure has six major divisions: cecum, ascending colon, transverse colon, descending colon, sigmoid colon, and rectum.

**Ostomy**—General term meaning a surgical procedure in which an artificial opening is formed to either allow waste (stool or urine) to pass from the body, or to allow food into the GI tract. An ostomy can be permanent or temporary, as well as single-barreled, double-barreled, or a loop.

**Small intestine**—The small intestine consists of three sections: duodenum, jejunum, and ileum.

**Spina bifida**—A congenital defect in the spinal column, characterized by the absence of the vertebral arches through which the spinal membranes and spinal cord may protrude.

**Stent**—A tube made of metal or plastic that is inserted into a vessel or passage to keep it open and prevent closure.

**Stoma**—A surgically created opening in the abdominal wall.

**Ureter**—The fibromuscular tube that transports the urine from the kidney to the bladder.

- Double-barrel ureterostomy. In this approach, both ureters are brought to the same side of the abdominal surface.
- Transuretero ureterostomy (TUU). This procedure brings both ureters to the same side of the abdomen, through the same stoma.

### Diagnosis/Preparation

Ureterostomy patients may have the following tests and procedures as part of their diagnostic work-up:

- Renal function tests; blood, urea, nitrogen (BUN); and creatinine.

- Blood tests, complete blood count (CBC), and electrolytes.
- Imaging studies of the ureters and renal pelvis. These studies characterize the ureters, and define the surgery required to obtain adequate ureteral length.

The quality, character, and usable length of the ureters is usually assessed using any of the following tests:

- Intravenous pyelogram (IVP). A special diagnostic test that follows the time course of excretion of a contrast dye through the kidneys, ureters, and bladder after it is injected into a vein.
- Retrograde pyelogram (RPG). X-ray study of the kidney, focusing on the urine-collecting region of the kidney and ureters.
- Antegrade nephrostogram.
- CT scan. A special imaging technique that uses a computer to collect multiple x-ray images into a two-dimensional cross-sectional image.
- MRI with intravenous gadolinium. A special technique used to image internal structures of the body, particularly the soft tissues. An MRI image is often superior to a routine x-ray image.

The presurgery evaluation also includes an assessment of overall patient stability. The surgery may take from two to six hours, depending on the health of the ureters, and the experience of the surgeon.

### Aftercare

After surgery, the condition of the ureters is monitored by IVP testing, repeated postoperatively at six months, one year, and then yearly.

Following ureterostomy, urine needs to be collected in bags. Several designs are available. One popular type features an open bag fitted with an anti-reflux valve, which prevents the urine from flowing back toward the stoma. A urostomy bag connects to a night bag that may be attached to the bed at night. Urostomy bags are available as one- and two-piece bags:

- One-piece bags: The adhesive and the bag are sealed together. The advantage of using a one-piece appliance is that it is easy to apply, and the bag is flexible and soft.
- Two-piece bags: The bag and the adhesive are two separate components. The adhesive does not need to be removed frequently from the skin, and can remain in place for several days while the bag is changed as required.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Ureterostomy is performed in a hospital setting by experienced surgeons trained in urology, the branch of medicine concerned with the diagnosis and treatment of diseases of the urinary tract and urogenital system. Specially trained nurses called wound ostomy continence nurses (WOCN) are commonly available for consultation in most major medical centers.

### Risks

The complication rate associated with ureterostomy procedures is less than 5–10%. Risks during surgery include heart problems, pulmonary (lung) complications, development of blood clots (thrombosis), blocking of arteries (embolism), and injury to adjacent structures, such as bowel or vascular entities. Inadequate ureteral length may also be encountered, leading to ureteral kinking and subsequent obstruction. If plastic tubes need inserting, their malposition can lead to obstruction and eventual breakdown of the opening (anastomosis). Anastomotic leak is the most frequently encountered complication.

### Normal results

Normal results for a ureterostomy include the successful diversion of the urine pathway away from the bladder, and a tension-free, watertight opening to the abdomen that prevents urinary leakage.

### Morbidity and mortality rates

The outcome and prognosis for ureterostomy patients depends on a number of factors. The highest rates of complications exist for those who have pelvic cancer or a history of radiation therapy.

In one study, a French medical team followed 69 patients for a minimum of one year (an average of six years) after TUU was performed. They reported one complication per four patients (6.3%), including a case requiring open drainage, prolonged urinary leakage, and common ureteral **death** (necrosis). Two complications occurred three and four years after surgery. The National Cancer Institute performed TUU for pelvic malignancy in 10 patients. Mean follow-up was 6.5 years. Complications include common ureteral narrowing (one patient); subsequent kidney removal, or



## QUESTIONS TO ASK THE DOCTOR

- Why is ureterostomy required?
- What type will be performed?
- How long will it take to recover from the surgery?
- When can normal activities be resumed?
- How many ureterostomies does the surgeon perform each year?
- What are the possible complications?

**nephrectomy** (one patient); recurrence of disease with ureteral obstruction (one patient); and disease progression in a case of inflammation of blood vessels, or vasculitis (one patient). One patient died of sepsis (infection in the bloodstream) due to urine leakage at the anastomosis, one died after a heart attack, and three died from metastasis of their primary cancer.

### Alternatives

There are several alternative surgical procedures available:

- **Ileal conduit urostomy**, also known as “Bricker’s loop.” The two ureters that transport urine from the kidneys are detached from the bladder, and then attached so that they will empty through a piece of the ileum. One end of the ileum piece is sealed off and the other end is brought to the surface of the abdomen to form the stoma. It is the most common technique used for urinary diversion.
- **Cystostomy**. The flow of urine is diverted from the bladder to the abdominal wall. It features placement of a tube through the abdominal wall into the bladder, and is indicated in cases of blockage or stricture of the ureters. It can be temporary or permanent.
- **Indiana pouch**. A pouch is constructed using the end part of the ileum and the first part of the large intestine (cecum). The remaining ileum is first attached to the large intestine to maintain normal digestive flow. A pouch is then created from the removed cecum, and the attached ileum is brought to the surface of the abdominal wall to create a stoma.
- **Percutaneous nephrostomy**. A nephrostomy is created when the flow of urine is diverted directly from the kidneys to the abdominal wall. Tubes are placed within the kidney to collect the urine as it is generated, and transport it to the abdominal wall. This procedure is usually temporary; however, it may be permanent for cancer patients.

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Uric acid tests see **Kidney function tests**

## Urinalysis

### Definition

A urinalysis is a group of manual and/or automated qualitative and semi-quantitative tests performed on a urine sample. A routine urinalysis usually includes the following tests: color, transparency, specific gravity, pH, protein, glucose, ketones, blood, bilirubin, nitrite, urobilinogen, and leukocyte esterase. Some laboratories include a microscopic examination of urinary sediment with all routine urinalysis tests. If not, it is customary to perform the microscopic exam, if transparency, glucose, protein, blood, nitrite, or leukocyte esterase is abnormal.

## Purpose

Routine urinalyses are performed for several reasons:

- general health screening to detect renal and metabolic diseases
- diagnosis of diseases or disorders of the kidneys or urinary tract
- monitoring of patients with diabetes

In addition, quantitative urinalysis tests may be performed to help diagnose many specific disorders, such as endocrine diseases, bladder cancer, osteoporosis, and porphyrias (a group of disorders caused by chemical imbalance). Quantitative analysis often requires the use of a timed urine sample. The urinary microalbumin test measures the rate of albumin excretion in the urine using laboratory tests. This test is used to monitor kidney function of persons with diabetes mellitus. In diabetics, the excretion of greater than 200  $\mu\text{g/mL}$  albumin is predictive of impending kidney disease.

## Precautions

### *Voided specimens*

All patients should avoid intense athletic training or heavy physical work before the test, as these activities may cause small amounts of blood to appear in the urine. Many urinary constituents are labile, and samples should be tested within one hour of collection or refrigerated. Samples may be stored at 36–46°F (2–8°C) for up to 24 hours for chemical urinalysis tests; however, the microscopic examination should be performed within four hours of collection, if possible. To minimize sample contamination, women who require a urinalysis during menstruation should insert a fresh tampon before providing a urine sample.

Over two dozen drugs are known to interfere with various chemical urinalysis tests. These include:

- ascorbic acid
- chlorpromazine
- L-dopa
- nitrofurantoin (Macrochantin, Furadantin)
- penicillin
- phenazopyridine (Pyridium)
- rifampin (Rifadin)
- tolbutamide

The preservatives that are used to prevent loss of glucose and cells may affect biochemical test results. The use of preservatives should be avoided whenever possible in urine tests.

## Description

Routine urinalysis consists of three testing groups: physical characteristics, biochemical tests, and microscopic evaluation.

### *Physical tests*

The physical tests measure the color, transparency (clarity), and specific gravity of a urine sample. In some cases, the volume (daily output) may be measured. Color and transparency are determined from visual observation of the sample.

**COLOR.** Normal urine is straw yellow to amber in color. Abnormal colors include bright yellow, brown, black (gray), red, and green. These pigments may result from medications, dietary sources, or diseases. For example, red urine may be caused by blood or hemoglobin, beets, medications, and some porphyrias. Black-gray urine may result from melanin (melanoma) or homogentisic acid (alkaptonuria, a rare metabolic disorder). Bright yellow urine may be caused by bilirubin (a bile pigment). Green urine may be caused by a bile pigment or certain medications. Orange urine may be caused by some medications or excessive urobilinogen (a chemical produced in the intestines). Brown urine may be caused by excessive amounts of urobilin or urobilin (chemical relatives of urobilinogen).

**TRANSPARENCY.** Normal urine is transparent. Turbid (cloudy) urine may be caused by either normal or abnormal processes. Normal conditions giving rise to turbid urine include precipitation of crystals, mucus, or vaginal discharge. Abnormal causes of turbidity include the presence of blood cells, yeast, and bacteria.

**SPECIFIC GRAVITY.** The specific gravity of urine is a measure of the concentration of dissolved solutes (substances in a solution), and it reflects the ability of the kidneys to concentrate the urine (conserve water). Specific gravity is usually measured by determining the refractive index of a urine sample (refractometry) or by chemical analysis. Specific gravity varies with fluid and solute intake. It will be increased (above 1.035) in persons with diabetes mellitus and persons taking large amounts of medication. It will also be increased after radiologic studies of the kidney owing to the excretion of x-ray contrast dye. Consistently low specific gravity (1.003 or less) is seen in persons with diabetes insipidus. In renal (kidney) failure, the specific gravity remains equal to that of blood plasma (1.008–1.010) regardless of changes in the patient's salt and water intake. Urine volume below 400 mL per day is considered oliguria (low urine production), and may occur in persons who are dehydrated and

## KEY TERMS

**Acidosis**—A condition of the blood in which bicarbonate levels are below normal.

**Alkalosis**—A condition of the blood and other body fluids in which bicarbonate levels are higher than normal.

**Bilirubin**—A yellow bile pigment found as sodium (soluble) bilirubinate, or as an insoluble calcium salt found in gallstones.

**Biliverdin**—A green bile pigment formed from the oxidation of heme, which is a bilin with a structure almost identical to that of bilirubin.

**Cast**—An insoluble gelled protein matrix that takes the form of the renal tubule in which it was deposited. Casts are washed out by normal urine flow.

**Catheter**—A thin flexible tube inserted through the urethra into the bladder to allow urine to flow out.

**Clean-catch specimen**—A urine specimen that is collected from the middle of the urine stream after the first part of the flow has been discarded.

**Cystine**—An amino acid normally reabsorbed by the kidney tubules. Cystinuria is an inherited disease in which cystine and some other amino acids are not reabsorbed by the body in normal amounts. Cystine crystals then form in the kidney, which leads to obstructive renal failure.

**Epithelium**—A general term for the layer of cells that lines blood vessels or small body cavities.

**Ketones**—Substances produced during the breakdown of fatty acids. They are produced in excessive amounts in diabetes and certain other abnormal conditions.

**pH**—A chemical symbol that denotes the acidity or alkalinity of a fluid, ranging from 1 (more acid) to 14 (more alkaline).

**Meatus**—A general term for an opening or passageway in the body. The urethral meatus should be cleansed before a urine sample is collected.

**Porphyrias**—A group of disorders involving heme biosynthesis, characterized by excessive excretion of porphyrins. The porphyrias may be either inherited or acquired (usually from the effects of certain chemical agents).

**Trichomonads**—Parasitic protozoa commonly found in the digestive and genital tracts of humans and other animals. Some species cause vaginal infections in women characterized by itching and a frothy discharge.

**Turbidity**—The degree of cloudiness of a urine sample (or other solution).

**Urethra**—The tube that carries urine from the bladder to the outside of the body.

**Urinalysis (plural, urinalyses)**—The diagnostic testing of a urine sample.

**Voiding**—The medical term for emptying the bladder or urinating.

those with some kidney diseases. A volume in excess of 2 liters (slightly more than 2 quarts) per day is considered polyuria (excessive urine production); it is common in persons with diabetes mellitus and diabetes insipidus.

### Biochemical tests

Biochemical testing of urine is performed using dry reagent strips, often called dipsticks. A urine dipstick consists of a white plastic strip with absorbent microfiber cellulose pads attached to it. Each pad contains the dried reagents needed for a specific test. The person performing the test dips the strip into the urine, lets it sit for a specified amount of time, and compares the color change to a standard chart.

Additional tests are available for measuring the levels of bilirubin, protein, glucose, ketones, and urobilinogen in urine. In general, these individual tests

provide greater sensitivity; they therefore permit detection of a lower concentration of the respective substance. A brief description of the most commonly used dry reagent strip tests follows.

**pH:** A combination of pH indicators (methyl red and bromthymol blue) react with hydrogen ions ( $H^+$ ) to produce a color change over a pH range of 5.0 to 8.5. pH measurements are useful in determining metabolic or respiratory disturbances in acid-base balance. For example, kidney disease often results in retention of  $H^+$  (reduced acid excretion). pH varies with a person's diet, tending to be acidic in people who eat meat but more alkaline in vegetarians. pH testing is also useful for the classification of urine crystals.

**Protein:** Based upon a phenomenon called the "protein error of indicators," this test uses a pH indicator, such as tetrabromophenol blue, that changes color (at constant pH) when albumin is present in the

urine. Albumin is important in determining the presence of glomerular damage. The glomerulus is the network of capillaries in the kidneys that filters low molecular weight solutes such as urea, glucose, and salts, but normally prevents passage of protein or cells from blood into filtrate. Albuminuria occurs when the glomerular membrane is damaged, a condition called glomerulonephritis.

**Glucose (sugar):** The glucose test is used to monitor persons with diabetes. When blood glucose levels rise above 160 mg/dL, the glucose will be detected in urine. Consequently, glycosuria (glucose in the urine) may be the first indicator that diabetes or another hyperglycemic condition is present. The glucose test may be used to screen newborns for galactosuria and other disorders of carbohydrate metabolism that cause urinary excretion of a sugar other than glucose.

**Ketones:** Ketones are compounds resulting from the breakdown of fatty acids in the body. These ketones are produced in excess in disorders of carbohydrate metabolism, especially Type 1 diabetes mellitus. In diabetes, excess ketoacids in the blood may cause life-threatening acidosis and coma. These ketoacids and their salts spill into the urine, causing ketonuria. Ketones are also found in the urine in several other conditions, including fever; pregnancy; glycogen storage diseases; and weight loss produced by a carbohydrate-restricted diet.

**Blood:** Red cells and hemoglobin may enter the urine from the kidney or lower urinary tract. Testing for blood in the urine detects abnormal levels of either red cells or hemoglobin, which may be caused by excessive red cell destruction, glomerular disease, kidney or urinary tract infection, malignancy, or urinary tract injury.

**Bilirubin:** Bilirubin is a breakdown product of hemoglobin. Most of the bilirubin produced in humans is conjugated by the liver and excreted into the bile, but a very small amount of conjugated bilirubin is reabsorbed and reaches the general circulation to be excreted in the urine. The normal level of urinary bilirubin is below the detection limit of the test. Bilirubin in the urine is derived from the liver, and a positive test indicates hepatic disease or hepatobiliary obstruction.

**Specific gravity:** Specific gravity is a measure of the ability of the kidneys to concentrate urine by conserving water.

**Nitrite:** Some disease bacteria, including the lactose-positive *Enterobacteriaceae*, *Staphylococcus*, *Proteus*, *Salmonella*, and *Pseudomonas* are able to reduce nitrate in urine to nitrite. A positive test for

nitrite indicates bacteruria, or the presence of bacteria in the urine.

**Urobilinogen:** Urobilinogen is a substance formed in the gastrointestinal tract by the bacterial reduction of conjugated bilirubin. Increased urinary urobilinogen occurs in prehepatic jaundice (hemolytic anemia), hepatitis, and other forms of hepatic necrosis that impair the circulation of blood in the liver and surrounding organs. The urobilinogen test is helpful in differentiating these conditions from obstructive jaundice, which results in decreased production of urobilinogen.

**Leukocytes:** The presence of white blood cells in the urine usually signifies a urinary tract infection, such as cystitis, or renal disease, such as pyelonephritis or glomerulonephritis.

### *Microscopic examination*

A urine sample may contain cells that originated in the blood, the kidney, or the lower urinary tract. Microscopic examination of urinary sediment can provide valuable clues regarding many diseases and disorders involving these systems.

The presence of bacteria or yeast and white blood cells helps to distinguish between a urinary tract infection and a contaminated urine sample. White blood cells are not seen if the sample has been contaminated. The presence of cellular casts (casts containing RBCs, WBCs, or epithelial cells) identifies the kidneys, rather than the lower urinary tract, as the source of such cells. Cellular casts and renal epithelial (kidney lining) cells are signs of kidney disease.

The microscopic examination also identifies both normal and abnormal crystals in the sediment. Abnormal crystals are those formed as a result of an abnormal metabolic process and are always clinically significant. Normal crystals are formed from normal metabolic processes; however, they may lead to the formation of renal calculi, or kidney stones.

### **Preparation**

A urine sample is collected in an unused disposable plastic cup with a tight-fitting lid. A randomly voided sample is suitable for routine urinalysis, although the urine that is first voided in the morning is preferable because it is the most concentrated. The best sample for analysis is collected in a sterile container after the external genitalia have been cleansed using the midstream void (clean-catch) method. This sample may be cultured if the laboratory findings indicate bacteruria.



To collect a sample using the clean-catch method:

- Females should use a clean cotton ball moistened with lukewarm water (or antiseptic wipes provided with collection kits) to cleanse the external genital area before collecting a urine sample. To prevent contamination with menstrual blood, vaginal discharge, or germs from the external genitalia, they should release some urine before beginning to collect the sample.
- Males should use a piece of clean cotton moistened with lukewarm water or antiseptic wipes to cleanse the head of the penis and the urethral meatus (opening). Uncircumcised males should draw back the foreskin. After the area has been thoroughly cleansed, they should use the midstream void method to collect the sample.
- For infants, a parent or health care worker should cleanse the baby's outer genitalia and surrounding skin. A sterile collection bag should be attached to the child's genital area and left in place until he or she has urinated. It is important to not touch the inside of the bag, and to remove it as soon as a specimen has been obtained.

Urine samples can also be obtained via bladder catheterization, a procedure used to collect uncontaminated urine when the patient cannot void. A catheter is a thin flexible tube that a health care professional inserts through the urethra into the bladder to allow urine to flow out. To minimize the risk of infecting the patient's bladder with bacteria, many clinicians use a Robinson catheter, which is a plain rubber or latex tube that is removed as soon as the specimen is collected. If urine for culture is to be collected from an indwelling catheter, it should be aspirated (removed by suction) from the line using a syringe and not removed from the bag in order to avoid contamination.

Suprapubic bladder aspiration is a collection technique sometimes used to obtain urine from infants younger than six months or urine directly from the bladder for culture. The doctor withdraws urine from the bladder into a syringe through a needle inserted through the skin.

### Aftercare

The patient may return to normal activities after collecting the sample and may start taking any medications that were discontinued before the test.

### Risks

There are no risks associated with voided specimens. The risk of bladder infection from catheterization with a Robinson catheter is about 3%.

### Normal results

Normal urine is a clear straw-colored liquid, but may also be slightly hazy. It has a slight odor, and some laboratories will note strong or atypical odors on the urinalysis report. A normal urine specimen may contain some normal crystals as well as squamous or transitional epithelial cells from the bladder, lower urinary tract, or vagina. Urine may contain transparent (hyaline) casts, especially if it was collected after vigorous **exercise**. The presence of hyaline casts may be a sign of kidney disease, however, when the cause cannot be attributed to exercise, running, or medications. Normal urine contains a small amount of urobilinogen, and may contain a few RBCs and WBCs. Normal urine does *not* contain detectable amounts of glucose or other sugars, protein, ketones, bilirubin, bacteria, yeast cells, or trichomonads. Normal values used in many laboratories are given below:

- Glucose: negative (quantitative less than 130 mg/day or 30 mg/dL).
- Bilirubin: negative (quantitative less than 0.02 mg/dL).
- Ketones: negative (quantitative 0.5–3.0 mg/dL).
- pH: 5.0–8.0.
- Protein: negative (quantitative 15–150 mg/day, less than 10 mg/dL).
- Blood: negative.
- Nitrite: negative.
- Specific gravity: 1.015–1.025.
- Urobilinogen: 0–2 Ehrlich units (quantitative 0.3–1.0 Ehrlich units).
- Leukocyte esterase: negative.
- Red blood cells: 0–2 per high power field.
- White blood cells: 0–5 per high power field (0–10 per high power field for some standardized systems).

### Resources

#### BOOKS

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- Wallach, Jacques. *Interpretation of Diagnostic Tests*, 7th ed. Philadelphia, PA: Lippincott Williams & Wilkins, 2000.

**ORGANIZATIONS**

American Association of Kidney Patients. 100 S. Ashley Drive, Suite 280, Tampa, FL 33260. (800) 749 2257. [www.aakp.org](http://www.aakp.org).

American Kidney Fund. 6110 Executive Blvd., Suite 1010, Rockville, MD 20852. (301) 881 3052. [www.akfinc.org](http://www.akfinc.org).

American Medical Technologists. 710 Higgins Road, Park Ridge, IL 60068 5765. (847) 823 5169. [www.amt1.com](http://www.amt1.com).

American Society for Clinical Pathology (ASCP). 2100 West Harrison Street, Chicago, IL 60612 3798. (312) 738 1336. [www.ascp.org](http://www.ascp.org).

National Kidney and Urologic Diseases Information Clearinghouse. 3 Information Way, Bethesda, MD 20892 3580.

**OTHER**

National Institutes of Health. [cited April 4, 2003]. [www.nlm.nih.gov/medlineplus/encyclopedia.html](http://www.nlm.nih.gov/medlineplus/encyclopedia.html).

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## Urinary anti-infectives

### Definition

Urinary anti-infectives are medicines used to treat or prevent infections of the urinary tract, which is the passage through which urine flows from the kidneys out of the body.

### Purpose

Normally, no bacteria or other disease-causing organisms live in the bladder. Likewise, the urethra—the tube-like structure that carries urine from the bladder to the outside of the body—usually does not contain any bacteria, or not enough to cause problems. But the bladder, urethra, and other parts of the urinary tract may become infected when disease-causing organisms enter it from other body regions or from outside the body. Urinary anti-infectives are used to treat such infections.

Although many **antibiotics** and some **sulfonamides** are equally effective in treating urinary tract infections, urinary anti-infectives have the advantage of being active only in the urinary tract. This means they are less likely to cause development of resistant microorganisms, or cause diarrhea by destroying the bacteria in the large intestine.

Some urinary anti-infectives have been used to prevent urinary tract infections, but the evidence that they are effective for this purpose is limited.

### Description

Commonly used urinary anti-infectives include methenamine (Urex, Hiprex, Mandelamine); nalidixic acid (NegGram); and nitrofurantoin (Macrobid, Furatoin, and other brands). Nalidixic acid belongs to a group of synthetic antibacterial drugs known as quinolones. The first quinolone to be approved for clinical use, nalidixic acid, has been used to treat urinary tract infections since 1967. Nitrofurantoin is also a synthetic antibacterial medication.

Urinary anti-infectives are available only with a physician's prescription. They come in capsule, tablet, granular, and liquid forms.

### Recommended dosage

#### *Methenamine*

For adults and children 12 years and over, the usual dosage is 1 gram, taken either twice a day or four times a day, depending on the form of the medication that the doctor prescribes. For children aged six to 12 years, the dosage ranges from 500 mg taken two to four times a day to 1 gram taken twice a day, again depending on the form of the drug. A physician must determine the dose for children under six years.

Urinary anti-infectives will not work properly unless the urine is acidic, with a pH reading of 5.5 or lower. The physician who prescribes the medicine will explain how to test the urine's acidity. He or she may suggest dietary changes that will make the urine more acidic, such as eating more protein; drinking cranberry juice; eating plums and prunes while avoiding most other fruits; and cutting down on milk and other dairy products. The patient should also avoid taking antacids.

#### *Nalidixic acid*

The recommended dosage of this drug for adults and children 12 years and older is 1 gram every six hours. If the medicine is taken for more than one or two weeks, the dosage may be decreased to 500 mg every six hours. A physician must determine the correct dosage for children three months to 12 years old. Children under three months should not take nalidixic acid because it causes bone problems in young animals and could have the same effect in young children.

#### *Nitrofurantoin*

**CAPSULES, TABLETS, OR LIQUID.** The usual dose for adults and adolescents is 50–100 mg every six hours.

## KEY TERMS

**Altitude sickness**—A set of symptoms that people who normally live at low altitudes may have when they climb mountains or travel to high altitudes. The symptoms include nosebleed, nausea, and shortness of breath.

**Anemia**—A low level of hemoglobin in the blood.

**Anticoagulant**—A type of medication given to prevent the formation of blood clots. Anticoagulants are sometimes called blood thinners.

**Bacteria**—Microscopically small one-celled forms of life that cause many diseases and infections.

**Glaucoma**—A condition in which fluid pressure in the eye is abnormally high. If not treated, glaucoma may lead to blindness.

**Glucose-6-phosphate dehydrogenase (G6PD) deficiency**—An inherited disorder in which the body lacks an enzyme that normally protects red blood cells from toxic chemicals. Certain drugs can cause patients' red blood cells to break down, resulting in anemia. This may also happen when they have a fever or an infection. The condition usually occurs in males. About 10% of black males have it, as do a

small percentage of people from the Mediterranean region.

**Granule**—A small grain or pellet. Medicines that come in granule form are usually mixed with liquids or sprinkled on food before they are taken.

**Hemoglobin**—The reddish-colored compound in blood that carries oxygen from the lungs throughout the body and brings waste carbon dioxide from the cells to the lungs, where it is released

**pH**—A measure of the acidity or alkalinity of a substance or compound. The pH scale ranges from 0 to 14. Values below 7 are acidic; values above 7 are alkaline.

**Psyllium**—A herb whose seeds contain a water-soluble fiber that adds bulk to the contents of the digestive tract. The bulk helps to prevent constipation. Laxatives containing psyllium may interfere with the body's absorption of urinary anti-infectives.

**Quinolones**—A group of synthetic antibacterial drugs originally derived from quinine. Nalidixic acid is the first quinolone that was approved for clinical use.

**Seizure**—A sudden attack, spasm, or convulsion.

**EXTENDED-RELEASE CAPSULES.** For adults and children 12 years and older, the usual dosage is 100 mg every 12 hours for seven days.

A physician must determine the correct dose of all forms of nitrofurantoin for children one month and older according to the child's body weight. Children under one month should not be given this medicine.

## Precautions

### *Methenamine*

Methenamine may produce adverse effects in some patients with systemic disorders. For example, it may worsen the symptoms of people with severe liver disease. People who are dehydrated or who have severe kidney disease may be more likely to have side effects that affect the kidneys.

### *Nalidixic acid*

Some people feel drowsy, dizzy, or less alert than usual when using this drug. Nalidixic acid may also cause blurred vision or other visual problems. Because of these possible side effects, anyone who takes nalidixic acid should not drive, operate machinery, or do

anything else that might be dangerous until they have found out how the drugs affect them.

Nalidixic acid may increase sensitivity to sunlight. Even brief exposure to sunlight may cause severe sunburn or a rash. Patients treated with this medication should avoid sun exposure, especially during high sun (between 10 A.M. and 3 P.M.). They should wear a hat or scarf and tightly woven clothing that covers the arms and legs; use a sunscreen with a sun protection factor (SPF) of at least 15; protect the lips with a lip balm containing sun block; and avoid the use of tanning beds, tanning booths, and sunlamps.

Diabetic patients should be aware that nalidixic acid may cause false results on some urine sugar tests. They should check with a physician before making any changes in their diet or diabetes medicine based on the results of a urine test.

In laboratory studies, nalidixic acid has been found to interfere with bone development in young animals. The drug's effects have not been studied in pregnant women, but because of its effects in animals, it is not recommended for use during pregnancy.

This medicine does not cause problems in most nursing babies whose mothers are taking it during lactation. However, nursing babies with glucose-6-phosphate dehydrogenase (G6PD) deficiency (an inherited disorder that affects mainly black males) may have blood problems if their mothers take nalidixic acid.

People with certain medical conditions may be more likely to have particular side effects if they take this medicine. For example, people with a history of seizures or severe hardening of the arteries in the brain may be more likely to have side effects that affect the nervous system. People with glucose-6-phosphate dehydrogenase (G6PD) deficiency are more likely to have side effects that affect the blood. In addition, people with liver disease or severe kidney disease are at increased risk of having any of the drug's possible side effects.

### ***Nitrofurantoin***

Pregnant women should not take this medicine within two weeks of their delivery date. They should not use it during labor and delivery, as this could cause problems in the baby.

Women who are breastfeeding should check with their physicians before using this medicine. It passes into breast milk and could cause problems in nursing babies whose mothers take it. This is especially true of babies with glucose-6-phosphate dehydrogenase (G6PD) deficiency. The medicine also should not be given directly to babies up to one month of age, as they are particularly sensitive to its effects.

Older people may be more likely to have side effects when taking nitrofurantoin, because they are more sensitive to the drug's effects.

Taking nitrofurantoin may cause problems for people with certain medical conditions. Side effects may be greater, for example, in people with lung disease or nerve damage. In people with kidney disease, the medicine may not work as well as it should, but may cause more side effects. Those with glucose-6-phosphate dehydrogenase (G6PD) deficiency who take nitrofurantoin may develop anemia.

Diabetic patients should be aware that this medicine may cause false results on some urine sugar tests. They should check with a physician before making any changes in diet or diabetes medicine based on the results of a urine test.

### ***General precautions for all urinary anti-infectives***

The symptoms of a urinary tract infection should improve within a few days of starting to take a urinary

anti-infective. If they do not, or if they become worse, the patient should consult a physician right away. Patients who need to take this medicine for long periods should see their doctors regularly, so that their improvement and any side effects can be monitored.

Anyone who has had unusual reactions to urinary anti-infectives in the past should let his or her physician know before taking the drugs again. The physician should also be told about any allergies to foods, dyes, preservatives, or other substances. Patients taking nalidixic acid should tell their physicians if they have ever had reactions to such other quinolones as cinoxacin (Cinobac), ciprofloxacin (Cipro), enoxacin (Penetrex), norfloxacin (Noroxin), or ofloxacin (Floxin), all of which are also used to treat or prevent infections. Anyone taking nitrofurantoin should let the physician know if he or she has had an unusual reaction to such drugs as furazolidone (Furoxone) or nitrofurazone (Furacin).

### **Side effects**

#### ***Methenamine***

Nausea and vomiting are not common, but may occur. These side effects do not need medical attention unless they are severe. One side effect that should be brought to a physician's attention immediately is a skin rash.

#### ***Nalidixic acid***

Some side effects are fairly minor and are likely to go away as the body adjusts to the drug. These include dizziness, drowsiness, headache, nausea or vomiting, stomach pain, and diarrhea. Unless these problems continue or are bothersome, they do not need medical attention.

Other side effects, however, should have prompt medical attention. Anyone who has such visual symptoms as blurred vision, double vision, decreased vision, changes in color vision, seeing halos around lights, or increased glare from lights should consult a physician immediately.

#### ***Nitrofurantoin***

This medicine may discolor the urine, causing it to turn reddish-yellow or brown. Patients should not be concerned about this change in color. Other possible side effects that do not need medical attention, unless they are severe, include pain in the stomach or abdomen, stomach upset, diarrhea, loss of appetite, and nausea or vomiting.



Anyone who has chest pain, breathing problems, fever, chills, or a cough while taking nitrofurantoin should consult their physician immediately.

### **General advice on side effects for all urinary anti-infectives**

Other side effects are possible when taking any urinary anti-infective. Anyone who has unusual symptoms while taking this type of medication should contact his or her physician.

## **Interactions**

### **Methenamine**

Certain medicines may make methenamine less effective. These include thiazide **diuretics** (water pills) and medicines that make the urine less acid, such as antacids, bicarbonate of soda (baking soda), and the drugs acetazolamide (Diamox), dichlorophenamide (Daranide), and methazolamide (Neptazane), which are used to treat glaucoma, epilepsy, altitude sickness, and other conditions.

### **Nalidixic acid**

People who are taking blood thinners (anticoagulants) may be more likely to have bleeding problems if they take this medicine.

### **Nitrofurantoin**

Nitrofurantoin may interact with many other medicines. For example, taking nitrofurantoin with certain drugs that include methyldopa (Aldomet), sulfonamides (sulfa drugs), vitamin K, and diabetes medicines taken by mouth may increase the chance of side effects that affect the blood. General side effects are more likely in people who take nitrofurantoin with the gout drugs probenecid (Benemid) or sulfinpyrazone (Anturane). The risk of side effects that involve the nervous system is higher in people who take nitrofurantoin with such drugs as lithium (Lithane); disulfiram (Antabuse); other anti-infectives; and the cancer drugs cisplatin (Platinol) and vincristine (Oncovin). Patients who have been vaccinated with DPT (diphtheria, tetanus, and pertussis) within the last 30 days or are vaccinated after taking nitrofurantoin are also more likely to have side effects that affect the nervous system. Because of the many possible interactions, anyone taking nitrofurantoin should be sure to consult a physician before combining it with any other medicine.

**Laxatives** containing psyllium and other bulk-forming substances may interfere with the body's absorption of nitrofurantoin. Patients with constipation who are taking nitrofurantoin should consult their doctor before taking an over-the-counter laxative.

### **General advice about drug interactions**

Patients should check with a physician or pharmacist before combining a urinary anti-infective with any other prescription or nonprescription (over-the-counter) medicine.

Patients who are taking any kind of herbal preparation or other alternative medicine should give their doctor and pharmacist a list of all the compounds that they use on a regular basis. Most of these preparations are unlikely to interact with urinary anti-infectives, but there is much that is still unknown about possible interactions between standard prescription medications and alternative medicines.

## **Resources**

### **BOOKS**

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- Juthani Mehta, M. "Asymptomatic Bacteriuria and Urinary Tract Infections in Older Adults." *Clinics of Geriatric Medicine* 23 (August 2007): 585-594.

### **ORGANIZATIONS**

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- United States Food and Drug Administration (FDA). 5600 Fishers Lane, Rockville, MD 20857-0001. (888) INFO FDA. <http://www.fda.gov> (accessed April 15, 2008).

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Urinary artificial sphincter see **Artificial sphincter insertion**

Urinary catheterization, female see **Catheterization, female**

Urinary catheterization, male see **Catheterization, male**

Urinary diversion see **Ureterostomy, cutaneous**

Urinary diversion surgery see **Ileal conduit surgery**

## Urine culture

### Definition

A urine culture is a diagnostic laboratory test performed to detect the presence of bacteria in the urine (bacteriuria).

### Purpose

Culture of the urine is a method of diagnosis for urinary tract infection that determines the number of microorganisms present in a given quantity of urine.

### Precautions

If delivery of the urine specimen to the laboratory within one hour of collection is not possible, it should be refrigerated. The healthcare provider should be informed of any **antibiotics** currently or recently taken.

### Description

There are several different methods for collection of a urine sample. The most common is the midstream clean-catch technique. Hands should be washed before beginning. For females, the external genitalia (sex organs) are washed two or three times with a cleansing agent and rinsed with water. In males, the external head of the penis is similarly cleansed and rinsed. The patient is then instructed to begin to urinate, and the urine is collected midstream into a sterile container. In infants, a urinary collection bag (plastic bag with an adhesive seal on one end) is attached over the labia in girls or a boy's penis to collect the specimen.

Another method is the catheterized urine specimen in which a lubricated catheter (thin rubber tube) is inserted through the urethra (tube-like structure in which urine is expelled from the bladder) into the bladder. This avoids contamination from the urethra or external genitalia. If the patient already has a urinary catheter in place, a urine specimen may be collected by clamping the tubing below the collection port and using a sterile needle and syringe to obtain the urine sample; urine cannot be taken from the drainage bag, as it is not fresh and has had an opportunity to grow bacteria at room temperature. On rare occasions, the healthcare provider may collect a urine sample by inserting a needle directly into the bladder (suprapubic tap) and draining the urine; this method is used only when a sample is needed quickly.

Negative culture results showing no bacterial growth are available after 24 hours. Positive results

## KEY TERMS

**Bacteriuria**—The presence of bacteria in the urine.

require 24–72 hours to complete identification of the number and type of bacteria found.

### Preparation

Drinking a glass of water 15–20 minutes before the test is helpful if there is no urge to urinate. There are no other special preparations or aftercare required for the test.

### Aftercare

No aftercare is required for a urine culture.

### Risks

There are no risks associated with the culture test itself. If insertion of a urinary catheter (thin rubber tube) is required to obtain the urine, there is a slight risk of introducing infection from the catheter.

### Normal results

No growth of bacteria is considered the normal result, and this indicates absence of infection.

### Abnormal results

Abnormal results, or a positive test, where bacteria are found in the specimen, may indicate a urinary tract infection. Contamination of the specimen from hair, external genitalia, or the rectum may cause a false-positive result. Identification of the number and type of bacteria, with consideration of the method used in obtaining the specimen, is significant in diagnosis.

*Escherichia coli* causes approximately 80% of infections in patients without catheters, abnormalities of the urinary tract, or calculi (stones). Other bacteria that account for a smaller portion of uncomplicated infections include *Proteus klebsiella* and *Enterobacter*.

### Alternatives

There are no alternatives to a urine culture.

### Precautions

Two precautions are needed. The first is to clean the urethral meatus by urinating and then stopping the

stream before collecting a specimen. The second is to use a sterile container to collect the urine specimen.

### Side effects

There are no known side effects associated with a urine culture.

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Urobilinogen test see **Urinalysis**

## Urologic surgery

### Definition

Urologic surgery is the integration of surgical activities for the pelvis—the colon, urogenital, and gynecological organs—primarily for the treatment of obstructions, dysfunction, malignancies, and inflammatory diseases. Common urologic operations include:

- renal (kidney) surgery
- kidney removal (nephrectomy)
- surgery of the ureters, including ureterolithotomy or removal of calculus (stones) in the ureters
- bladder surgery
- pelvic lymph node dissection
- prostatic surgery, removal of the prostate
- testicular (scrotal) surgery
- urethra surgery
- surgery to the penis

### Purpose

Conditions that commonly dictate a need for urologic surgery include neurogenic sources like spinal cord injury; injuries to the pelvic organs; chronic digestive and urinary diseases; and prostate infections and inflammations. There are many other common chronic and malignant diseases that can benefit from resection, surgical augmentation, or surgery to clear obstructions. These conditions impact the digestive, renal, and reproductive systems.

Most organs are susceptible to cancer in the form of tumors and invasion of the surrounding tissue. Urologic malignancies are on the rise. Other conditions that are seen more frequently include kidney stones, diseases and infections; pancreatic diseases;

## KEY TERMS

**Genitourinary reconstruction**—Surgery that corrects birth defects or the results of disease that involve the genitals and urinary tract, including the kidneys, ureters, bladder, urethra, and the male and female genitals.

**Nephrectomy**—Surgical removal of a kidney.

**Neurogenic bladder**—Bladder dysfunction caused by neurological diseases that alter the brain's messages to the bladder.

**Prostatectomy**—Prostate cancer surgery that includes partial or complete removal of the prostate.

ulcerative colitis; penile dysfunction; and infections of the genitourinary tract.

Urologic surgery has been revolutionized by striking advances in urodynamic diagnostic systems. Changes in these areas have been particularly beneficial for urologic surgery: **laparoscopy**, endoscopic examination for colon cancer, implantation procedures, and imaging techniques. These procedural and imaging advances have brought the field of urology to a highly active and innovative stage, with new surgical options created each year.

## Demographics

According to the National Kidney Foundation, kidney and urologic diseases affect at least 5% of the American population, and cause over 260,000 deaths. As the population ages, these conditions are expected to increase, especially among ethnic minorities who have a disproportionate share of urologic diseases. Major urologic surgery includes radical and partial resections for malignant and benign conditions; and implantation and diversion surgeries.

## Cancer

Prostate cancer is the most common cancer affecting males in the United States. One in six men will have the disease at some time in his life. It is, however, treated successfully with surgery.

According to the Urological Foundation, more than 63,200 new cases of bladder cancer are detected each year. In the United States, bladder cancer is the fourth most common cancer in men and the eighth most common for women.

Kidney cancer occurs in 51,190 new patients per year, with almost 13,000 deaths. It is the eighth most common cancer in men and the tenth most common cancer in women. Renal cell carcinoma makes up 85% of all kidney tumors. In adults ages 50–70 years, kidney cancer occurs twice as often in men as women. At the time of diagnosis, metastasis is present in 25–30% of patients with renal cell carcinoma.

## Other conditions

Enlarged prostate (benign prostate hyperplasia, BPH) is very common, and often treated with surgery. Interstitial cystitis (bladder infection of unknown origin) often affects women with severe pain and incontinence. The condition, like other forms of severe incontinence, requires surgery.

Incontinence is increasingly diagnosed as a problem among the aging population in the United States, and is gaining recognition for its highly debilitating effects both in its fecal and urinary forms. According to the National Institute of Diabetes & Digestive & Kidney Diseases (NIDDK), more than 6.5 million Americans have fecal incontinence. Fecal incontinence affects people of all ages; many cases are never reported. Women are five times more likely than men to have fecal incontinence. This is primarily due to obstetric injury, especially with forceps delivery and anal sphincter laceration.

Urinary incontinence affects an estimated 38% of women aged 60 or older, and an estimated 17% of men aged 60 or older. According to one study published in the *American Journal of Gastroenterology*, only 34% of incontinent patients have ever mentioned their problem to a physician, even though 23% wear absorbent pads, 12% take medications, and 11% lead lives restricted by their incontinence.

Many surgical procedures are now available to correct both fecal and urinary incontinence. They include retropubic slings for urinary incontinence, artificial sphincter implants for urinary and fecal incontinence, and bladder and colon diversion surgeries for restoration of voiding and waste function with an outside appliance called an ostomy. Kidney surgery and transplantation account for a large segment of urologic surgery. Benign conditions include sexual dysfunction, kidney stones, and fertility issues.

## Description

Until the late twentieth century, urological operations usually involved open abdominal surgery with full incision, lengthy hospital stays, and long recovery periods. Today, surgery is less traumatic, with shortened



hospitalizations. Minimally invasive surgeries are the norm in many cases, with new laparoscopic procedures developed each year. Laparoscopic surgery is effective for many kidney tumors and kidney removal (**nephrectomy**), lymph node excision, prostate and ureteral cancers, as well as incontinence, urological reconstruction, kidney stones, and some cases of bladder dysfunction.

### Diagnosis/Preparation

Testing is often required to determine if a patient is better suited for open or laparoscopic surgery. Blood tests for some cancers, as well as function tests for the affected organs, will be required. Radiographic or **ultrasound** techniques are helpful in providing images of abnormalities.

**Cystoscopy** is often used with bladder and urethra surgery. In this procedure, a thin telescope-like instrument is inserted directly into the bladder. Disorders of the colon may be studied with endoscopes, imaging instruments inserted directly into the colon. Urodynamic studies of the bladder and sphincter determine how the bladder fills and empties. Digital rectal exams diagnose prostatic disorders. In this procedure, the physician feels the prostate with a gloved, lubricated finger inserted into the rectum.

### Aftercare

Hospital stays range from one day to one week, depending upon the level of organ involvement and type of urologic surgery (open versus laparoscopic). Major urologic surgeries may require stents (temporary diversion of urine or feces) and catheters that are removed after surgery. Some surgeries are staged in two parts to accommodate the removal of diseased tissue, and the augmentation or reconstruction to replace function. Laparoscopic surgery patients benefit from shorter hospital stays, more rapid recovery, and possibly lower morbidity rates than open surgery procedures. This is increasingly true for prostate cancer surgeries.

### Risks

The risks of urologic surgery vary with the type of surgical procedure (open or laparoscopic), and the extent of organ involvement. According to one study of 2,407 urologic surgeries in four centers, the overall complication rate was 4.4%, with a mortality rate of 0.08%.

Open surgery poses the standard surgery and anesthetic risks associated with strain on the heart and lungs. Risks of infection at the wound site accompany all surgeries, open and laparoscopic. The risk of

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Urologic surgery is performed by surgeons who specialize in the treatment of urologic conditions. Surgery is performed in a general hospital, regional center, or clinic, depending upon the type of procedure.

injury to adjacent organs is higher in laparoscopic surgery. Kidney removal and transplantation have many risks because of the extent of the surgery, as do surgeries of the colon, bladder, and prostate.

Significant gains have been made in prostate surgery. Urinary control issues following prostate surgery, especially radical prostatectomy, have improved. However, postoperative urinary incontinence remains a significant risk, with 27% of patients in one study reporting the need for some kind of leakage protection. In the same study, only 14.2% of previously potent men reported the ability to achieve and maintain a postoperative erection that is sufficient for sexual intercourse. Urologic surgeons are well versed in the risks and benefits of the surgeries they perform, and they expect to be asked questions related to these issues.

### Normal results

The expected surgery result is a topic that the urologic surgeon and patient should address prior to surgery. It is important that the patient understands the issues of recovery, rehabilitation, training or retraining, and the limitations surgery may offer for basic daily functions and enjoyment. Results of urologic surgery are individual, and depend upon the health of the patient and his or her motivation to deal with postoperative recovery issues and changes to organ function brought about by the surgery.

### Alternatives

Many urological diseases can be dealt with through diet, weight loss, and lifestyle changes. These modifications are especially significant in preventing and treating conditions of the urinary tract. Obesity and nutrition play a significant role in urologic diseases, and impact many urologic cancers, inflammatory and ulcerative conditions, incontinence, and sexual dysfunction.

## QUESTIONS TO ASK THE DOCTOR

- How many procedures does this physician and hospital perform compared to other facilities?
- What are the urination and sexual intercourse risks of this surgery?
- Does this condition offer alternatives to surgery without risks of exacerbating the condition?
- How often are patients dissatisfied with their outcomes?

Medical interventions are another form of treatment, particularly for infectious and inflammatory urologic conditions. They are particularly useful along with special adjunctive surgical procedures for the treatment of incontinence and painful bladder and kidney conditions. While many cancers must be treated surgically, prostate cancer is often treated with a “wait and see” approach due to its slow rate of growth. There is an increasing trend for men with slow-growing prostate cancers to have regular check-ups instead of immediate treatment.

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Uterine fibroid removal see **Myomectomy**

## Uterine stimulants

### Definition

Uterine stimulants (uterotonics) are medications given to cause a woman’s uterus to contract, or to increase the frequency and intensity of the contractions. These drugs are used to: induce (start) or augment (speed) labor; facilitate uterine contractions following a miscarriage; induce abortion; or reduce hemorrhage following childbirth or abortion. The three uterotonics used most frequently are the oxytocins, prostaglandins, and ergot alkaloids. Uterotonics may be given intravenously (IV), intramuscularly (IM), as a vaginal gel or suppository, or by mouth.

### Purpose

Uterine stimulants are used to induce labor in certain circumstances when the mother’s labor has not started naturally. These circumstances may include the mother’s being past her due date; that is, the pregnancy has lasted longer than 40 weeks. Labor is especially likely to be induced if tests indicate a decrease in the volume of amniotic fluid. Uterotonics may also be used in cases of premature rupture of the membranes; preeclampsia (elevated blood pressure in the later stages of pregnancy); diabetes; and intrauterine growth retardation (IUGR), if these conditions require delivery before labor has begun. These medications may be recommended if the expectant mother lives a great distance from the healthcare facility and there is concern for either her or her baby’s safety if she were unable to reach the facility once labor begins.

Uterine stimulants are also used in the augmentation of existing contractions, to increase their strength and frequency when labor does not move along well.

According to the American College of Obstetrics and Gynecology (ACOG), there continues to be an increase in the rate of induced labor. The ACOG reported that the increase in the rate of Caesarian sections is not due to the induction process but to other factors, such as the condition of the mother’s

cervix at the time of induction and whether the pregnancy was the woman's first.

### Precautions

It is important to establish a clear baseline of **vital signs** before a woman is given any uterine stimulant. Consistent reevaluation and documentation of vital signs permit faster recognition of an abnormal change in a woman's condition. Documentation includes the time and dosage of any medications given, as well as a record of any side effects. A faster pulse and a drop in blood pressure signal a potential hemorrhage. When oxytocin is given intravenously, it must be diluted in IV fluid and never given as a straight IV. PGs should not be administered if there is any question about the condition of the fetus—for example, an abnormal fetal heart rate tracing. Methergine should never be given intravenously, and never to a woman with hypertension (high blood pressure).

### Description

#### *Oxytocin*

Oxytocin is a naturally occurring hormone used to induce labor. The production and secretion of natural oxytocin is stimulated by the pituitary gland. It is also available in synthetic form under the trade names of Pitocin and Syntocinon.

Oxytocin is used in a contraction **stress test** (CST). A CST is done prior to the onset of labor to evaluate the fetus's ability to withstand the contractions of the uterus. To avoid the possibility of exogenous (introduced) oxytocin putting the woman into labor, she may instead be asked to stimulate her nipples to release her natural oxytocin. A negative, or normal, CST result is three contractions within a 10-minute period with no abnormal slowing of the fetal heart rate (FHR). The CST occasionally produces false positives, however.

Oxytocin may be used in the treatment of a miscarriage to assure that all the products of conception (POC) are expelled from the uterus. If the fetus died but was not expelled, a prostaglandin (PGE<sub>2</sub>) may be given to ripen the cervix to facilitate a dilatation and evacuation, or to encourage uterine contractions. The prostaglandin may be administered either in gel form or as a vaginal suppository.

In a routine delivery, oxytocin may be given to the mother after the placenta has been delivered in order to help the uterus contract and minimize bleeding. It is also used to treat uterine hemorrhage. While hemorrhage occurs in about 4% of vaginal deliveries and 6%

## KEY TERMS

**Alkaloid**—Any of a group of bitter-tasting alkaline compounds that contain nitrogen and are commonly found in plants. Alkaloids derived from ergot can be used as uterine stimulants.

**Antidiuretic**—A medication or other compound that suppresses the production of urine.

**Caesarian section**—An incision made through the wall of a pregnant woman's abdomen and uterus in order to deliver the fetus. It is commonly abbreviated as C-section.

**Cyanosis**—A bluish discoloration of the skin and mucous membranes caused by low levels of oxygen in the blood.

**Ergot alkaloids**—Compounds derived from a fungus, *Claviceps purpurea*, which grows on rye plants and forms a hard blackish body. Ergot itself is toxic.

**Hemorrhage**—The loss of an excessive amount of blood in a short period of time. After childbirth, a loss of more than 500 mL over a 24-hour period is considered a postpartum hemorrhage.

**Induce**—To begin or start.

**Miscarriage**—The loss of a fetus before it is viable, usually between the third and seventh months of pregnancy. A miscarriage is sometimes called a spontaneous abortion.

**Postpartum**—After childbirth or after delivery.

**Prostaglandins**—A group of unsaturated fatty acids involved in the contraction of smooth muscle, control of body temperature, and other body functions.

**Vital signs**—Measurements of a patient's essential body functions, usually defined as pulse rate, breathing rate, and body temperature.

of Caesarian deliveries, it accounts for about 35% of maternal deaths due to bleeding during pregnancy. If the bleeding started at the placental detachment site, contractions of the uterus help to close off the blood vessels and thereby stop excessive bleeding. Additional medications may be used, including PGF<sub>2α</sub> (Hemabate), misoprostol (Cytotec), or the ergot alkaloid methylergonovine (Methergine).

#### *Prostaglandins*

Prostaglandins (PGs) play a major role in stimulating the uterine contractions at the beginning of labor. Research indicates that PGs are also involved in the

transition from the early phase of labor to the later stages. In addition, PGs may be used to ripen the cervix prior to induction. Administration of prostaglandins is sometimes sufficient to stimulate labor, and the woman needs no further medication for labor to progress. There are many PGs used in medicine, but the most significant are PGE<sub>1</sub>, PGE<sub>2</sub>, and PGF<sub>2</sub><sub>alpha</sub>. Researchers are investigating which prostaglandins are the most effective for specific purposes. For example, PGE<sub>2</sub> in the form of dinoprostone (Cervidil and Prepidil) has proved to be superior to the PGF series for cervical ripening. Misoprostol (Cytotec), a synthetic form of PGE<sub>1</sub>, is also effective in cervical ripening and labor induction, while the PGF<sub>2</sub><sub>alpha</sub> analogue, carboprost (Prostin 15-M or Hemabate), is the preferred prostaglandin for stimulating the uterus.

### Ergot alkaloids

Ergot alkaloids are derived from a fungus, *Claviceps purpurea*, which grows primarily on rye grain. The fungus forms a hard blackish body known as a sclerotium, which contains alkaloid compounds that can be used to treat migraine headache. Ergot by itself, however, is toxic to the central nervous system of humans and animals, producing irritability, spasms, cramps, and convulsions. Because of its potentially harmful side effects, one ergot-based drug (Ergonovine or Ergotrate) was taken off the American market in 1993. Methylergonovine maleate (Methergine) is now the only ergot derivative in use in the United States. It is given only as a uterine stimulant to control PPH. Because of the risk of complications, and because the use of Methergine is contraindicated in many women, it has largely been replaced by the PGs as a second-line uterotonic.

### Preparation

A healthcare professional should review information about a medication or procedure with the pregnant woman before administering it to make sure that she understands what will happen during the procedure or the potential side effects of the medication. The patient should inform the doctor or nurse about any allergies to medications, as well as any side effects she may have experienced previously.

If the patient is anxious about induction of labor or augmentation of contractions, the nurse or doctor should discuss these concerns and relieve the patient's anxiety.

### Aftercare

The expectant mother should be monitored closely during induction of labor or cervical ripening.

The FHR and uterine contractions are usually monitored for an hour after induction. Frequent checks of the patient's vital signs alert the nurse to any potential complications.

### Risks

#### Oxytocin

Oxytocin takes effect rapidly when it is given intravenously. Individual responses to oxytocin vary considerably; for this reason, the drug dosage is usually increased slowly and incrementally. Oxytocin can cause hyperstimulation of the uterus, which in turn can place the fetus at risk for asphyxia. Hyperstimulation is defined as more than five contractions in 10 minutes, contractions lasting longer than 60 seconds, and increased uterine tone either with or without significant decrease in FHR. Uterine rupture has also been linked to oxytocin administration, particularly when the drug is given for four hours or longer.

Oxytocin has a mild antidiuretic effect that is usually dose related; it can lead to water intoxication (hyponatremia). Onset occurs gradually and may go unnoticed. Signs of water intoxication may include reduced urine output, confusion, nausea, convulsions, and coma. Expectant mothers receiving oxytocin should have their blood pressure monitored closely, as both hypotension and hypertension can occur.

Although the subject remains controversial, some evidence suggests oxytocin increases the incidence of neonatal jaundice. Although oxytocin may increase the risk of uterine rupture in women who were delivered by Caesarian section in a previous pregnancy, contraindications to the use of the drug are virtually the same as contraindications for labor. Other side effects of oxytocin include nausea, vomiting, cardiac arrhythmias, and fetal bradycardia (slowing of the heartbeat). When used judiciously, oxytocin is a very effective medication for the progression of labor.

#### Prostaglandins

PGs have significant systemic side effects. These include headache, nausea, diarrhea, tachycardia (rapid heartbeat), vomiting, chills, fever, sweating, hypertension, and hypotension (low blood pressure). There is also an increased risk of uterine hyperstimulation and uterine rupture. PGF<sub>2</sub><sub>alpha</sub> (carboprost—Prostin 15-M or Hemabate) can cause hypotension, pulmonary edema, and intense bronchospasms in women with asthma. Because carboprost stimulates the production of steroids, it may be contraindicated in women with disorders of the adrenal gland. When used for abortion, it may result in sufficient blood loss to cause



anemia, which may make a **transfusion** necessary. Medical problems (or a history) of diabetes, epilepsy, heart or blood vessel disease, jaundice, kidney disease, or liver disease should be brought to the attention of the health care practitioner before the patient is given carboprost. The use of this PG has been reported to increase the fluid pressure in the eyes in women with glaucoma; however, this side effect is fortunately rare.

### *Ergot alkaloids*

Ergot alkaloids have an alpha-adrenergic action with a vasoconstrictive effect, which means that they cause the blood vessels to become narrower. These drugs can cause hypertension, cardiovascular changes, cyanosis, muscle pain, tingling, other symptoms associated with decreased blood circulation, and severe uterine cramping. The healthcare professional should be informed of other medications taken by the patient. The presence or history of such medical problems as angina, hypertension, stroke, infection, kidney and liver disease, and Raynaud's phenomenon may be contraindications to the use of ergot alkaloids.

### **Normal results**

The normal results of uterine stimulants, when administered in appropriate circumstances and correct dosages, are preparation of the cervix for childbirth; induction or stimulation of uterine contractions to produce a safe delivery of a newborn; encouragement of a complete spontaneous or **induced abortion**; elimination of blood clots or other tissue debris from the uterus; and the slowing or cessation of hemorrhage following childbirth or abortion.

Normal results would include the achievement of these outcomes without significant side effects for the mother or fetus.

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Uterus removal see **Hysterectomy**  
Uvulopalatoplasty see **Snoring surgery**



## Vagal nerve stimulation

### Definition

Vagal nerve stimulation is a treatment for epilepsy in which an electrode is implanted in the neck to deliver electrical impulses to the vagus nerve.

### Purpose

Vagal nerve stimulation is an alternative to medication or surgical removal of brain tissue in controlling epileptic seizures. The seizures of epilepsy are caused by uncontrolled electrical discharges spreading through the brain. Antiseizure drugs interrupt this process by reducing the sensitivity of individual brain cells to stimulation. Brain surgery for epilepsy either removes the portion of the brain where seizures originate, or cuts nerve fibers to prevent the nerve impulses that occur during a seizure from spreading to other parts of the brain. Vagal nerve stimulation uses a different approach: It provides intermittent electrical stimulation to a nerve outside the brain—the vagus, or tenth cranial nerve, which influences certain patterns of brain activity.

The vagus nerve is a major connection between the brain and the rest of the body. It carries sensory information from the body to the brain, and motor commands from the brain to the body. The vagus is involved in complex control loops between these destinations; its precise pathways and mechanisms are still not fully understood. It is also not known how stimulation of the vagus nerve works to reduce seizure activity—it may stimulate inhibitory pathways that prevent the brain's electrical activity from getting out of control, interrupt some feedback loops that worsen seizures, or act in some other fashion.

Vagal nerve stimulation has been effective in reducing seizure frequency in patients whose seizures are not controlled by drugs, and who are either not

candidates for other types of brain surgery or who have chosen not to undergo these procedures.

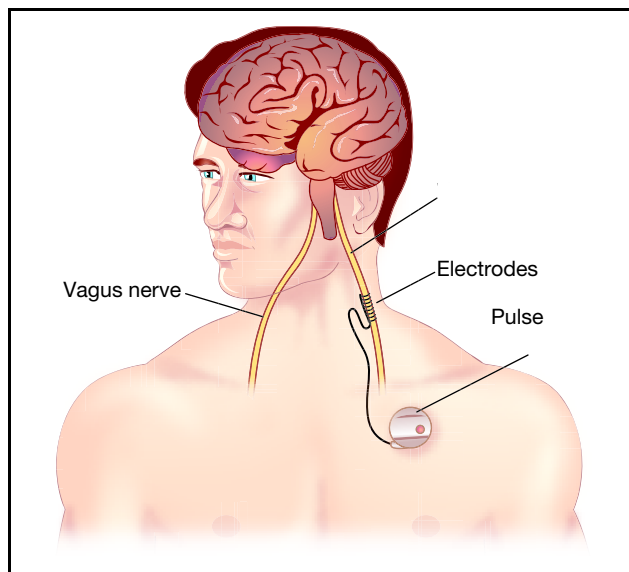
### Demographics

About 2.7 million people in the United States have been diagnosed with epilepsy. Ten percent of patients who are newly diagnosed with epilepsy do not respond well to medications, however, and so may be candidates for surgical treatment. Vagus nerve stimulation was first performed in the United States in 1988 and received final approval by the United States Food and Drug Administration (FDA) in July 1997. As of 2007, approximately 32,000 people worldwide are being treated with vagus nerve stimulation. One registry of patients who are being treated with vagus nerve stimulation shows that 60% were performed for patients with partial seizures, 15% were performed for patients with Lennox-Gastaut syndrome (also known as mixed seizures), and 25% were performed for patients with generalized seizures.

### Description

The vagal nerve stimulator (VNS) has two parts: an electrode that wraps around the left vagus nerve in the neck, and a pulse generator, which is implanted under the skin below the collarbone. The two parts are connected by a wire. Stimulation is performed only on the left vagal nerve, as the right vagal nerve helps control the heartbeat.

Surgery to implant a VNS device takes about two hours. A neurosurgeon implants the electrode and generator while the patient is under **general anesthesia**. A vertical incision is made in the left side of the neck, and the helical electrode is attached to the nerve itself. A second incision is made on the left side of the chest below the collarbone, and the pulse generator (a disc about 2 in [5 cm] in diameter) is implanted under the skin. The connecting wire is threaded around the muscles and bones to join the electrode and generator.



(Illustration by Electronic Illustrators Group.)

The generator makes a small bulge under the skin, but is hidden by clothing after the operation.

Before the neurosurgeon closes the incisions, he or she tests the VNS device to make sure it is working, and programs it to deliver the lowest amount of stimulation. The device is usually timed to stimulate the vagus nerve for 30 seconds every five minutes.

### Diagnosis/Preparation

A candidate for vagal nerve stimulation will have had many tests already to determine the focal point of seizure activity. Preoperative tests include neuroimaging, as well as psychological tests to determine the patient's cognitive (thinking) strengths and weaknesses.

The patient must be fully informed about VNS—how it works, its advantages and disadvantages, what will happen during surgery—before the operation is scheduled. A video as well as written material about VNS is available to view and discuss with the doctor.

### Aftercare

Implantation of the stimulator in an adult may be performed as either an outpatient or inpatient procedure. In the latter case, the patient will remain in the hospital overnight for monitoring of heart function and other **vital signs**. Children who are receiving a VNS are usually scheduled for an overnight stay. Pain medication is given as needed.

## KEY TERMS

**Epilepsy**—The name for a group of syndromes characterized by periodic temporary disturbances of brain function. The symptoms of an epileptic seizure may include loss of consciousness, abnormal movements, falling, emotional reactions, and disturbances of sight or hearing.

**Helical**—Having a spiral shape.

**Neurologist**—A physician who specializes in diagnosing and treating disorders of the nervous system.

**Seizure**—A single episode of epilepsy. Seizures are also called convulsions or fits.

**Vagus nerve**—The tenth cranial nerve, running from the head through the neck and chest into the abdomen. Intermittent electrical stimulation of the vagus nerve can help to control epileptic seizures.

The stimulation parameters are adjustable, and the neurologist may require several visits to find the right settings. Settings are adjusted with a magnetic wand that delivers commands to the stimulator's computer chip. The patient will be taught how to use a magnet to temporarily increase stimulation, to prevent a seizure, or to abort it once it begins.

The VNS generator is powered by a battery that lasts several years. It is replaced during an outpatient procedure under **local anesthesia**.

### Risks

The most common adverse effects from vagal nerve stimulation are a hoarse voice, cough, headache, and ear pain. These side effects can be reduced by adjusting the stimulation settings, and may subside on their own over time. Infection and device malfunction are possible, though rare.

Patients who have had a VNS implanted must avoid strong magnets, which may affect the stimulator settings. Areas with warning signs posted regarding **pacemakers** should be avoided. The patient should consult with the neurologist and the neurosurgeon about other hazards.

### Normal results

Approximately half of all patients who have received vagal nerve stimulation experience about a 50% reduction in seizures. Another 9% of patients obtain complete relief from seizures. Most patients who continue to take antiseizure medications can

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

The implanting of a VNS device is performed by a neurosurgeon in a hospital, in consultation with a neurologist.

## QUESTIONS TO ASK THE DOCTOR

- What will the procedure cost? Will my insurance cover the cost?
- How often will I need to return to have the stimulator adjusted?
- Will my medication dosages be reduced after this procedure?
- How long will the procedure take?
- How many VNS devices have you implanted? What is your success rate?

reduce their dosage, however, which offers some relief from the side effects of these drugs.

### Morbidity and mortality rates

Vagal nerve stimulation is a relatively safe procedure. Pilot studies of 300 patients that were done prior to FDA approval of VNS reported the following complication rates: hoarseness, 37% of patients; coughing, 14%; voice alteration, 13%; chest pain, 12%; and nausea, 2%.

### Alternatives

Some candidates for vagal nerve stimulation are also likely to be candidates for a **corpus callosotomy**, temporal lobectomy, or other surgical procedures.

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Richard Robinson

Vaginal wall repair see **Colporrhaphy**

Vaginotomy see **Colpotomy**

## Vagotomy

### Definition

Vagotomy is the surgical cutting of the vagus nerve to reduce acid secretion in the stomach.

### Purpose

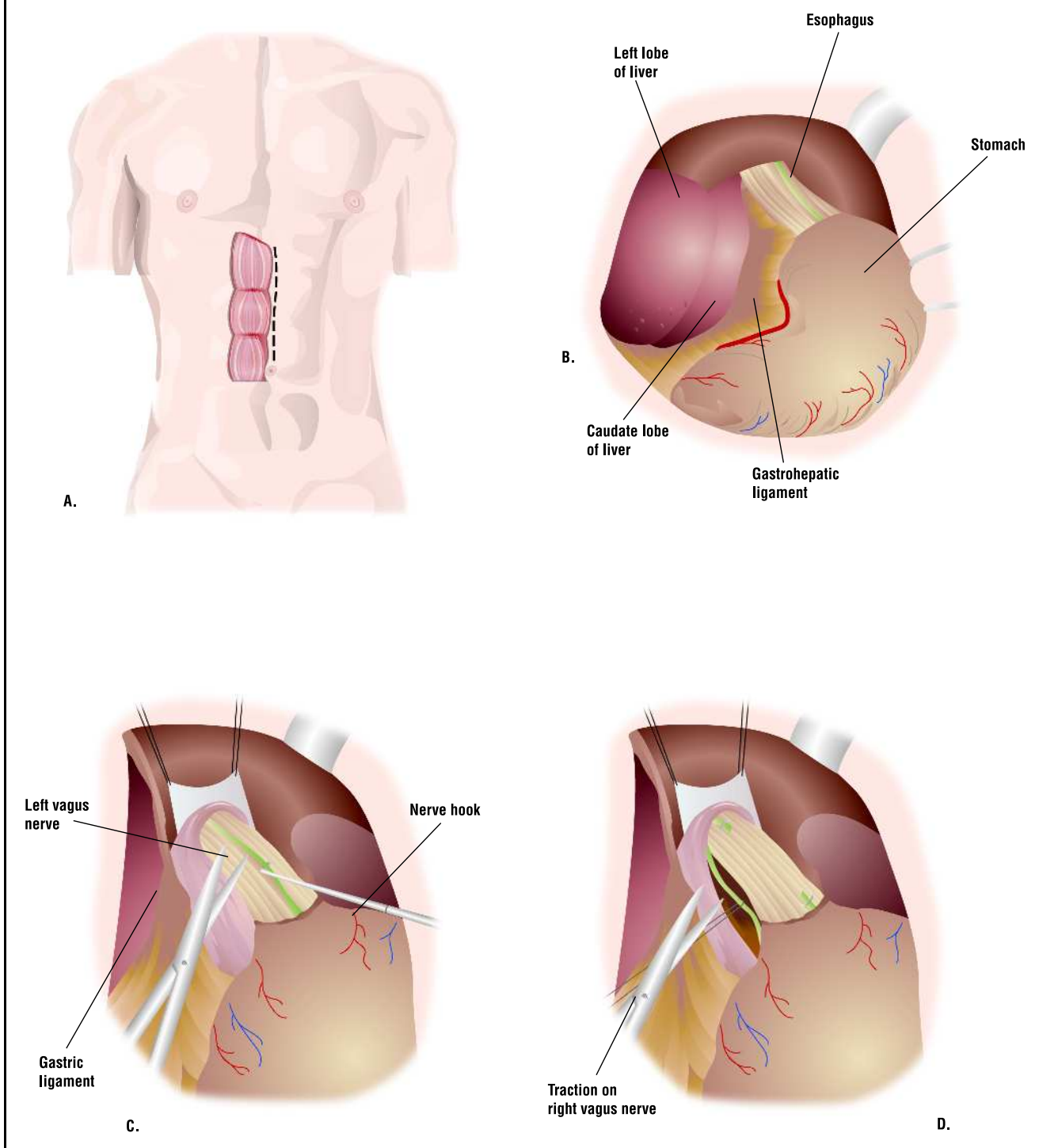
The vagus nerve trunk splits into branches that go to different parts of the stomach. Stimulation from these branches causes the stomach to produce acid. Too much stomach acid leads to ulcers that may eventually bleed and create an emergency situation.

A vagotomy is performed when acid production in the stomach can not be reduced by other means. The purpose of the procedure is to disable the acid-producing capacity of the stomach. It is used when ulcers in the stomach and duodenum do not respond to medication and changes in diet. It is an appropriate surgery when there are ulcer complications, such as obstruction of digestive flow, bleeding, or perforation. The frequency with which elective vagotomy is performed has decreased in the past 20 years as it has become clear that the primary cause of ulcers is an infection by a bacterium called *Helicobacter pylori*. Drugs have become increasingly effective in treating ulcers. However, the number of vagotomies performed in emergency situations has remained about the same.

A vagotomy procedure is often performed in conjunction with another gastrointestinal surgery, such as partial removal of the stomach (**antrectomy** or subtotal **gastrectomy**).



## Vagotomy



To perform a vagotomy, the surgeon makes an incision in the patient's abdomen (A). The stomach is located (B), and the vagus nerves are cut in turn (C and D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Duodenum**—The section of the small intestine closest to the stomach.

**Gastric glands**—Branched tubular glands located in the stomach.

**Gastric ulcer**—An ulcer of the stomach, duodenum, or other part of the gastrointestinal system. Also called a peptic ulcer.

**Latarjet's nerve**—Terminal branch of the anterior vagal trunk, which runs along the lesser curvature of the stomach.

**Parietal cells**—Cells of the gastric glands that secrete hydrochloric acid and intrinsic factor.

**Peristalsis**—The rhythmic contractions that move material through the bowel.

**Pyloroplasty**—Widening of the pyloric canal and any adjacent duodenal structure by means of a longitudinal incision.

## Demographics

Gastric (peptic) ulcers are included under the general heading of gastrointestinal (GI) diseases. GI disorders affect an estimated 25–30% of the world's population. In the United States, 60 million adults experience gastrointestinal reflux at least once a month, and 25 million adults suffer daily from heartburn. Left untreated, these conditions often evolve into ulcers. Four million people have active peptic ulcers; about 350,000 new cases are diagnosed each year. Four times as many duodenal ulcers as gastric ulcers are diagnosed. The first-degree relatives of patients with duodenal ulcer have a two to three times greater risk of developing duodenal ulcer. Relatives of gastric ulcer patients have a similarly increased risk of developing a gastric ulcer.

## Description

A vagotomy can be performed using closed (laparoscopic) or open surgical technique. The indications for a laparoscopic vagotomy are the same as open vagotomy.

There are four basic types of vagotomy procedures:

- Truncal or total abdominal vagotomy. The main vagal trunks are divided, and surgery is accompanied by a drainage procedure, such as pyloroplasty.
- Selective (total gastric) vagotomy. The main vagal trunks are dissected to the point where the branch

leading to the biliary tree divides, and there is a cut at the section of vagus close to the hepatic branch. This procedure is rarely indicated or performed.

- Highly selective vagotomy (HSV). HSV selectively deprives the parietal cells of vagal nerves, and reduces their sensitivity to stimulation and the release of acid. It does not require a drainage procedure. The branches of Latarjet's nerve are divided from the esophagogastric junction to the crow's foot along the lesser curvature of the stomach.
- Thoracoscopic vagotomy. Performed through the third, sixth, and seventh left intercostal spaces, the posterior vagus trunk is isolated, clipped, and a segment excised.

A vagotomy is performed under **general anesthesia**. The surgeon makes an incision in the abdomen and locates the vagus nerve. Either the trunk or the branches leading to the stomach are cut. The abdominal muscles are sewn back together, and the skin is closed with sutures.

Often, other gastrointestinal surgery is performed (e.g., part of the stomach may be removed) at the same time. Vagotomy causes a decrease in peristalsis, and a change in the emptying patterns of the stomach. To ease this, a **pyloroplasty** is often performed to widen the outlet from the stomach to the small intestine.

## Diagnosis/Preparation

A gastroscopy and x rays of the gastrointestinal system determine the position and condition of the ulcer. Standard preoperative blood and urine tests are done. The patient discusses with the anesthesiologist any medications or conditions that might affect the administration of anesthesia.

## Aftercare

Patients who have had a vagotomy stay in the hospital for about seven days. Nasogastric suctioning is required for the first three or four days. A tube is inserted through the nose and into the stomach. The stomach contents are then suctioned out. Patients eat a clear liquid diet until the gastrointestinal tract regains function. When patients return to a regular diet, spicy and acidic foods should be avoided.

It takes about six weeks to fully recover from the surgery. The sutures that close the skin can be removed in seven to 10 days. Patients are encouraged to move around soon after the operation to prevent the formation of deep vein blood clots. Pain medication, stool softeners, and **antibiotics** may be prescribed following the operation.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Patients who receive vagotomies are most often seen in emergency situations where bleeding and perforated ulcers require immediate intervention. A vagotomy is usually performed by a board-certified surgeon, either a general surgeon who specializes in gastrointestinal surgery or a gastrointestinal endoscopic surgeon. The procedure is performed in a hospital setting.

### Risks

Standard surgical risks, such as excessive bleeding and infection, are potential complications. In addition, the emptying patterns of the stomach are changed. This can lead to dumping syndrome and diarrhea. Dumping syndrome is a condition in which the patient experiences palpitations, sweating, nausea, cramps, vomiting, and diarrhea shortly after eating.

The following complications are also associated with vagotomy surgery:

- Gastric or esophageal perforation. May occur from an electrocautery injury or by clipping the branch of the nerve of Latarjet.
- Delayed gastric emptying. Most common after truncal and selective vagotomy, particularly if a drainage procedure is not performed.

People who use alcohol excessively, smoke, are obese, and are very young or very old are at higher risk for complications.

### Normal results

Normal recovery is expected for most patients. Ulcers recur in about 10% of those who have vagotomy without stomach removal. Recurrent ulcers are also found in 2–3% of patients who have some portion of their stomach removed.

### Morbidity and mortality rates

In the United States, approximately 3,000 deaths per year are due to duodenal ulcer and 3,000 to gastric ulcer. There has been a marked decrease in reported hospitalization and mortality rates for gastric ulcer.

## QUESTIONS TO ASK THE DOCTOR

- What are the possible complications involved in vagotomy surgery?
- What surgical preparation is needed?
- What type of anesthesia will be used?
- How is the surgery performed?
- How long is the hospitalization?
- How many vagotomies does the surgeon perform in a year?

### Alternatives

The preferred short-term treatment for gastric ulcers is drug therapy. A recent review surveying medical articles published from 1977 to 1994 concluded that drugs such as cimetidine, ranitidine, famotidine, H<sub>2</sub> blockers, and sucralfate were efficient, with omeprazole considered the “gold standard” for active gastric ulcer treatment. Surgical intervention, however, is recommended for people who do not respond to medical therapy.

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Tish Davidson, A.M.  
Monique Laberge, Ph.D.

Valvuloplasty, balloon see **Balloon valvuloplasty**

Varicose vein sclerotherapy see **Sclerotherapy for varicose veins**

Vascular study see **Angiography**

## Vascular surgery

### Definition

Vascular surgery is the treatment of surgery on diagnosed patients with diseases of the arterial, venous, and lymphatic systems (excluding the intracranial and coronary arteries).

### Purpose

Vascular surgery is indicated when a patient has vascular disease that cannot be treated by less invasive, non-surgical treatments. The purpose of vascular surgery is to treat vascular diseases, which are diseases of the arteries and veins. Arterial disease is a condition in which blood clots, arteriosclerosis, and other vascular conditions occur in the arteries. Venous disease involves problems that occur in the veins. Some vascular conditions occur only in arteries, others occur only in the veins, and some affect both veins and arteries.

### Demographics

As people age, vascular diseases are very common. Since they rarely cause symptoms in the early stages, many people do not realize that they suffer from these diseases. A large percentage of the 10 million people in the United States who may have peripheral vascular disease (PVD) are males. In the majority of cases, the blockage is caused by one or more blood clots that travel to the lungs from another part of the body. Factors that increase the chances of vascular disease include:

- increasing age (which results in a loss of elasticity in the veins and their valves)
- a family history of heart or vascular disease
- illness or injury
- pregnancy
- prolonged periods of inactivity sitting, standing, or bed rest
- smoking
- obesity
- hypertension, diabetes, high cholesterol, or other conditions that affect the health of the cardiovascular system
- lack of exercise

### Description

Vascular surgery involves techniques relating to endovascular surgeries, including balloon **angioplasty** and/or stenting, aortic and peripheral vascular endovascular stent/graft placement, thrombolysis, and other adjuncts for vascular reconstruction.

The vascular system is the network of blood vessels that circulate blood to and from the heart and lungs. The circulatory system (made up of the heart, arteries, veins, capillaries, and the circulating blood) provides nourishment to the body's cells and removes their waste. The arteries carry oxygenated blood from the heart to the cells. The veins return the blood from the cells back to the lungs for reoxygenation and recirculation by the heart. The aorta is the largest artery leaving the heart; it then subdivides into smaller arteries going to every part of the body. The arteries, as they narrow, are connected to smaller vessels called capillaries. In these capillaries, oxygen and nutrients are released from the blood into the cells, and cellular wastes are collected for the return trip. The capillaries then connect to veins, which return the blood back to the heart.

The aorta stems from the heart, arches upward, and then continues down through the chest (thorax) and the abdomen. The iliac arteries, which branch out from the aorta, provide blood to the pelvis and legs. The thoracic section of the aorta supplies blood to the upper body, as it continues through the chest. The abdominal section of the aorta, which supplies blood to the lower body, continues through the abdomen.

Vascular diseases are usually caused by conditions that clog or weaken blood vessels, or damage valves that control the flow of blood in and out of the veins, thus robbing them of vital blood nutrients and oxygen.



## KEY TERMS

**Ankle-brachial index (ABI) test**—A means of checking the blood pressure in the arms and ankles using a regular blood pressure cuff and a special ultrasound stethoscope (Doppler). The pressure in the ankle is compared to the pressure in the arm.

**Aorta**—A large, elastic artery beginning at the upper part of the left ventricle of the heart that becomes the main trunk of the arterial system.

**Aortic aneurysms**—Occurs when an area in the aorta (the main artery of the heart) is weakened and bulges like a balloon.

**Arteriogram**—A test to check the blood pressure at several points in the leg by using a blood pressure cuff and a Doppler. The patient is then asked to walk on a treadmill, after which the ankle pressure is taken again to determine if the pressure decreased after walking.

**Abdominal aortic aneurysm**—Occurs when an area in the aorta (the main artery of the heart) is weakened and bulges like a balloon. The abdominal section of the aorta supplies blood to the lower body.

**Aneurysm**—A weakening of the artery wall, due to atherosclerosis, causing a bulge that can rupture, and lead to thrombosis or embolism.

**Angiography or angiogram**—An x-ray exam of the arteries and veins (blood vessels) to diagnose blockages and other blood vessel problems.

**Atherosclerosis**—A form of arteriosclerosis affecting the innermost area of the artery; a series of calcified deposits that can close down the vessel.

**Arteriogram**—An x-ray picture of an artery achieved by injecting an opaque dye with a needle or tube into the affected artery.

**Artery**—A blood vessel conveying blood in a direction away from the heart.

**Bruit**—A roaring sound created by a partially blocked artery.

**Capillary**—Smallest extremity of the arterial vessel, where oxygen and nutrients are released from the blood into the cells, and cellular waste is collected.

**Carotid artery**—Major artery leading to the brain, blockages of which can cause temporary or permanent strokes.

**Carotid artery disease**—A condition in which the arteries in the neck that supply blood to the brain become clogged, causing the danger of a stroke.

**Carotid endarterectomy**—A surgical technique for removing intra-arterial obstructions of the internal carotid artery.

**Cerebral aneurysm**—The dilation, bulging, or ballooning out of part of the wall of a vein or artery in the brain.

**Cholesterol**—An abundant fatty substance in animal tissues. High levels in the diet are a factor in the cause of atherosclerosis.

**Claudication**—Attacks of lameness or pain chiefly in the calf muscles, brought on by walking because of a lack of oxygen reaching the muscle.

**Computed tomography (CT) scan**—A special type of x ray that can produce detailed pictures of structures inside the body.

A few common diseases affecting the arteries are peripheral vascular disease (PVD), carotid artery disease, and aortic aneurysms.

Surgery is used to treat specific diseased arteries, such as atherosclerosis, to help prevent strokes or heart attacks, improve or relieve angina or hypertension, remove aneurysms, improve claudication, and save legs that would otherwise have to be amputated. The choices involve repairing the artery, bypassing it, or replacing it.

As people age, atherosclerosis, commonly called hardening of the arteries, occurs with the constant passage of blood through the arteries. It can take on a number of forms, of which atherosclerosis (hardening

of the innermost portion) is the most common. This occurs when fatty material containing cholesterol or calcium (plaque) is deposited on the innermost layer of the artery. This causes a narrowing of the inside diameter of the blood vessel. Eventually, the artery becomes so narrow that a blood clot (thrombus) forms, and blocks blood flow to an entire portion of the body. This condition is called PVD, or peripheral arterial disease. In another form of atherosclerosis, a rough area or ulcer forms in the diseased interior of the artery. Blood clots then tend to develop on this ulcer, break off, and travel further along, forming a blockage where the arteries get narrower. A blockage resulting from a clot formed elsewhere in the body is called an embolism.

**Collaterals**—Alternate pathways for arterial blood.

**Coronary**—Of or relating to the heart.

**Embolism**—Obstruction or closure of a vessel by a transported clot of foreign matter.

**Endovascular grafting**—A procedure that involves the insertion of a delivery catheter through a groin artery into the abdominal aorta under fluoroscopic guidance.

**Intracranial**—Existing or occurring within the cranium; affecting or involving intracranial structures.

**Lower extremity amputation**—To cut a limb from the body.

**Lymphangiography**—Injection of dye into lymphatic vessels followed by x rays of the area. It is a difficult procedure, as it requires surgical isolation of the lymph vessels to be injected.

**Lymphoscintigraphy**—A technique in which a radioactive substance that concentrates in the lymphatic vessels is injected into the affected tissue and mapped using a gamma camera, which images the location of the radioactive tracer.

**Magnetic resonance imaging (MRI)**—A noninvasive diagnostic technique that produces computerized images of internal body tissues and is based on nuclear magnetic resonance of atoms within the body induced by the application of radio waves.

**Plethysmography**—A test in which a patient sits inside a booth called a plethysmograph and breathes through a mouthpiece, while pressure and air flow measurements are collected to measure the total lung volume.

**Pulmonary embolism**—A blocked artery in the lung.

**Renal artery aneurysm**—An aneurysm relating to, involving, or located in the region of the kidneys.

**Thoracic aortic aneurysm**—Occurs when an area in the thoracic section of the aorta (the chest) is weakened and bulges like a balloon. The thoracic section supplies blood to the upper body.

**Thrombus**—A blood clot that may form in a blood vessel or in one of the cavities of the heart.

**Thrombosis**—The formation or presence of a blood clot within a blood vessel.

**Thrombolysis**—A treatment that opens up blood flow and may prevent permanent damage to the blood vessels.

**Ulcer**—A lesion or rough spot formed on the surface of an artery.

**Vascular**—Relating to the blood vessels.

**Ultrasound scan**—The scan produces images of arteries on a screen and is used to evaluate the blood flow, locate blockages, and measure the size of the artery.

**Vasculogenic erectile dysfunction**—The inability to attain or sustain an erection satisfactory for coitus, due to atherosclerotic disease of penile arteries, inadequate impedance of venous outflow (venous leaks), or a combination of both.

**Venous stasis disease**—A condition in which there is pooling of blood in the lower leg veins that may cause swelling and tissue damage, and lead to painful sores or ulcers.

**Varicose veins**—Twisted, enlarged veins near the surface of the skin, which develop most commonly in the legs and ankles.

People who have few areas affected by PVD may be treated with angioplasty by opening up the blood vessel with a balloon placed on the end of a catheter. A stent is often used with angioplasty to help keep the artery open. The type of surgery used to treat PVD is based upon the size and location of the damaged artery. The surgery techniques used for severe PVD include:

- Bypass surgery is preferred for people who have many areas of blockage or a long, continuous blockage.
- Aortobifemoral bypass is used for PVD affecting the major abdominal artery (aorta) and the large arteries that branch off of it.
- In a technique called thromboendarterectomy, the inner diseased layers of the artery are removed, leaving the relatively normal outer coats of the artery.
- Resection involves a technique to remove a diseased artery following an aneurysm; a bypass is created with a synthetic graft.
- In a bypass graft, a vein graft from another part of the body or a graft made from artificial material is used to create a detour around a blocked artery.
- Tibioperoneal bypass is used for PVD affecting the arteries in the lower leg or foot.
- Femoropopliteal (fem-pop) bypass surgery is used for PVD affecting the arteries above and below the knee.

- Embolectomy is a technique in which an embolic clot on the wall of the artery is removed, using an inflatable balloon catheter.
- Thrombectomy is a technique in which a balloon catheter is inserted into the affected artery beyond a blood clot. The balloon is then inflated and pulled back, bringing the clot with it.

An aneurysm occurs when weakened blood vessels bulge like balloons as blood flows through them. Once they have grown to a certain size, there is a risk of rupture and life-threatening bleeding. There are two types of aortic aneurysms: abdominal aortic aneurysm (AAA) and thoracic aortic aneurysm. This classification is based on where the aneurysm occurs along the aorta. Aneurysms are more common in the abdominal section of the aorta than the thoracic section.

Most blood clots originate in the legs, but they can also form in the veins of arms, the right side of the heart, or even at the tip of a catheter placed in a vein. Venous disease conditions that usually occur in the veins of the legs include:

- varicose veins
- phlebitis
- venous stasis disease
- deep vein thrombosis (DVT)
- claudication
- blood clots

Carotid artery disease is a condition in which the arteries in the neck that supply blood to the brain become clogged; this condition can cause a stroke.

Lymphatic obstruction involves blockage of the lymph vessels, which drain fluid from tissues throughout the body and allow immune cells to travel where they are needed. Some of the causes of lymphatic obstruction (also known as swelling of the lymph passages), include infections such as chronic cellulitis, or parasitic infections such as filariasis, trauma, tumors, certain surgeries including **mastectomy**, and radiation therapy. There are rare forms of congenital lymphedema that probably result from abnormalities in the development of the lymphatic vessels. Most patients with lymphedema will not need surgery, as the symptoms are usually managed by other techniques. Surgical therapy for lymphedema includes removal of tissue containing abnormal lymphatics, and less commonly, transplant of tissue from areas with normal lymphatic tissues to areas with abnormal lymphatic drainage. In rare cases, bypass of abnormal lymphatic tissue is attempted, sometimes using vein grafts.

Other examples of vascular surgery include:

- cerebral aneurysm
- acute arterial and graft occlusion

- carotid endarterectomy
- endovascular grafting
- vasculogenic erectile dysfunction
- renal artery aneurysm
- surgery on varicose veins
- lower extremity amputation

## Diagnosis/Preparation

In order for a patient to be diagnosed with a vascular disease, he or she must be clinically evaluated by a vascular surgeon, which includes a history and **physical examination**. A vascular surgeon also treats vascular disorders by non-operative means, including drug therapy and risk factor management.

The symptoms produced by atherosclerosis, thrombosis, embolisms, or aneurysms depend on the particular artery affected. These conditions can sometimes cause pain, but often there are no symptoms at all.

A physician has many ways of feeling, hearing, measuring, and even seeing arterial blockages. Many arteries in the body can be felt or palpated. A doctor can feel for a pulse in an area he or she believes afflicted. Usually, the more advanced the arteriosclerosis, the less pulse in a given area.

As the artery becomes blocked, it can cause a noise very much like water roaring over rocky rapids. The physician can listen to this noise (bruit) directly, or can use special amplification systems to hear the noise.

There are other tests that can be done to determine if arterial blood flow is normal, including:

- ankle-brachial index (ABI) test
- arteriogram
- segmental pressure test
- ultrasound scan
- magnetic resonance imaging (MRI)
- computed tomography (CT) scan
- angiography
- lymphangiography
- lymphoscintigraphy
- plethysmography
- duplex ultrasound scanning

There may be no symptoms of vascular disease caused by blood clots until the clot grows large enough to block the flow of blood through the vein. Symptoms that may come on suddenly include:

- pain
- sudden swelling in the affected limb

- reddish blue discoloration
- enlargement of the superficial veins
- skin that is warm to the touch

The physician will probably do an evaluation of all organ systems, including the heart, lungs, circulatory system, kidneys, and the gastrointestinal system. The decision whether to have surgery or not is based on the outcome of these evaluations.

For high-risk patients undergoing vascular surgery, research has shown that taking oral beta-blockers one to two weeks before surgery and continuing for at least two weeks after the operation can significantly reduce the chance of **dying** or having a heart attack. Scientists suspect that the drug improves oxygen balance in the wall of the heart and stabilizes plaques in the arteries.

### Aftercare

The length of time in intensive care and hospitalization will vary with each surgery, as will the recovery time, depending on numerous factors. Because surgery for an AAA is more serious, the patient can expect to be in intensive care for 24 hours, and in the hospital for five to 10 days, providing the patient was healthy and had a smooth operative and postoperative course. The hospital stay will likely increase if there are complications. It may take as long as six months to fully recover from surgery for an AAA.

Living a heart-healthy lifestyle is the best way of preventing and controlling vascular disease: quit smoking; eat nutritious foods low in fat; **exercise**; maintain a healthy weight; and control risk factors such as high blood pressure, high cholesterol, diabetes, hypertension, and other factors that contribute to vascular disease.

Medications that may be used to treat PVD include:

- aspirin and other antiplatelet medications to treat leg pain
- statins to lower cholesterol levels
- medications to control high blood pressure
- medications to control diabetes
- anticoagulants (these are rarely, but not generally, used to treat PVD unless the person is at an increased risk for forming blood clots)

### Risks

All surgeries carry some risks. There is a risk of infection whenever incisions are required. Operations in the chest or those that involve major blood vessels carry a higher risk of complications. Patients that have

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A vascular surgeon performs the procedure in a hospital operating room. Applicants for residency training in vascular surgery must have successfully completed a general surgery residency and be eligible for the board examination in general surgery. An individual must meet the standards set by the Vascular Surgery Board of the American Board of Surgery for cognitive knowledge and hypothetical case management. At the completion of a vascular surgery residency, both a written and oral examination must be completed before certification. A vascular surgeon is required to undergo periodic written reexamination.

high blood pressure, chronic lung or kidney disease, or other illnesses are at greater risk of complications during and after surgery. Other risks of vascular surgery include:

- bleeding
- failed or blocked grafts
- heart attack or stroke
- smoking
- leg swelling if a leg vein is used
- people over 65 years are at greater risk for brain impairment after major surgery
- the more damaged the circulatory system is before surgery, the higher susceptibility to mental decline after vascular surgery
- impotence

The patient should discuss risks with the surgeon after careful review of the patient's medical history and a physical examination.

### Normal results

The success rate for vascular surgery varies depending on a number of factors that may influence the decision on whether to have surgery or not, as well as the results.

The chance that an aneurysm will rupture generally increases with the size of the aneurysm; AAAs smaller than 1.6 in (4 cm) in diameter have up to a 2% risk of rupture, while ones larger than 2 in (5 cm) in diameter have a 22% risk of rupture within two years.

Arterial bypass surgery and peripheral bypass surgery have very good success rates. Most of those who



## QUESTIONS TO ASK THE DOCTOR

- Can my vascular disease be controlled with lifestyle changes?
- If a procedure is required, am I a candidate for a less invasive, interventional radiology treatment?
- What are the risks and benefits of this operation?
- What are the normal results of this operation?
- What happens if this operation does not go as planned?
- What is the expected recovery time?

undergo AAA surgery recover well, except in the case of a rupture. Most patients who have a ruptured aortic aneurysm die due to excessive, rapid blood loss.

Surgical therapy for lymphedema has met with limited success, and requires significant experience and technical expertise.

### Morbidity and mortality rates

Peripheral vascular disease affects 10 million people in the United States, including 5% of those over 50. Only a quarter of PVD sufferers are receiving treatment. More than two million people in the United States develop DVT each year. More than 650,000 Americans experience a pulmonary embolism every year. Of those, approximately 200,000 people die from the condition.

### Alternatives

There are a few alternatives to treating vascular disease, although extensive research has not been done. Acupuncture is used to aid in hypertension and chelation therapy is thought to stabilize the effects of vascular disease. The focus should be on maintaining a proper diet and being aware of a family history of vascular disease so as to catch it as early as possible.

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- The National Heart, Lung and Blood Institute. 6701 Rockledge Drive, P.O. Box 30105, Bethesda, MD 20824-0105. (301) 592-8573. E mail: [nhlbiinfo@rover.nhlbi.nih.gov](mailto:nhlbiinfo@rover.nhlbi.nih.gov). <http://www.nhlbi.nih.gov> (accessed April 16, 2008).
- National Institutes of Health (NIH), Department of Health and Human Services. 9000 Rockville Pike, Bethesda, MD 20892.
- The Society for Vascular Surgery. 900 Cummings Center, #221 U, Beverly, MA 01915. <http://www.vascularweb.org> (accessed April 16, 2008).
- Society of Interventional Radiology. 10201 Lee Highway, Suite 500, Fairfax, VA. 22030. (800) 488-7284. E mail: [info@sirweb.org](mailto:info@sirweb.org). <http://www.sirweb.org/index.shtml> (accessed April 16, 2008).
- The U.S. Department of Health and Human Services. 200 Independence Avenue, S.W., Washington, DC 20201. (877) 696-6775.
- Valley Baptist Heart and Vascular Institute. 2101 Pease Street, P.O. Drawer 2588, Harlingen, TX 78550. (956) 389-4848.

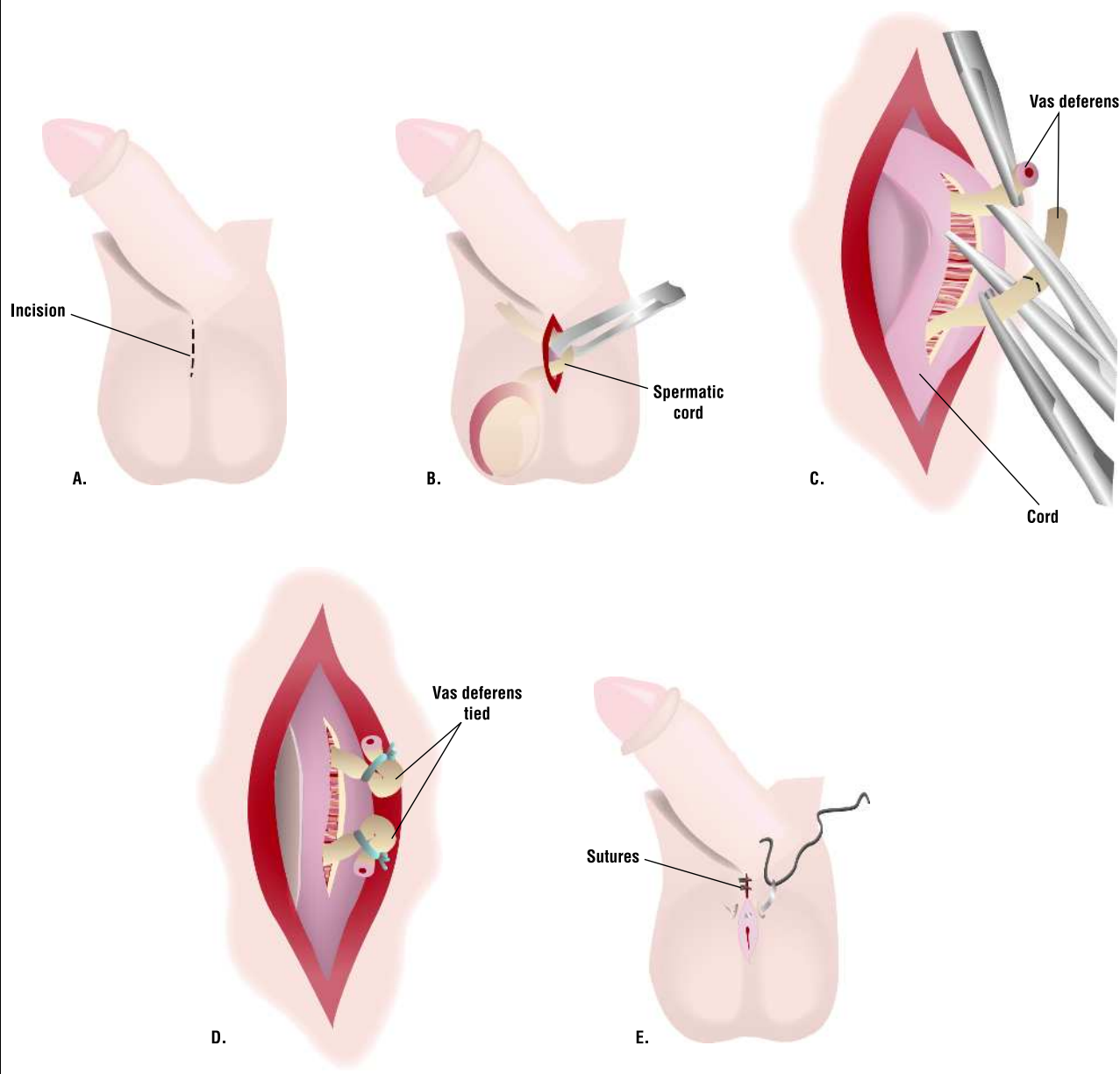
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## Vasectomy

### Definition

A vasectomy is a surgical procedure performed on adult males in which the vasa deferentia (tubes that carry sperm from the testicles to the seminal

## Vasectomy



In a vasectomy, an incision is made in the man's scrotum. The spermatic cord is pulled out (B) and incised to expose the vas deferens, which is then severed (C). The ends may be cauterized or tied off (D). After the procedure is repeated on the opposite cord, the scrotal incision is closed (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

vesicles) are cut, tied, cauterized (burned or seared), or otherwise interrupted. The semen no longer contains sperm after the tubes are cut, so conception cannot occur. The testicles continue to produce sperm, but the sperm die and are absorbed by the body.

### Purpose

The purpose of the vasectomy is to provide reliable contraception. Research indicates that the level of effectiveness is 99.6%. Vasectomy is the most reliable method of contraception and has fewer complications

## KEY TERMS

**Ejaculation**—The act of expelling the sperm through the penis during orgasm. The fluid that is released is called the ejaculate.

**Epididymitis**—Inflammation of the small tube that rests on top of the testicle and is part of the system that carries sperm from the testicle to the penis. The condition can be successfully treated with antibiotics, if necessary.

**Scrotum**—The sac that contains the testicles.

**Sperm granuloma**—A collection of fluid that leaks from an improperly sealed or tied vas deferens. The fluid usually disappears on its own, but can be drained, if necessary.

**Testicles**—The two egg-shaped organs found in the scrotum that produce sperm.

**Tubal ligation**—A female sterilization surgical procedure in which the fallopian tubes are tied in two places and cut between. This prevents eggs from moving from the ovary to the uterus.

**Vas deferens (plural, vasa deferentia)**—The Latin name for the duct that carries sperm from the testicle to the epididymis. In a vasectomy, a portion of each vas deferens is removed to prevent the sperm from entering the seminal fluid.

**Vasovasostomy**—A surgical procedure that is done to reverse a vasectomy by reconnecting the ends of the severed vasa deferentia.

and a faster recovery time than female sterilization methods. Some insurance plans will cover the cost of the procedure.

### Demographics

Approximately 500,000 vasectomies are performed annually in the United States. About one out of every six men over the age of 35 has had a vasectomy. Higher vasectomy rates are associated with higher levels of education and income.

### Description

Vasectomies are usually performed in the doctor's office or an outpatient clinic using **local anesthesia**. The area around the patient's scrotum (the sac containing the testicles that produce sperm) is shaved and cleaned with an antiseptic solution to reduce the chance of infection. A small incision is made in the scrotum. Each vas deferens (one from each testicle) is

tied in two places with nonabsorbent (permanent) sutures and the tube is severed between the ties. The ends may be cauterized (burned or seared) to decrease the chance that they will leak or grow back together.

"No-scalpel" vasectomies are gaining in popularity. Instead of an incision, a small puncture is made into the scrotum. The vasa deferentia are cut and sealed in a manner similar to that described above. No **stitches** are necessary and the patient has less pain. Other advantages include less damage to the tissues, less bleeding, less risk of infection, and less discomfort after the procedure. The no-scalpel method was developed in China in the mid-1970s and has been used in the United States since 1988. About one-third of vasectomies in the United States are performed with this technique.

The patient is not sterile immediately following the procedure. Men must use other methods of contraception until two consecutive semen analyses confirm that there are no sperm present in the ejaculate. It takes about four to six weeks, or 15–20 ejaculations, to clear all of the sperm from the tubes.

In some cases, vasectomies may be reversed by a procedure known as a **vasovasostomy**. In this procedure, the surgeon reconnects the ends of the severed vasa deferentia. A vasectomy should be considered permanent, however, as there is no guarantee of successful reversal. Vasovasostomies are successful in approximately 40–50% of men, although the success rate varies considerably with the individual surgeon. In the mid 2000s between 6% and 12% of American men were requesting reversals of their vasectomies. The cost of the procedure in the United States can be considerable, ranging from \$5,000–20,000.

### Diagnosis/Preparation

No special physical preparation is required for a vasectomy. The physician will first assess the patient's general health in order to identify any potential problems that could occur. The doctor will then explain the possible risks and side effects of the procedure. The patient is asked to sign a consent form that indicates that he understands the information he has received, and gives the doctor permission to perform the operation.

### Aftercare

Following the surgery, ice packs are often applied to the scrotum to decrease pain and swelling. A dressing (or athletic supporter) that supports the scrotum can also reduce pain. Mild over-the-counter (OTC) pain medication such as **aspirin** or **acetaminophen**

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Vasectomy is a minor procedure that can be performed in a clinic or doctor's office on an out-patient basis. The procedure is generally performed by a urologist, who is a medical doctor that has completed specialized training in the diagnosis and treatment of diseases of the urinary tract and genital organs.

## QUESTIONS TO ASK THE DOCTOR

- How often do you perform vasectomies?
- What is your rate of complications?
- How long will the procedure take?
- What will the procedure cost?
- Will my insurance cover the cost?
- Do you perform vasectomy reversal? If so, what is your success rate?

(Tylenol) should be able to control any discomfort. Activities may be restricted for one or two days, and no sexual intercourse for three or four days.

### Risks

There are very few risks associated with vasectomy other than infection, bruising, epididymitis (inflammation of the tube that carries the sperm from the testicle to the penis), and sperm granulomas (collections of fluid that leaks from a poorly sealed or tied vas deferens). These complications are easily treated if they do occur. Patients do not experience difficulty achieving an erection, maintaining an erection, or ejaculating. There is no decrease in the production of the male hormone (testosterone), and the patient's sex drive and sexual performance are not altered. Vasectomy is safer and less expensive than **tubal ligation** (sterilization of a female by cutting the fallopian tubes to prevent conception).

According to both the World Health Organization (WHO) and the National Institutes of Health (NIH), there is no evidence that a vasectomy will increase a man's long-term risk of testicular cancer, prostate cancer, or heart disease.

### Normal results

Vasectomies are more than 99% successful in preventing conception. As such, male sterilization is one of the most effective methods of contraception available.

### Morbidity and mortality rates

Complications occur in approximately 5% of vasectomies. The rates of incidence of some of the more common complications include:

- mild bleeding into the scrotum: one in 400
- major bleeding into the scrotum: one in 1,000

- infection: one in 100
- epididymitis: one in 100
- sperm granuloma: one in 500
- persistent pain: one in 1,000

Fournier gangrene is a very rare but possible complication of vasectomy in which the lining of tissue underneath the skin of the scrotum becomes infected (a condition called fasciitis). Fournier gangrene progresses very rapidly and is treated with aggressive antibiotic therapy and surgery to remove necrotic (dead) tissue. Despite treatment, a mortality rate of 45% has been reported for this condition.

### Alternatives

There are numerous options available to couples who are interested in preventing pregnancy. The most common methods are female sterilization, oral contraceptives, and the male condom. Female sterilization has a success rate of 99.5%; oral contraceptives, 95–99.5%; and the male condom, 86–97%.

### Resources

#### ORGANIZATIONS

Alan Guttmacher Institute. 1302 Connecticut Ave., NW, Suite 700, Washington, DC 20036. (202) 296 4012 or toll free (877) 823 0262. <http://www.guttmacher.org> (accessed April 16, 2008).

Planned Parenthood Federation of America. 434 West 33rd Street, New York, NY 10001. 212 541 7800. <http://www.plannedparenthood.org> (accessed April 16, 2008).

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Vasectomy reversal see **Vasovasostomy**

## Vasovasostomy

### Definition

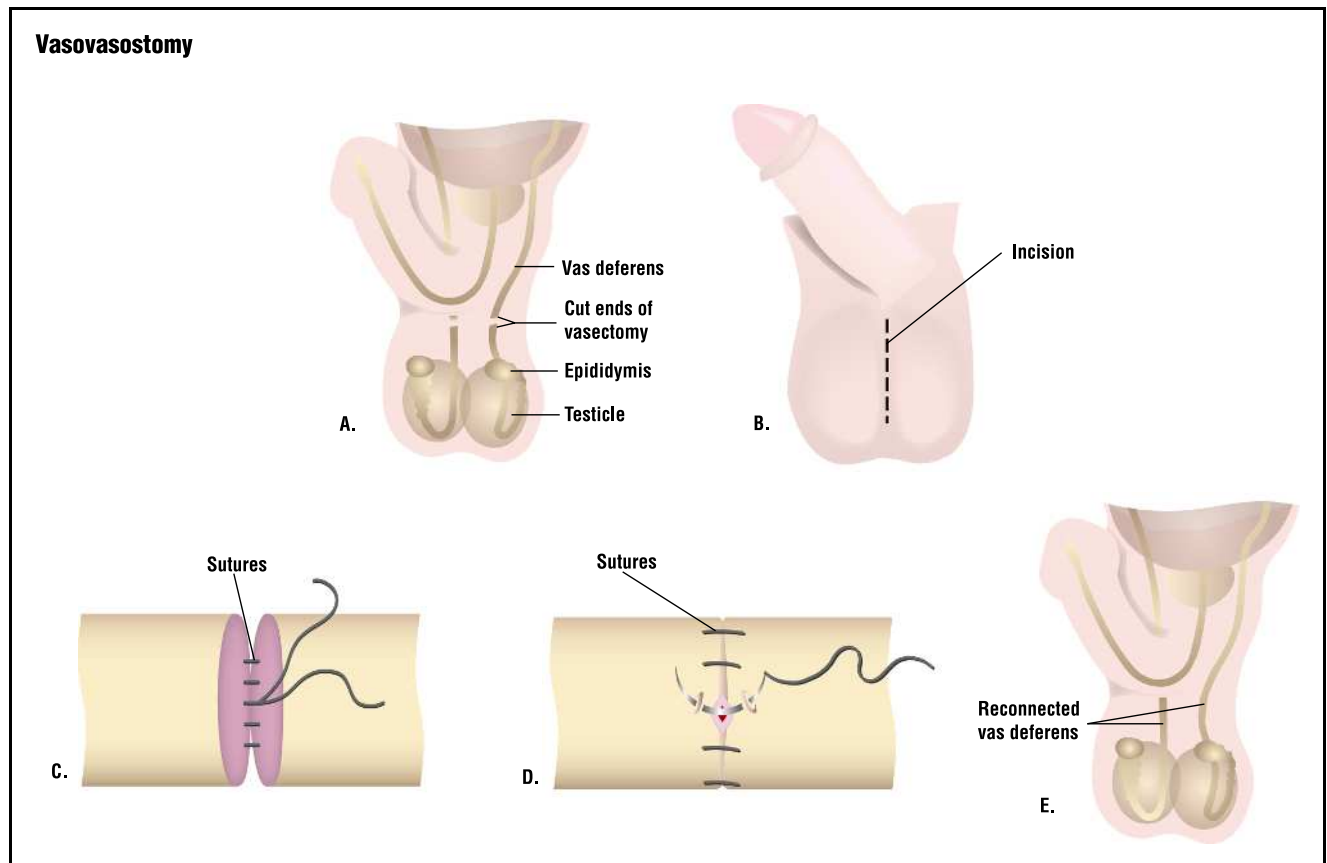
A vasovasostomy is a surgical procedure in which the effects of a **vasectomy** (male sterilization) are reversed. During a vasectomy, the vasa deferentia,

which are ducts that carry sperm from the testicles to the seminal vesicles, are cut, tied, cauterized (burned or seared), or otherwise interrupted. A vasovasostomy creates an opening between the separated ends of each vas deferens so that the sperm may enter the semen before ejaculation.

### Purpose

The purpose of a vasovasostomy is to restore a man's fertility, whereas a vasectomy, or male sterilization, is performed to provide reliable contraception (birth control). Research indicates that the level of effectiveness in preventing pregnancy is 99.6%. Vasectomy is the most reliable method of contraception and has less risk of complications and a faster recovery time than female sterilization methods.

In many cases, a vasectomy can be reversed. Vasectomy reversal does not, however, guarantee a successful pregnancy. The longer the time elapsed since a man has had a vasectomy, the more difficult the



In a vasovasostomy, the surgeon makes an incision in scrotum at the site of the vasectomy scar (B). The spermatic cords are located, and the two vas deferens are reconnected with two layers of suture (C and D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Atrophy**—Withering away.

**Congenital**—Present at birth.

**Epididymis**—A coiled cordlike structure at the upper border of the testis, in which sperm mature and are stored.

**Hematoma**—A localized collection of blood in an organ or tissue due to broken blood vessels.

**Intracytoplasmic sperm injection (ICSI)**—A process in which a single sperm is injected into a female egg.

**In vitro fertilization (IVF)**—A process in which sperm are incubated with a female egg under carefully controlled conditions, then transferred to the female uterus once fertilization has occurred.

**Scrotum**—The sac that contains the testicles.

**Vas deferens (plural, vasa deferentia)**—The Latin name for the duct that carries sperm from the testicle to the epididymis. In a vasectomy, a portion of each vas deferens is removed to prevent the sperm from entering the seminal fluid.

**Vasoepididymostomy**—A type of vasectomy reversal in which the vas deferens is attached to the epididymis, the structure where sperm matures and is stored.

reversal and the lower the success rate. The rate of sperm return if a vasovasostomy is performed within three years of a vasectomy is 97%; this number decreases to 88% by three to eight years after vasectomy, 79% at nine to 14 years, and 71% after 15 years. In addition, other factors affect the success rate of vasectomy reversal, including the age of the female partner, her fertility potential, the method of reversal used, and the experience of the surgeon performing the procedure.

Vasovasostomies are also performed in men who are sterile because of genital tract obstructions rather than prior vasectomies. A vasovasostomy may also be performed on occasion to relieve pain associated with postvasectomy pain syndrome.

## Demographics

An estimated 5% of men who have had a vasectomy later decide that they would like to have children. Some reasons for wanting a vasectomy reversal include **death** of a child, death of a spouse, divorce, or

experiencing a change in circumstances so that having more children is possible. One study found that divorce was the most commonly reported reason for a vasovasostomy and that the average age of men requesting a vasovasostomy is approximately 40 years.

About 7.4% of infertile men have primary genital tract obstructions caused by trauma, gonorrhea or other venereal infections, or congenital malformations of the vasa deferentia. Many of these men are good candidates for surgical treatment of their infertility.

## Description

Most surgeons prefer to have the patient given either a continuous anesthetic block or **general anesthesia** because of the length of time required for the operation. A vasovasostomy generally takes two to three hours to perform, depending on the complexity of the surgery and the experience of the operating physician. More complex surgeries may take as long as five hours. The advantage of general anesthesia is that the patient remains unconscious for the duration of the surgery, which ensures that he remains comfortable. Regional anesthesia, such as a spinal block, allows the patient to remain awake during the procedure while blocking pain in the area of the surgery.

After an adequate level of anesthesia has been reached, the surgeon will make an incision from the top of one side of the scrotum, sometimes moving upward as far as several inches into the abdominal area. A similar incision will then be made on the other side of the scrotum. The vasa deferentia will be identified and isolated from surrounding tissue. Fluid will be removed from the testicular end of each vas deferens and analyzed for presence of sperm. If sperm are found, then a simpler procedure to connect the cut ends of the vasa deferentia will be performed. If no sperm are found, a more complex procedure called a vasoepididymostomy or epididymovasostomy (in which the vas deferens is attached to the epididymis, a structure in which the sperm mature and are stored) may be more successful in restoring sperm flow.

There are two techniques that may be used to reconnect the cut ends of the vasa deferentia. A single-layer closure involves stitching the outer layer of each cut end of the tube together with a very fine suture thread. This procedure takes less time but is often less successful in restoring sperm flow. A double-layer closure, however, involves stitching the inner layer of each cut end of the tube first, and then stitching the outer layer. After reconnection is established,

the vasa deferentia are returned to their anatomical place and the scrotal incisions closed.

### Diagnosis/Preparation

Before a vasovasostomy is performed, the patient will undergo a preoperative assessment, including a **physical examination** of the scrotum. This evaluation will allow the surgeon to determine what sort of vasectomy reversal should be performed and how extensive the surgery might be. A medical history will be taken. The physician will review the patient's medical records in order to determine how the patient's vasectomy was performed; if large portions of the vasa deferentia were removed during surgery, the vasectomy reversal will be more complicated and may have a lower chance of success. The patient's partner should also undergo a fertility assessment, including a gynecologic exam, to assess her reproductive health.

Some surgeons prefer to give the patient a broad-spectrum antibiotic about half an hour before surgery as well as a mild sedative.

### Aftercare

After the procedure the patient will be transferred to a **recovery room** where he will remain for approximately three hours. The patient will be asked to void urine before discharge. Pain medication is prescribed and usually required for one to three days after the procedure. **Antibiotics** may be given after the procedure as well as beforehand to prevent infection. Ice packs applied to the scrotum will help to decrease swelling and discomfort. Heavy lifting, **exercise**, and sexual activity should be avoided for up to four weeks while the vasovasostomy heals.

Patients are usually allowed to return to work within three days. They may shower within two days after surgery, but should avoid soaking the incision (by taking a tub bath or going swimming) for about two weeks. The surgeon will schedule the patient for an incision check about a week after surgery and a semen analysis three months later.

### Risks

The complications that most commonly occur after vasovasostomy include swelling, bruising, and symptoms associated with anesthesia (nausea, headache, etc.). There is a risk of low sperm count if the operation is done inadequately or if scarring partially blocks the channel inside the vasa deferentia. Less common complications are infection or severe hematoma (collection of blood under the skin). The most serious potential complication of a vasovasostomy is

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A vasovasostomy can be performed in a hospital, clinic, or doctor's office on an outpatient basis. The procedure is generally performed by a urologist, a medical doctor who has completed specialized training in the diagnosis and treatment of diseases of the urinary tract and genital organs.

testicular atrophy (wasting away), which may result from damage to the spermatic artery during the procedure.

### Normal results

If a successful vasectomy reversal has been performed, the average time to achieving pregnancy after the procedure is one year, with most pregnancies occurring within the first two years. A good sperm count usually returns within three to six months.

### Morbidity and mortality rates

The chance that the vasa deferentia will become obstructed after a successful reversal is approximately 10%. Some doctors recommend that patients bank their sperm as a precautionary measure. Scrotal hematoma occurs in 1–2% of patients after vasovasostomy, and infection in less than 1%.

### Alternatives

A vasoepididymostomy may be performed if the physician determines that a vasovasostomy will be insufficient in restoring sperm flow. The determining factor is usually the absence of sperm or fluid in the testicular end of the cut vas deferens (which is found during surgery), although a swollen or blocked epididymis found during a preoperative scrotal examination may also indicate a vasoepididymostomy will be necessary.

There are some options available to men and their partners who are seeking to conceive after a vasectomy but wish to avoid vasectomy reversal. As sperm are no longer present in the man's ejaculate, they may be retrieved from the testicle or epididymis by extraction (removal of tissue) or aspiration (removed by a needle). The sperm may then be incubated with a female egg under carefully controlled conditions, then transferred to the female uterus once fertilization has

## QUESTIONS TO ASK THE DOCTOR

- How often do you perform vasectomy reversals?
- What is your success rate?
- What is your rate of complications?
- What technique do you recommend for reestablishing sperm flow?
- How long will the procedure take?
- What will vasectomy reversal cost me? Will my insurance cover the cost?

occurred; this process is called in vitro fertilization (IVF). A process called intracytoplasmic sperm injection (ICSI) may be used to improve the success rate of IVF; in this procedure, a single sperm is injected into the female egg.

### Resources

#### BOOKS

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#### ORGANIZATIONS

American Board of Urology (ABU). 2216 Ivy Road, Suite 210, Charlottesville, VA 22903. (434) 979 0059. [www.abu.org](http://www.abu.org).

Center for Male Reproductive Medicine. 2080 Century Park East, Suite 907, Los Angeles, CA 90067. (310) 277 2873. [www.malereproduction.com](http://www.malereproduction.com).

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## Vein ligation and stripping

### Definition

Vein ligation and stripping is a surgical approach to the treatment of varicose veins. It is also sometimes called phlebectomy. Ligation refers to the surgical tying-off of a large vein in the leg called the greater saphenous vein, while stripping refers to the removal of this vein through incisions in the groin area or behind the knee. If some of the valves in the saphenous vein are healthy, the weak portion of the vein can be closed off by ligation. If the entire vein is weak, it is closed off and pulled downward and out through an incision made below it. Tying and removal of the greater saphenous vein are done to reduce the pressure of blood flowing backward through this large vein into the smaller veins that feed into it.

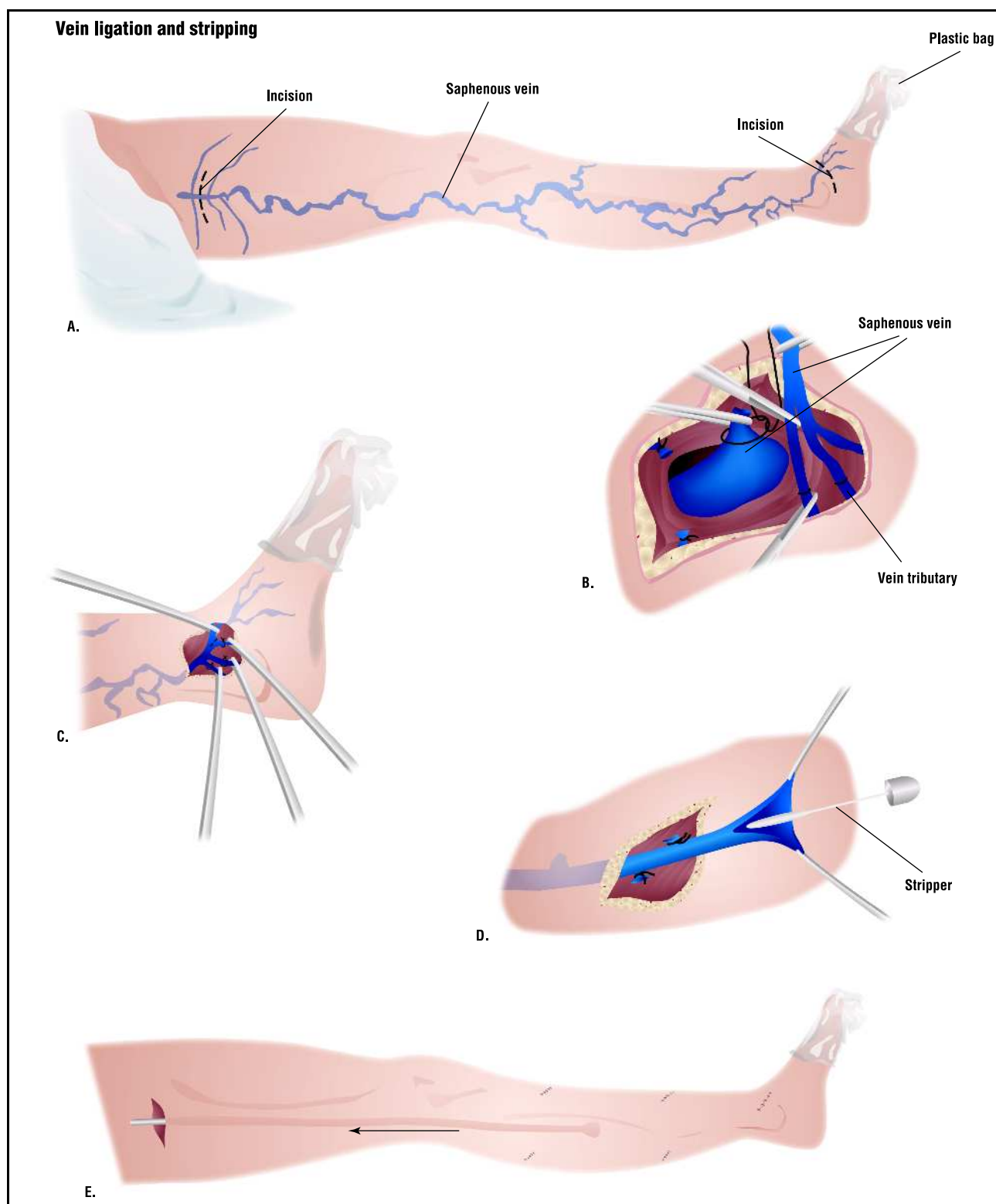
Phlebectomy is one of the oldest forms of treatment for varicose veins; the earliest description of it was written by Aulus Cornelius Celsus, a Roman historian of medicine, in 45 A.D. The first description of a phlebectomy hook comes from a textbook on surgery published in 1545. The modern technique of ambulatory (outpatient) phlebectomy was developed around 1956 by a Swiss dermatologist named Robert Muller. As of 2008, surgical ligation and stripping of the saphenous vein are performed less frequently because of the introduction of less invasive forms of treatment.

### Purpose

The purpose of vein ligation and stripping is to reduce the number and size of varicose veins that cannot be treated or closed by other measures. The reasons for **vascular surgery** in general include:

- Improvement of the appearance of the legs; large varicose veins are considered disfiguring by many people.
- Relief from pain, leg cramps, and fatigue that may be associated with varicose veins.
- Treatment of skin problems that may develop as complications of varicose veins; these include chronic





To treat varicose veins in the leg, the saphenous vein may be removed by ligation and stripping (A). First an incision is made in the upper thigh, and the saphenous vein is separated from its tributaries (B). Another incision is made above the foot (C). The lower portion of the vein is cut, and a stripper is inserted into the vein (D). The stripper is pulled through the vein and out the incision in the upper thigh (E). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Ablation**—The destruction or removal of a body part. Saphenous ablation refers to several techniques for closing and destroying the greater saphenous vein without cutting or stripping.

**Edema**—The presence of abnormally large amounts of fluid in the soft tissues of the body.

**Endovascular**—Inside a blood vessel. Endovascular treatments of varicose veins are those that are performed inside the veins.

**Incompetent**—In a medical context, insufficient. An incompetent vein is one that is not performing its function of carrying blood back to the heart.

**Ligation**—The act of tying off a blood vessel.

**Lumen**—The channel or cavity inside a tube or hollow organ of the body.

**Palpation**—Examining by touch as part of the process of physical diagnosis.

**Percussion**—Thumping or tapping a part of the body with the fingers for diagnostic purposes.

**Phlebectomy**—Surgical removal of a vein or part of a vein.

**Phlebology**—The study of veins, their disorders, and their treatments. A phlebologist is a doctor who specializes in treating spider veins, varicose veins, and associated disorders.

**Saphenous veins**—Two large superficial veins in the leg that may be treated by ligation and stripping as

therapy for varicose veins. The greater saphenous vein runs from the foot to the groin area, while the short saphenous vein runs from the ankle to the knee.

**Sclerose**—To harden or undergo hardening. Sclerosing agents are chemicals that are used in sclerotherapy to cause swollen veins to fill with fibrous tissue and close down.

**Seroma**—A collection of blood serum or lymphatic fluid in body tissues. It is an occasional complication of vascular surgery.

**Telangiectasia**—The medical term for the visible discolorations produced by permanently swollen capillaries and smaller veins.

**Thrombophlebitis**—The inflammation of a vein associated with the formation of blood clots.

**Trendelenburg's test**—A test that measures the speed at which the lower leg fills with blood after the leg has first been raised above the level of the heart. It is named for Friedrich Trendelenburg (1844–1924), a German surgeon.

**Tumescent anesthesia**—A type of local anesthesia originally developed for liposuction in which a large volume of diluted anesthetic is injected into the tissues around the vein until they become tumescent (firm and swollen).

**Varicose**—Abnormally enlarged and distended.

**Varix (plural, varices)**—The medical term for an enlarged blood vessel.

eczema, skin ulceration, external bleeding, and abnormal pigmentation of the skin.

- Prevention of such disorders as thrombophlebitis and pulmonary blood clots.

## Demographics

The World Health Organization (WHO) estimates that about 25% of adults around the world have some type of venous disorder in the legs. The proportion of the general population with varicose veins is higher, however, in the developed countries. The American College of Phlebology (ACP), which is a group of dermatologists, plastic surgeons, gynecologists, and general surgeons with special training in the treatment of venous disorders, states that more than 80 million people in the United States suffer from varicose veins. In the past, the female-to-male ratio has been close to four to one, but

this figure is changing due to the rapid rise in obesity among adult males in the past two decades.

Varicose veins are more common in middle-aged and elderly adults than in children or young adults. Although varicose veins tend to run in families, they do not appear to be associated with specific racial or ethnic groups.

## Description

### *Causes of varicose veins*

The venous part of the circulatory system returns blood to the heart to be pumped to the lungs for oxygenation, in contrast to the arterial system, which carries oxygenated blood away from the heart to be distributed throughout the body. Veins are more likely than arteries to expand or dilate if blood volume or pressure increases, because they consist of only one layer of tissue; this is in contrast to arteries, in which there are three layers.

There are three major categories of veins: superficial veins, deep veins, and perforating veins. All varicose veins are superficial veins; they lie between the skin and a layer of fibrous connective tissue called fascia, which cover and support the muscles and the internal organs. The deep veins of the body lie within the muscle fascia. This distinction helps to explain why a superficial vein can be removed or closed without damage to the deep circulation in the legs. Perforating veins are veins that connect the superficial and deep veins.

Veins contain one-way valves that push blood inward and upward toward the heart against the force of gravity when they are functioning normally. The blood pressure in the superficial veins is usually low, but if it rises and remains at a higher level over a period of time, the valves in the veins begin to fail. The blood flows backward and collects in the lower veins, and the veins dilate, or expand. Veins that are not functioning properly are said to be incompetent. As the veins expand, they become more noticeable under the surface of the skin. Small veins, or capillaries, often appear as spider-shaped or tree-like networks of reddish or purplish lines under the skin. The medical term for these is telangiectasias, but they are commonly known as spider veins or thread veins. Larger veins that form flat, blue-green networks often found behind the knee are called reticular varicosities. True varicose veins are formed when the largest superficial veins become distorted and twisted by a long-term rise in blood pressure in the legs.

The most important veins in the lower leg are the two saphenous veins: the greater saphenous vein, which runs from the foot to the groin area, and the short saphenous vein, which runs from the ankle to the knee. It is thought that varicose veins develop when the valves at the top of the greater saphenous vein fail, allowing more blood to flow backward down the leg and increase the pressure on the valves in the smaller veins in turn. The practice of ligation and stripping of the greater saphenous vein is based on this hypothesis.

Some people are at increased risk for developing varicose veins. These risk factors include:

- Sex. Females in any age group are more likely than males to develop varicose veins. It is thought that female sex hormones contribute to the development of varicose veins by making the veins dilate more easily. Many women experience increased discomfort from varicose veins during their menstrual periods.
- Genetic factors. Some people have veins with abnormally weak walls or valves. They may develop varicose veins even without a rise in blood pressure in the

superficial veins. This characteristic tends to run in families.

- Pregnancy. A woman's total blood volume increases during pregnancy, which increases the blood pressure in the venous system. In addition, the hormonal changes of pregnancy cause the walls and valves in the veins to soften.
- Using birth control pills.
- Obesity. Excess body weight increases the pressure on the veins.
- Occupational factors. People who have jobs that require standing or sitting for long periods of time—without the opportunity to walk or move around—are more likely to develop varicose veins.

### *Ambulatory phlebectomy*

Ambulatory phlebectomy is the most common surgical procedure for treating medium-sized varicose veins, as of early 2008. It is also known as stab avulsion or micro-extraction phlebectomy. An ambulatory phlebectomy is performed under **local anesthesia**. After the patient's leg has been anesthetized, the surgeon makes a series of very small vertical incisions 0.39–1.18 in (1–3 mm) in length along the length of the affected vein. These incisions do not require **stitches** or tape closure afterward. Beginning with the more heavily involved areas of the leg, the surgeon inserts a phlebectomy hook through each micro-incision. The vein segment is drawn through the incision, held with a mosquito clamp, and pulled out through the incision. This technique requires the surgeon to be especially careful when removing varicose veins in the ankle, foot, or back of the knee. The procedure takes about 45–50 minutes.

After all the vein segments have been removed, the surgeon washes the patient's leg with hydrogen peroxide and covers the area with a foam wrap, several layers of cotton wrap, and an adhesive bandage. A compression stocking is then drawn up over the wrapping. The **bandages** are removed three to seven days after surgery, but the compression stocking must be worn for another two to four weeks to minimize bruising and swelling. The patient is encouraged to walk around for 10 or so minutes before leaving the office; this mild activity helps to minimize the risk of a blood clot forming in the deep veins of the leg.

### *Transilluminated powered phlebectomy*

Transilluminated powered phlebectomy (TIPP) is a newer technique that avoids the drawbacks of stab avulsion phlebectomy, which include long operating times, the risk of scar formation, and a relatively high

risk of infection developing in the micro-incisions. Transilluminated powered phlebectomy is performed with an illuminator and a motorized resector. After the patient has been anesthetized with light **general anesthesia**, the surgeon makes only two small incisions: one for the illuminating device and the other for the resector. After making the first incision and introducing the illuminator, the surgeon uses a technique called tumescent anesthesia to plump up the tissues around the veins and make the veins easier to remove. Tumescent anesthesia was originally developed for **liposuction**. It involves the injection of large quantities of a dilute anesthetic into the tissues surrounding the veins until they become firm and swollen.

After the tumescent anesthesia has been completed, the surgeon makes a second incision to insert the resector, which draws the vein by suction toward an inner blade. The suction then removes the tiny pieces of venous tissue left by the blade. After all the clusters of varicose veins have been treated, the surgeon closes the two small incisions with a single stitch or Steri-Strips. The incisions are covered with a gauze dressing and the leg is wrapped in a sterile compression dressing.

## Diagnosis/Preparation

### Diagnosis

Vein ligation and stripping and ambulatory phlebectomies are considered elective cosmetic procedures; they are not performed on an emergency basis. For this reason, patients should check with their insurance provider to see whether these procedures are covered. Costs vary but generally run between \$600 and \$2,000 per leg for the surgeon's fee; anesthesia and hospitalization are extra.

The process of diagnosis may begin with the patient's complaints about the appearance of the legs or of pain and cramps, as well as with the physician's observations. It is important to note that there is no correlation between the size or number of a patient's varicose veins and the amount of pain that is experienced. Some people experience considerable discomfort from fairly small varices, while others may have no symptoms from clusters of extremely swollen varicose veins. If the patient mentions pain, burning sensations, or other physical symptoms, the doctor will need to rule out other possible causes, such as nerve root irritation, osteoarthritis, diabetic neuropathy, or problems in the arterial circulation. Relief of pain when the leg is elevated is the most significant diagnostic sign of varicose veins.

After taking the patient's medical history and a family history of venous disorders, the doctor examines the patient from the waist down to note the location of varicose veins and to palpate (touch with gentle pressure) for signs of other venous disorders. Palpation helps the doctor locate both normal and abnormal veins; further, some varicose veins can be detected by touch even though they cannot be seen through the skin. Ideally, the examiner will have a small raised platform for the patient to stand on during the **physical examination**. The doctor will ask the patient to turn slowly while standing, and will be looking for scars or other signs of trauma, bulges, and areas of discoloration in the skin, or other indications of chronic venous insufficiency. While palpating the legs, the doctor will note areas of unusual warmth or soreness, cysts, and edema (swelling of the soft tissues due to fluid retention). Next, the doctor will percuss (tap on) certain parts of the legs where the larger veins lie closer to the surface. By gently tapping or thumping on the skin over these areas, the doctor can feel if there are any fluid waves in the veins and determine whether further testing for venous insufficiency is required.

The next stage of the diagnostic examination is an evaluation of the valves in the patient's greater saphenous vein. The doctor places a tourniquet around the patient's upper thigh while the patient is lying on the examination table with the leg raised. The patient is then asked to stand on the floor. If the valves in this vein are working properly, the lower superficial veins should not fill up rapidly as long as the tourniquet remains tied. This test is known as Trendelenburg's test. It has, however, been largely replaced by the use of duplex Doppler **ultrasound**, which maps the location of the varicose veins in the patient's leg and provides information about the condition of the valves in the veins. Most insurance companies now also require a Doppler test before authorizing surgical treatment. The doctor's findings will determine whether the greater saphenous vein will require ligation and stripping or endovenous ablation before smaller varicose veins can be treated.

Some disorders or conditions are contraindications for vascular surgery, including:

- cellulitis and other infectious diseases of the skin
- severe edema associated with heart or kidney disease (these disorders should be brought under control before a phlebectomy is performed)
- uncontrolled diabetes
- disorders that affect the immune system, including HIV infection
- severe heart or lung disorders



### Preparation

Patients preparing for vascular surgery are asked to discontinue **aspirin** or aspirin-related products for a week before the procedure. They should not eat or drink after midnight on the day of surgery. They should not apply any moisturizers, creams, tanning lotions, or sun block to the legs on the day of the procedure.

A patient scheduled for an ambulatory phlebectomy should arrive at the surgical center about an hour and a half before the procedure. All clothing must be removed before changing into a hospital gown. The patient is asked to walk up and down in the room or hallway for about 20 minutes to make the veins stand out. The surgeon marks the outlines of the veins with an indelible ink marker on the patient's legs while he or she is standing up. An ultrasound may be done at this point to verify the location and condition of the veins. The patient is then taken into the **operating room** for surgery.

Although patients are encouraged to walk around for a few minutes after an ambulatory phlebectomy, they should make arrangements for a friend or relative to drive them home from the surgical facility.

### Aftercare

Surgical ligation and stripping of the greater saphenous vein usually requires an overnight stay in the hospital and two to eight weeks of **recovery at home** afterward.

Aftercare following surgical treatment of varicose veins includes wearing medical compression stockings that apply either 20–30 mmHg or 30–40 mmHg of pressure for two to six weeks after the procedure. Wearing compression stockings minimizes the risk of edema, discoloration, and pain. Fashion support stockings are a less acceptable alternative because they do not apply enough pressure to the legs.

The elastic surgical dressing applied at the end of an ambulatory phlebectomy should be left in place after returning home. Mild pain-killing medications may be taken for discomfort.

The patient is advised to watch for redness, swelling, pus, fever, and other signs of infection.

Patients are encouraged to walk, ride a bicycle, or participate in other low-impact forms of **exercise** (such as yoga and tai chi) to prevent the formation of blood clots in the deep veins of the legs. They should lie down with the legs elevated above heart level for 15 minutes at least twice a day, and use a foot stool when sitting to keep the legs raised.

### Risks

Vein ligation and stripping carries the same risks as other surgical procedures under general anesthesia, such as bleeding, infection of the incision, and an adverse reaction to the anesthetic. Patients with leg ulcers or fungal infections of the foot are at increased risk of developing infections in the incisions following surgical treatment of varicose veins.

Specific risks associated with vascular surgery include:

- Deep venous thrombosis.
- Bruising. Bruising is the most common complication of phlebectomies, but heals itself in a few days or weeks.
- Scar formation. Phlebectomy has been found to produce permanent leg scars more frequently than sclerotherapy.
- Injury to the saphenous nerve. This complication results in numbness, tingling, or burning sensations in the area around the ankle. It usually goes away without further treatment within six to 12 months.
- Seromas. A seroma is a collection of uninfected blood serum or lymphatic fluid in the tissues. Seromas usually resolve without further treatment, but can be drained by the surgeon, if necessary.
- Injury to the arteries in the thigh and groin area. This complication is extremely rare, but it can have serious consequences. One example is amputation of the leg.
- Leg swelling. This complication is caused by disruption of the lymphatic system during surgery. This lasts about two to three weeks and can be managed by wearing compression stockings.
- Recurrence of smaller varicose veins.

### Normal results

Normal results of vein ligation and stripping, or ambulatory phlebectomy, include reduction in the size and number of varicose veins in the leg. About 95% of patients also experience significant relief of pain.

### Morbidity and mortality rates

The mortality rate following vein ligation and stripping has been reported to be one in 30,000. The incidence of deep venous thrombosis (DVT) following vascular surgery is estimated to be 0.6%.

## Alternatives

### *Conservative treatments*

Patients who are experiencing discomfort from varicose veins may be helped by any or several of the following approaches:

- Exercise. Walking or other forms of exercise that activate the muscles in the lower legs can relieve aching and cramping because these muscles keep the blood moving through the leg veins. One specific exercise that is often recommended is repeated flexing of the ankle joint. Flexing the ankles five to 10 times every few minutes and walking around for one to two minutes every half hour throughout the day helps to prevent the venous congestion that results from sitting or standing in one position for hours at a time.
- Avoiding high-heeled shoes. Shoes with high heels do not allow the ankle to flex fully when the patient is walking. This limitation of the range of motion of the ankle joint makes it more difficult for the leg muscles to contract and force venous blood upwards toward the heart.
- Elevating the legs for 15–30 minutes once or twice a day. This change of position is frequently recommended for reducing edema of the feet and ankles.
- Wearing compression hosiery. Compression benefits the leg veins by reducing inflammation as well as improving venous outflow. Most manufacturers of medical compression stockings now sell some relatively sheer hosiery that looks attractive in addition to providing support.
- Medications. Drugs that have been used to treat the discomfort associated with varicose veins include nonsteroidal anti-inflammatory drugs (NSAIDs) and preparations of vitamins C and E. One prescription medication that is sometimes given to treat circulatory problems in the legs and feet is pentoxifylline, which improves blood flow in the smaller capillaries. Pentoxifylline is sold under the brand name Trender.

If appearance is the patient's primary concern, varicose veins can be partially covered with specially formulated cosmetics that come in a wide variety of skin tones. Some of these preparations are available in waterproof formulations for use during swimming and other athletic activities.

### *Endovenous ablation*

Endovenous ablation refers to two newer and less invasive methods for treating incompetent saphenous veins. In the Closure® method, which was approved by

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Surgical treatment of varicose veins is usually performed by general surgeons or by vascular surgeons, who are trained in the diagnosis and medical management of venous disorders as well as surgical treatment of them. Most vascular surgeons have completed five years of residency training in surgery after medical school, followed by one to two years of specialized fellowship training.

Phlebectomies and endovenous ablation treatments are performed in ambulatory surgery centers as outpatient procedures. Ligation and stripping of the greater saphenous vein, however, is more commonly performed in a hospital as an inpatient operation.

the Food and Drug Administration (FDA) in 1999, the surgeon passes a catheter into the lumen of the saphenous vein. The catheter is connected to a radiofrequency generator and delivers heat energy to the vein through an electrode in its tip. As the tissues in the wall of the vein are heated, they shrink and coagulate, which closes and seals the vein. The temperature inside the wall of the vein is limited to 185°F (85°C) to prevent heat damage to surrounding tissues. Radiofrequency ablation of the saphenous vein has been demonstrated to be safe and at least as effective as surgical stripping of the vein; in addition, patients can return to work the next day. About 95% of patients are satisfied with the procedure and would recommend it to others. The procedure produces good cosmetic results that last at least 5 years; the longer-term effectiveness of radiofrequency ablation, however, is not known, as of 2008. Its chief risk is loss of feeling in a patch of skin about the size of a quarter above the knee. This numbness usually resolves in about six months. One limitation of radiofrequency ablation is that present catheters cannot be used with extremely twisted or crooked veins. The most frequent complication reported with this procedure is deep vein thrombosis.

Endovenous laser treatment, or EVLT, uses a laser instead of a catheter with an electrode to heat the tissues in the wall of an incompetent vein in order to close the vein. Although EVLT appears to be as safe and effective as radiofrequency ablation, patients experience more discomfort and bruising afterward;

## QUESTIONS TO ASK THE DOCTOR

- Can my varicose veins be treated without ligation and stripping?
- Am I a candidate for treatment with EVLT or radiofrequency ablation?
- What specific technique(s) do you perform most frequently?
- Which treatment technique(s) do you recommend and why?
- What are the risks of these techniques?
- Are other patients satisfied with the results?

most require two to three days of recovery at home after laser treatment. EVLT is reported to give as good results as surgery or laser ablation, with a low rate (less than 7%) of varicose vein recurrence after two years. As with radiofrequency ablation, EVLT cannot be used in extremely crooked veins. EVLT is not yet widely used; fewer than 10,000 cases worldwide have been reported, as of 2007. The major side effect that has been described is skin burns.

### Sclerotherapy

Sclerotherapy is a treatment method in which irritating chemicals in liquid or foam form are injected into spider veins or smaller reticular varicosities to close them off. The chemicals cause the vein to become inflamed, and lead to the formation of fibrous tissue and closing of the lumen, or central channel of the vein. Sclerotherapy is sometimes used in combination with other techniques to treat larger varicose veins.

### Complementary and alternative (CAM) treatments

According to Dr. Kenneth Pelletier, former director of the program in complementary and alternative treatments at Stanford University School of Medicine, horse chestnut extract works as well as compression stockings when used as a conservative treatment for varicose veins. Horse chestnut (*Aesculus hippocastanum*) preparations have been used in Europe for some years to treat circulatory problems in the legs; most recent research has been carried out in Great Britain and Germany. The usual dosage is 75 mg twice a day, at meals. The most common side effect of oral preparations of horse chestnut is occasional indigestion in some patients.

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Rebecca Frey, PhD

Venography see **Phlebography**

## Venous thrombosis prevention

### Definition

Venous thrombosis prevention refers to the use of medications, other devices, or behavioral changes to prevent blood clots from forming in veins within the body.



Putting on flight socks before a long flight can help prevent venous thrombosis. (Slick Stock Images / Alamy)

### Purpose

Different preventative methods can also maintain normal blood flow and therefore enable oxygen and nutrients to reach the cells of the body. Blood clots can be painful and can cause serious damage to tissues and organs. Sometimes, they can cause rapid **death**. Blood clot prevention can enhance blood flow and save lives.

### Description

Blood clots can form in any vein within the body. Deep vein thrombosis (DVT) can be quite serious. DVT occurs when a blood clot (thrombus) forms in the legs or pelvis; in a few cases, DVT occurs in the arms. If the thrombus is large enough, it can block the blood flow within the vein, cutting off oxygen to the tissues. An embolus (a clot that breaks away from the wall of the blood vessel) can travel into the lung, the heart, or the brain where it can disrupt the normal functioning of these organs and become life threatening. Some blood clots distend the walls of the blood vessel, creating a sac called an aneurysm. Sometimes the aneurysm bursts, causing blood to leak out. If this occurs within the brain, the heart, or the lungs, it can be fatal.

Venous thrombosis can occur for a number of reasons. There are three large categories of factors that influence the likelihood of DVT: changes in the rate of blood flow; injuries to the tissue lining the inner walls of the veins; and changes in the thickness of the blood or its ability to coagulate. These three categories are known as Virchow's triad, named for Rudolf Virchow (1821–1902), a German physician and pathologist.



Patients with DVT may have disease within the blood vessels such as an inflammation of the walls of the vein (phlebitis) or hereditary blood clotting disorders. The patient may also develop blood clots because of other medical conditions such as heart disease, heart failure, stroke, or cancer. Some drugs used in cancer chemotherapy increase the risk of DVT. Clots can also occur after surgery or prolonged bed rest or inactivity. People who smoke and take oral contraceptives may be more susceptible to blood clots. Pregnancy and childbirth also increase the risk of DVT, as do Crohn's disease and ulcerative colitis. Such autoimmune disorders as systemic lupus erythematosus (SLE) increase the risk of DVT; about 9% of lupus patients develop spontaneous DVT. Last, people who have had surgery to remove or close varicose veins have an increased risk of DVT.

The classical symptoms of DVT include pain, swelling, and redness of the affected leg, and dilation of the surface veins. The doctor can examine the leg for possible DVT by measuring the circumference of both legs at the same point to see whether one is swollen, or palpate (touch with light pressure) the veins in the affected leg to see whether the area is sore or tender. The absence of these signs and symptoms, however, does not mean that the patient does not have DVT. As of 2008, there is no laboratory blood test that can definitely confirm or exclude a diagnosis of DVT.

Pulmonary embolism (PE) is one of the most common, but highly fatal, types of blood clots that patients experience. Sometimes there is little or no warning, causing sudden death. On the other hand, some doctors think that cases of DVT and PE are underdiagnosed; one researcher estimates that one of every 9 persons in the United States develops recognized DVT before the age of 80. Studies of autopsies indicate that approximately 80% of all cases of DVT and PE remain undiagnosed even when they are the immediate cause of death. About 90% of pulmonary embolisms are the result of DVT in the legs or the pelvis; the clot moves into the lung and blocks the pulmonary artery. Most often, the DVT occurs in the recovery period after surgery, though there is an alarming trend of DVT events that are the result of airline travel. In 1999, nearly 2,000 Americans, many of them young and fit, died from travel-related DVT strokes. In 2003, NBC reporter David Bloom, who was embedded with the United States Army as he covered the war in Iraq, died of a pulmonary embolism due to his riding in a cramped position for long hours over several days.

## KEY TERMS

**Aneurysm**—A sac created by the distention of the walls of a blood vessel.

**Embolus**—A clot that breaks away from the wall of the blood vessel and travels throughout the body.

**Phlebitis**—An inflammation of the walls of a vein.

**Prophylaxis**—A measure designed to preserve health and/or prevent the spread of disease.

**Thrombus**—A clot that forms within a blood vessel and remains attached to its place of origin.

**Venous thrombosis**—The formation or presence of a blood clot in a vein.

**Virchow's triad**—Three categories of factors that affect a patient's risk of venous thrombosis: alterations in the rate of blood flow; injuries to the tissue lining the walls of the veins; and alterations in the blood's ability to coagulate.

## Prevention methods

There are several methods physicians use to prevent blood clots. Some use medications, others use mechanical means, and still others require behavioral changes, or a combination of all of these.

### *Heparin and other blood thinners*

Anticoagulants (blood thinners) such as heparin are often prescribed as prophylactics for venous thrombosis. These drugs decrease the clotting ability of the blood. A study published in 2008 indicates that anticoagulant prophylaxis prevents about 48% of cases of DVT. There has been very good success combining heparin and pneumatic compression stockings, especially for colorectal and cardiac surgery patients.

There are some precautions, however, for using this drug. People who have had an unusual reaction to the drug should not take it, as well as those with allergies to beef and pork. Women who are pregnant and nursing should only use anticoagulants with caution. In addition, certain medications should not be used with heparin. They include **aspirin**, hyperthyroid medication, and drugs for pain or inflammation.

### *Mechanical leg pumps (pneumatic compression stockings)*

Mechanical stimulation of the calf muscles of the leg can help stimulate blood flow. Many hospitals require all surgery patients, especially those who

have abdominal or cardiac surgery, to wear pneumatic compression stockings. These devices wrap around the lower leg from ankle to the knee, and some reach as high as the thigh. When plugged in and turned on, a pneumatic device pumps air into chambers within the stocking, which gently tighten around the legs for a few seconds and then are released. This pulsing massage keeps the blood flowing and discourages venous thrombosis.

### **Compression stockings**

Often physicians recommend compression stockings for patients to prevent DVT and edema, and to treat varicose veins and phlebitis. Graduated compression stockings apply more pressure at the ankle and less up the leg and closer to the knee. This pressure prevents backflow of blood and clot formation. A controlled trial to measure the effectiveness of compression stockings in preventing DVT is underway in Canada, as of the summer of 2007.

### **Exercise**

Sitting for long periods or being confined to bed after surgery or during a long illness can slow blood flow, allowing clots to form. As soon as possible after surgery, the patient should move the legs, stand, and begin taking short walks. Travelers or people who work sitting at a desk or computer for several hours at a time should take a break every hour to get up and move around. People can also do such specific exercises as ankle circles or leg lifts while sitting in the confines of an airplane or lying in bed.

### **Fluids**

It is important not to restrict fluids when recovering from surgery, traveling, or working for long periods in a seated position. Not only will the body be kept hydrated, but drinking fluids will help prevent venous thrombosis. Drinking fluids keeps the blood liquid and moving, discouraging clot formation. Travelers should drink something every hour. This may be difficult since some air carriers may not have frequent beverage service.

### **Preparation**

The most important preparation that the patient can do is discuss his or her own personal risk of developing blood clots with a physician. If medication is given, the patient should be instructed how to take it and what side effects to look for. Special exercises should be explained to the patient, and a daily walk should be encouraged.

### **Normal results**

Any of these prevention methods can help a patient avoid having a blood clot after surgery or during long periods of inactivity such as bed rest or while traveling. Travelers and sedentary workers may find moving around and drinking fluids are the best methods for them to prevent blood clots. For patients recovering from surgery, however, a combination of methods is usually necessary. Pneumatic compression pumps with or without a round of heparin may be the best option for surgery patients.

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Ventilation see **Mechanical ventilation**

## Ventricular assist device

### Definition

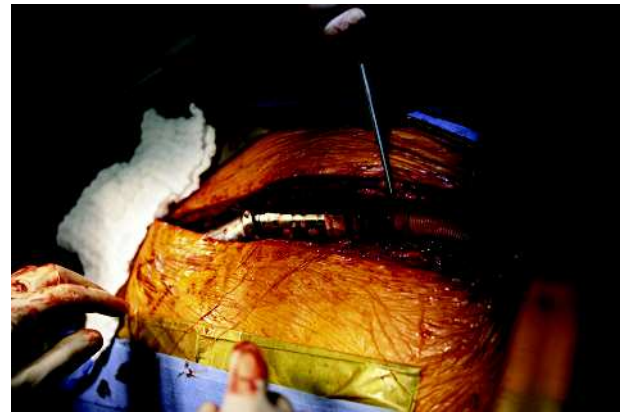
A ventricular assist device (VAD) is a battery-operated mechanical system consisting of a blood pump and a control unit used for temporary support of blood circulation. The VAD decreases the workload of the heart while maintaining adequate blood flow and blood pressure.

### Purpose

A VAD is a temporary life-sustaining device. VADs can replace the left ventricle (LVAD), the right ventricle (RVAD), or both ventricles (BIVAD). They are used when the heart muscle is damaged and needs to rest in order to heal, or when blood flow from the heart is inadequate. In November 2002, the Food and Drug Administration (FDA) approved the use of one type of LVAD as a form of permanent treatment for patients who are ineligible for a heart transplant. VADs can also be used as a bridge in patients awaiting **heart transplantation** or in patients whose bodies have rejected a transplanted heart.

Examples of patients who might be candidates for a VAD are those who:

- have suffered a massive heart attack
- cannot be weaned from heart-lung bypass after treatment with intravenous fluids, medications, and insertion of a balloon pump in the aorta
- have an infection in the heart wall that does not respond to conventional treatment
- are awaiting a heart transplant and are unresponsive to drug therapy and intravenous fluids
- are undergoing high-risk procedures to clear blockages in a coronary artery



**A ventricular assist device being removed.** (Michelle Del Guercio / Photo Researchers, Inc.)

Although one in five people suffer left-side ventricular failure, only a minority are candidates for VADs. To be considered for a VAD, patients must meet specific criteria with regard to blood flow, blood pressure, and general health.

### Demographics

About 40,000 people in the United States need a heart from a compatible donor, but only 2,200 donor hearts become available each year; hence there is a great need for mechanical devices that can keep patients alive during the wait for transplantation.

VADs are available to all patients in cardiovascular crisis, but their use is contraindicated in patients with:

- irreversible renal failure
- severe peripheral vascular disease
- irreversible brain damage
- cancer that has spread (metastasized)
- severe liver disease
- blood clotting disorders
- severe lung disease
- infections that do not respond to antibiotics
- advanced age

### Description

A VAD is selected based on specific patient criteria, including the patient's size; the length of time that support will be needed; the amount of support (total or partial) required; and the type of flow desired (pulsatile or continuous). Different heart problems require different types of flow.

## KEY TERMS

**Anticoagulant**—A type of medication given to prevent the formation of blood clots in the circulatory system.

**Aorta**—The main artery in humans and other mammals, arising from the left ventricle of the heart.

**Artery**—A blood vessel that carries blood from the heart to other parts of the body.

**Coronary blood vessels**—The arteries and veins that supply blood to the heart muscle.

**Pulmonary artery**—The major artery that carries blood from the right ventricle of the heart to the lungs.

**Ventricles**—The two thickly walled lower chambers of the heart that receive blood from the upper chambers and send it into the major arteries.

A VAD is implanted under **general anesthesia** in a hospital **operating room**. After the patient has been anesthetized, the surgeon makes an incision in the chest. He or she then inserts a catheter into the jugular vein in the neck. The catheter is threaded through the pulmonary artery, which carries blood from the right ventricle of the heart to the lungs. The catheter is used to measure the oxygen levels in the blood and to administer medications. A urinary catheter is also inserted and used to measure the output of urine. The surgeon sutures the catheters in place, then attaches tubing to connect the catheters to the VAD's pump. Once the pump is turned on, blood flows out of the diseased ventricle and into the pump. The blood is then returned to the proper artery; an LVAD is connected to the aorta, which leaves the heart from the left ventricle, whereas an RVAD is connected to the pulmonary artery. After the VAD has been implanted, the surgeon closes the incisions in the heart and the chest wall. The complete operation may take several hours.

### Preparation

VADs are used in patients who have not benefited from other forms of treatment for heart disease. In order to evaluate a patient's eligibility for a VAD, the doctor will use **cardiac catheterization** to demonstrate poor cardiac function and make pressure measurements of the chambers in the patient's heart. Blood samples are drawn in order to measure the levels of blood cells and electrolytes in the patient's circulation.

Monitoring of the heart includes an **electrocardiogram** (EKG) as well as measurements of arterial and venous blood pressures.

### Aftercare

After a VAD implant, the patient is monitored in an **intensive care unit** (ICU) with follow-up laboratory studies. He or she will remain in the hospital for at least five to seven days. A breathing tube may be left in place until the patient is awake and able to breathe comfortably. Anticoagulant (blood thinning) medications are given to prevent the formation of blood clots, and **antibiotics** are given to prevent infections.

Patients are slowly and gradually weaned from the VAD, except for those patients awaiting a heart transplant or approved for long-term use of the VAD. As the patient improves, he or she will begin a regular **exercise** program. Some VADs require drive lines connected to the control console that penetrate the chest or abdominal cavity. These connections must be cleansed and bandaged to prevent infection of the device. With appropriate training, the patient can continue treatment at home, returning to the hospital only when necessary.

Fully implanted VADs do not require the patient to remain connected to a bedside control console and power unit. He or she will need to carry battery packs in a waistband or shoulder harness, however. In addition, some fully implanted VADs require the patient to plug a cord attached to their body into an electrical outlet at night.

### Risks

VAD insertion carries risks of severe complications. Bleeding from the surgery is common; it occurs in as many as 30–50% of patients. Other complications include the development of blood clots; partial paralysis of the diaphragm; respiratory failure; kidney failure; failure of the VAD; damage to the coronary blood vessels; stroke; and infection.

An additional risk is physical dependency on the device. If VADs are inserted in both ventricles, the heart may become so dependent that the patient cannot be weaned from ventricular support.

In addition to physical complications, many patients find that their emotions and cognitive functions are affected by the implantation procedure. Depression, mood swings, and memory loss are not unusual in patients with VADs.



## WHO PERFORMS THIS PROCEDURE AND WHERE IS IT PERFORMED?

A VAD is implanted by a cardiothoracic surgeon. A cardiothoracic surgeon is a physician who has completed medical school followed by an internship and residency program for specialized training in cardiac and thoracic surgery.

VADs are implanted in hospitals that are equipped to handle cardiopulmonary bypass procedures, with surgeons that have been trained in the specific techniques required by a given type of VAD. The cost of supplies and the special training required limit the type and number of devices that can be implanted in a specific hospital. Patients are transported to specialized transplant centers for continued support and treatment if their heart function is not expected to return to normal.

### Normal results

Because VADs are used in the treatment of critically ill patients, outcomes vary widely according to the state of the patient's health before treatment. The signs of a successful implant include normal cardiac output with normal blood pressure and systemic and pulmonary vascular resistance.

If the patient is a candidate for a heart transplant, a successful VAD transplant may allow him or her to continue treatment at home. The goal of this extended support is to survive the wait for a donor organ. As many as 5% of patients with implanted VADs may recover an adequate level of heart muscle function, however, and avoid the need for a heart transplant.

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## QUESTIONS TO ASK THE DOCTOR

- What types of VAD are available for implant at your institution?
- Which of these devices have you been trained to implant?
- What is the success rate for VAD patients at your hospital?
- What institutions are available for transport for patients waiting for a heart transplant?

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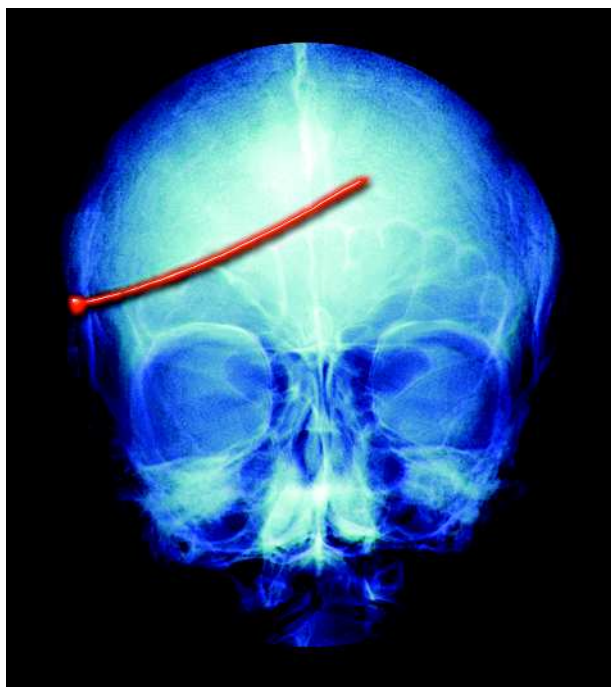
## Ventricular shunt

### Definition

A ventricular shunt is a tube that is surgically placed in one of the fluid-filled chambers inside the brain (ventricles). The fluid around the brain and the spinal column is called cerebrospinal fluid (CSF). When infection or disease causes an excess of CSF in the ventricles, the shunt is placed to drain it and thereby relieve excess pressure.

### Purpose

A ventricular shunt relieves hydrocephalus, a condition in which there is an increased volume of CSF within the ventricles. In hydrocephalus, pressure from the CSF usually increases. It may be caused by a tumor of the brain or of the membranes covering the brain (meninges), infection of or bleeding into the CSF, or



**An x ray of a skull with a ventricular shunt.** (Living Art Enterprises, LLC / Photo Researchers, Inc.)

inborn malformations of the brain. Symptoms of hydrocephalus may include headache, personality disturbances and loss of intellectual abilities (dementia), problems in walking, irritability, vomiting, abnormal eye movements, or a low level of consciousness.

Normal pressure hydrocephalus (a condition in which the volume of CSF increases without an increase in pressure) is associated with progressive dementia, problems walking, and loss of bladder control (urinary incontinence). Even though CSF is not thought to be under increased pressure in this condition, it may also be treated by ventricular shunting.

### Demographics

The congenital form of hydrocephalus is believed to occur at an incidence of approximately one to four out of every 1,000 births. The incidence of acquired hydrocephalus is not exactly known. The peak ages for the development of hydrocephalus are in infancy, between four and eight years, and in early adulthood. Normal pressure hydrocephalus generally occurs in patients over the age of 60.

### Description

The ventricular shunt tube is placed to drain fluid from the ventricular system in the brain to the cavity of the abdomen or to the large vein in the neck (jugular

## KEY TERMS

**Cerebrospinal fluid**—Fluid bathing the brain and spinal cord.

**Computed tomography (CT) scan**—An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

**Dementia**—Progressive loss of mental abilities.

**Magnetic resonance imaging (MRI)**—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

vein). Therefore, surgical procedures must be done both in the brain and at the drainage site. The tubing contains valves to ensure that fluid can only flow out of the brain and not back into it. The valve can be set at a desired pressure to allow CSF to escape whenever the pressure level is exceeded.

A small reservoir may be attached to the tubing and placed under the scalp. This reservoir allows samples of CSF to be removed with a syringe to check the pressure. Fluid from the reservoir can also be examined for bacteria, cancer cells, blood, or protein, depending on the cause of hydrocephalus. The reservoir may also be used to inject **antibiotics** for CSF infection or chemotherapy medication for meningeal tumors.

### Diagnosis/Preparation

The diagnosis of hydrocephalus should be confirmed by diagnostic imaging techniques, such as computed tomography scan (CT scan) or **magnetic resonance imaging (MRI)**, before the shunting procedure is performed. These techniques will also show any associated brain abnormalities. CSF should be examined if infection or tumor of the meninges is suspected. Patients with dementia or mental retardation should undergo neuropsychological testing to establish a baseline psychological profile before the shunting procedure.

As with any surgical procedure, the surgeon must know about any medications or health problems that may increase the patient's risk. Because infections are both common and serious, antibiotics are often given before and after surgery.

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Ventricular shunting is performed in a hospital operating room by a neurosurgeon, a surgeon who specializes in the treatment of diseases of the brain, spinal cord, and nerves.

### Aftercare

To avoid infections at the shunt site, the area should be kept clean. CSF should be checked periodically by the doctor to be sure there is no infection or bleeding into the shunt. CSF pressure should be checked to be sure the shunt is operating properly. The eyes should be examined regularly because shunt failure may damage the nerve to the eyes (optic nerve). If not treated promptly, damage to the optic nerve causes irreversible loss of vision.

### Risks

Serious and long-term complications of ventricular shunting are bleeding under the outermost covering of the brain (subdural hematoma), infection, stroke, and shunt failure. When a shunt drains to the abdomen (ventriculoperitoneal shunt), fluid may accumulate in the abdomen or abdominal organs may be injured. If CSF pressure is lowered too much, patients may have severe headaches, often with nausea and vomiting, whenever they sit up or stand.

### Normal results

After shunting, the ventricles get smaller within three or four days. This shrinkage occurs even when hydrocephalus has been present for a year or more. Clinically detectable signs of improvement occur within a few weeks. The cause of hydrocephalus, duration of hydrocephalus before shunting, and associated brain abnormalities affect the outcome.

Of patients with normal pressure hydrocephalus who are treated with shunting, 25–80% experience long-term improvement. Normal pressure hydrocephalus is more likely to improve when it is caused by infection of or bleeding into the CSF than when it occurs without an underlying cause.

### Morbidity and mortality rates

Complications of shunting occur in 30% of cases, but only 5% are serious. Infections occur in 5–10% of

## QUESTIONS TO ASK THE DOCTOR

- Why is a ventricular shunt recommended in my case?
- What is the cause of the hydrocephalus?
- What diagnostic tests will be performed prior to the shunt being placed?
- Where will the shunt be placed?
- Are there any alternatives to a ventricular shunt?

patients, and as many as 80% of shunts develop a mechanical problem at some point and need to be replaced.

### Alternatives

In some cases of hydrocephalus, certain drugs may be administered to temporarily decrease the amount of CSF until surgery can be performed. In patients with hydrocephalus caused by a tumor, removal of the tumor often cures the buildup of CSF. Approximately 25% of patients respond to therapies other than shunt placement.

Patients with normal pressure hydrocephalus may experience a temporary improvement in walking and mental abilities upon the temporary drainage of a moderate amount of CSF. This improvement may be an indication that shunting will improve their condition.

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## Vertical banded gastroplasty

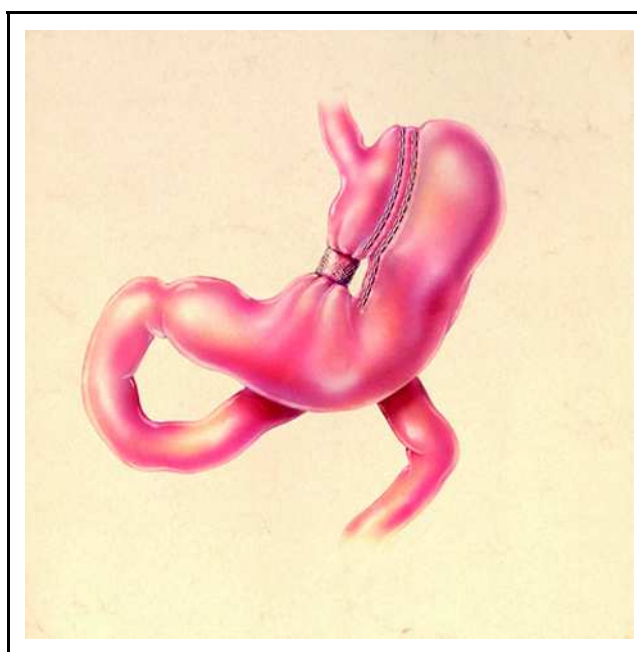
### Definition

Vertical banded gastroplasty, or VBG, is an elective surgical procedure in which the stomach is partitioned with **staples** and fitted with a plastic band to limit the amount of food that the stomach can hold at one time. Gastroplasty is a term that comes from two Greek words, *gaster*, or "stomach," and *plassein*, "to form or shape." Stomach stapling, also known as VBG, is part of a relatively new surgical subspecialty called bariatric surgery. The word "bariatric" is also derived from two Greek words, *barys*, which means "heavy," and *iatros*, which means "healer." A restrictive bariatric procedure, VBG controls the amount of food that the stomach can hold—in contrast to mal-absorptive surgeries, in which the food is rerouted within the digestive tract to prevent complete absorption of the nutrients in the food.

### Purpose

The purpose of VBG is the treatment of morbid (unhealthy) obesity. It is one of the first successful procedures in bariatric surgery. VBG was developed in its present form in 1982 by Dr. Edward E. Mason, a professor of surgery at the University of Iowa.

Bariatric surgery in general is important in the management of severe obesity because it is the only method, as of 2008, that has demonstrated long-term success in the majority of patients. Weight reduction diets, **exercise** programs, and appetite suppressant medications have had a very low long-term success rate in managing morbid obesity. Most people who try to lose weight on reduced-calorie diets regain two-thirds of the weight lost within one year; within five



Vertical banded gastroplasty

**Vertical banded gastroplasty.** (PHOTOTAKE Inc. / Alamy)

years, they have gained more weight in addition to all the weight they had lost previously. Appetite suppressants often have undesirable or harmful side effects, as well as having a low rate of long-term effectiveness; in 1997, the Food and Drug Administration (FDA) banned the sale of fenfluramine and phentermine ("fen-phen") when these substances were discovered to cause damage to heart valves.

Obesity is a major health problem not only because it is widespread in the American population—as of 2008, 35% of adults in the United States meet the National Institutes of Health (NIH) criteria for obesity—but because it greatly increases a person's risk of developing potentially life-threatening disorders. Obesity is associated with type 2 (non-insulin-dependent) diabetes, hypertension, abnormal blood cholesterol levels, liver disease, coronary artery disease, sleep apnea syndrome, and certain types of cancer. In addition to these disorders, obesity is a factor in what has been called lifestyle-limiting conditions. These conditions are not life-threatening, but they can have an enormous impact on people's day-to-day lives, particularly in their relationships and in the working world. Lifestyle-limiting conditions related to obesity include osteoarthritis and gout; urinary stress incontinence; heartburn; skin disorders caused by heavy perspiration accumulating in folds of skin; leg swelling and varicose veins; gallstones; and abdominal hernias. Obese women frequently suffer from irregular menstrual



## KEY TERMS

**Appetite suppressant**—A medication given to reduce the desire to eat.

**Bariatrics**—The branch of medicine that deals with the prevention and treatment of obesity and related disorders.

**Body mass index (BMI)**—A measurement that has replaced weight as the preferred determinant of obesity. The BMI can be calculated (in American units) as 703.1 times a person's weight in pounds divided by the square of the person's height in inches.

**Comorbid**—A term applied to a disease or disorder that occurs at the same time as another disease condition. There are a number of health problems that are comorbid with obesity.

**Dehiscence**—A separation or splitting apart. In a vertical banded gastroplasty, dehiscence refers to the coming apart of the line of staples used to form the stomach pouch.

**Gastric pacing**—An experimental form of obesity surgery in which electrodes are implanted in the muscle of the stomach wall. Electrical stimulation paces the timing of stomach contractions so that the patient feels full on less food.

**Hernia**—The protrusion of a loop or piece of tissue through an incision or abnormal opening in other tissues. Incisional hernias sometimes occur after open VBGs.

**Laparoscope**—An instrument that allows a doctor to look inside the abdominal cavity. A less invasive form of VBG can be performed with the help of a laparoscope.

**Malabsorptive**—A type of bariatric surgery in which a part of the stomach is partitioned off and connected to a lower portion of the small intestine in order to reduce the amount of nutrients that the body absorbs from the food.

**Morbid**—Unwholesome or bad for health. Morbid obesity is a condition in which the patient's weight is a very high risk to his or her health. The NIH (National Institutes of Health) prefers the term "severely obese" to "morbidly obese."

**Obesity**—Excessive weight gain due to accumulation of fat in the body, sometimes defined as a BMI (body mass index) of 30 or higher, or body weight greater than 30% above one's desirable weight on standard height-weight tables.

**Prevalence**—The number of cases of a disease or disorder that are present in a given population at a specific time.

**Restrictive**—A type of bariatric surgery that works by limiting the amount of food that the stomach can hold. Vertical banded gastroplasty is a restrictive procedure.

**Sleep apnea syndrome**—A disorder in which the patient's breathing temporarily stops at intervals during the night due to obstruction of the upper airway. People with sleep apnea syndrome do not get enough oxygen in their blood and often develop heart problems.

**Stricture**—An abnormal narrowing of a body canal or opening. Sometimes strictures form near the plastic band in a VBG. A stricture may also be called a stenosis.

periods and infertility. Finally, societal prejudice against obese people is widespread and frequently mentioned as a source of acute psychological distress. Surgical treatment of obesity has been demonstrated to relieve emotional pain as well as to reduce risks to the patient's physical health.

### Demographics

Like other procedures in bariatric surgery, VBG is performed only on patients who are severely or morbidly obese by NIH standards. Severe obesity is presently defined as a body mass index (BMI) of 35 or higher. Nonetheless, it is the epidemic with the greatest prevalence in the United States, as of 2003. One out of

every 20 adults, or 15 million people in the United States, has a BMI greater than 35. In addition to the increase in the sheer number of people defined as obese between 1986 and 2000, the increase in those defined as morbidly obese (BMI > 40) or super-obese (BMI > 50) has risen even faster. According to the American Society for Bariatric Surgery (ASBR), while the prevalence of obesity in the United States doubled between 1986 and 2000, the prevalence of morbid obesity quadrupled and the prevalence of super-obesity increased fivefold.

At present, few figures are available regarding the number of VBGs performed in the United States each year compared with other types of obesity surgery,

although there is evidence that the number of VBGs has steadily declined each year since 1991. The International Bariatric Surgery Registry (IBSR) at the University of Iowa is presently compiling a database to monitor the outcomes of different procedures and to analyze statistical data about patients undergoing obesity surgery. In 2000, the IBSR analyzed data on a group of 14,641 people who had had obesity surgery as of 1998. The patients weighed an average of 280 lb (127 kg) at the time of surgery and had an average BMI of 46. Slightly less than 20% of the patients had BMIs between 35 and 39.9; 76.1% had BMIs of 40 or higher.

## Description

There are two major types of VBG—open, which is the older of the two procedures; and the laparoscopic VBG, which is performed through very small incisions with the help of special instruments.

### *Open vertical banded gastroplasty*

The open VBG is done under **general anesthesia**. In most cases, it takes one to two hours to perform. The surgeon makes an incision several inches long in the patient's upper abdomen. After cutting through the layers of tissue over the stomach, the surgeon cuts a hole, or "window," into the upper part of the stomach a few inches below the esophagus. The second step involves placing a line of surgical staples from the window in the direction of the esophagus, which creates a small pouch at the upper end of the stomach. The surgeon must measure the size of this pouch very carefully; when completed, it is about 10% of the size of a normal stomach and will hold about a tablespoon of solid food.

After forming the pouch and checking its size, the surgeon takes a band made out of polypropylene plastic and fits it through the window around the outlet of the stomach pouch. The vertical band is then stitched into place. Because the polypropylene does not stretch, it holds food in the stomach longer, which allows the patient to feel full on only a small amount of food.

Following the placement of the band, the surgeon will check to make sure that there is no leakage around the window and the line of surgical staples. The area of surgery will then be washed out with a sterile saline solution and the incision closed.

### *Laparoscopic vertical banded gastroplasty*

A laparoscopic vertical banded gastroplasty, or LVBG, is performed with the help of a bariatric laparoscope. A laparoscope is a small tube, 0.39 in (10 mm) in diameter, that holds a fiberoptic cable that allows

the surgeon to view the inside of the abdominal cavity on a high-resolution video screen and record the operation on a video recorder. In a laparoscopic VBG, the surgeon makes three small incisions on the left side of the abdomen for inserting the laparoscope, and a fourth incision about 2.5 in (14 cm) long on the right side. The formation of the stomach pouch and insertion of the plastic band are done through these small incisions. Because it is more difficult for the surgeon to maneuver the instruments through the small openings, an LVBG takes longer than an open VBG, about two to four hours.

A laparoscopic VBG requires that the surgeon spend more training and practice than with an open VBG. In the event of complications developing during a laparoscopic VBG, the surgeon usually completes the operation using the open procedure.

## Diagnosis/Preparation

### *Diagnosis*

**DETERMINATION OF OBESITY.** The diagnosis of a patient for bariatric surgery begins with measuring the degree of the patient's obesity. This measurement is crucial because the NIH and almost all health insurers have established specific limits for approval of bariatric procedures.

The obesity guidelines that are cited most often were drawn up by Milliman and Robertson, a nationally recognized company that establishes medical need for a wide variety of procedures for health insurers. The Milliman and Robertson criteria for a patient to qualify for weight loss surgery include:

- Be least 100 lb (45 kg) over ideal weight, as defined by life insurance tables; have a BMI of 40 or higher; or have a BMI over 35 with a coexisting serious medical condition (for example: severe diabetes or coronary artery disease).
- Demonstrate failure to lose or regain of weight despite having tried a multidisciplinary weight control program.
- Have another cause of obesity, such as an endocrine disorder.
- Have attained full adult height.

The patient must be treated not only by a doctor with special training in obesity surgery, but in a comprehensive program that includes preoperative psychological screening and medical examination; nutritional counseling; exercise counseling; and participation in support groups.

There are several ways to measure obesity. Some are based on the relationship between a person's

height and weight. The older measurements of this correlation are the so-called height-weight tables that listed desirable weights for a given height. The limitation of height-weight tables is that they do not distinguish between weight of human fatty tissue and weight of lean muscle tissue—many professional athletes and bodybuilders are overweight by the standards of these tables. A more accurate measurement of obesity is body mass index, or BMI. The BMI is an indirect measurement of the amount of body fat. The BMI is calculated in American measurements by multiplying a person's weight in pounds by 703.1, then dividing that number by the person's height in inches squared. A BMI between 19 and 24 is considered normal; 25–29 is overweight; 30–34 is moderately obese; 35–39 is severely obese; 40 or higher is defined as morbidly obese; and 50 or higher is super-obese.

More direct methods of measuring body fat include measuring the thickness of the skinfold at the back of the upper arm, and bioelectrical impedance analysis (BIA). Bioelectrical impedance measures the total amount of water in the body, using a special instrument that calculates the different degrees of resistance to a mild electrical current in different types of body tissue. Fatty tissue has a higher resistance to the current than body tissues containing larger amounts of water. A higher percentage of body water indicates a greater amount of lean tissue.

**PSYCHOLOGICAL EVALUATION.** Psychiatric and psychological screening before a VBG is done to evaluate the patient's emotional stability and to ensure the expectations of the results of weight loss are not unrealistic. Because of social prejudice against obesity, some obese people who have felt isolated from others or suffered job discrimination come to think of weight loss surgery as a magical or quick solution to all the problems in their lives. In addition, the surgeon will want to make sure that the patient understands the long-term lifestyle adjustments that are necessary after surgery, and that the patient is committed to making those changes. A third reason for a psychological assessment before a VBG is to determine whether the patient's eating habits are compulsive; these would be characterized by the persistent and irresistible impulse to eat from unknown or unconscious purposes. Compulsive eating is not a reason for not having weight loss surgery, but it does mean that the psychological factors contributing to the patient's obesity will also require treatment.

**OTHER TESTS AND EXAMINATIONS.** Patients must have a complete **physical examination** and blood tests before being considered for a VBG. Some bariatric surgeons will not accept patients with histories of

major psychiatric illness; alcohol or drug abuse; previous abdominal surgery; or collagen vascular diseases, which include systemic lupus erythematosus (SLE) and rheumatoid arthritis. Many will not accept patients younger than 16 or older than 55, although some surgeons report successful VBGs in patients over 70. In any event, the patient will need to provide documentation of physical condition, particularly comorbid diseases or disorders, to their insurance company.

### *Preparation*

Preparation for bariatric surgery requires more attention to certain matters than most other forms of surgery requiring hospitalization.

**HEALTH INSURANCE ISSUES.** Both bariatric surgeons and people who have had weight loss surgery report that obtaining preauthorization for a VBG from insurance companies is a lengthy, complicated, and frequently frustrating process. Insurance companies tend to reflect the prejudices against obese people that exist in the wider society. In addition, bariatric surgery is expensive—between \$20,000 and \$35,000 per procedure, according to the National Institutes of Health. Although this situation is slowly changing because of increasingly widespread recognition of the high costs of obesity-related diseases, people considering a VBG should start early to secure approval for their operation.

**LIFESTYLE CHANGES.** A VBG requires a period of **recovery at home** after **discharge from the hospital**. Since the patient's physical mobility will be limited, the following should be done before the operation:

- Arrange for leave from work, assistance at home, help with driving, and similar tasks and commitments.
- Obtain a handicapped parking permit.
- Check the house or apartment thoroughly for needed adjustments to furniture, appliances, lighting, and personal conveniences; specific recommendations include the purchase of a shower chair and toilet seat lift. People recovering from bariatric surgery must minimize bending, stooping, and any risk of falling.
- Stock up on prescription medications, nonperishable groceries, cleaning supplies, and similar items to minimize shopping. Food items should include plenty of clear liquids (juices, broth, soups) and soft foods (oatmeal and other cooked cereals, gelatin dessert mixes).

- Have a supply of easy-care clothing with elastic waistbands and simple fasteners. Shoes should be slip-ons or fastened with Velcro.
- Take “before” photographs prior to the operation, and make a written record of body measurements. These should include measurements of the neck, waist, wrist, widest part of hips, bust or chest, knees, and ankles, as well as shoe size. The pre-operation photographs and measurements help to document the rate and amount of weight lost. Patients who have had weight loss surgery also point out that these records serve to boost morale by allowing the patient to measure progress in losing weight after the surgery.

#### PRE-OPERATION CLASSES AND SUPPORT GROUPS.

In line with the Milliman and Robertson guidelines, most bariatric surgeons now have “preop” classes and ongoing support groups for patients scheduled for VBG and other types of bariatric surgery. Facilitators of these classes can answer questions regarding preparation for the operation and what to expect during recovery, particularly about changes in eating patterns. In addition, they provide opportunities for patients to share concerns and experiences. Patients who have attended group meetings for weight loss surgery often report that simply sharing accounts of the effects of severe obesity on their lives strengthened their resolve to have the operation. In addition, clinical studies indicate that patients who have attended preop classes are less anxious before surgery and generally recover more rapidly.

**MEDICAL PREPARATION.** Patients scheduled for a gastroplasty are advised to eat lightly the day before surgery. The surgeon will provide specific instructions about taking medications prescribed for other health conditions. The patient will be given pre-operation medications that usually include a laxative to clear the lower digestive tract, an anti-nausea drug, and an antibiotic to lower the risk of infection. Some surgeons ask patients to shower on the morning of their surgery with a special antiseptic skin cleanser.

### Aftercare

Aftercare following a gastroplasty has long-term as well as short-term aspects.

#### *Short-term aftercare*

Patients who have had an open VBG usually remain in the hospital for four to five days after surgery; those who have had a laparoscopic VBG may return home after two to three days. Aftercare in the hospital typically includes:

- Pain medication. After returning from surgery, patients are given a patient-controlled anesthesia, or PCA device. The PCA is a small pump that delivers a dose of medication into the IV when the patient pushes a button.
- Clear fluids. Inpatient food is limited to a liquid diet following a VBG.
- Oxygen treatment and breathing exercises to get the patient’s lungs back into shape. Patients are encouraged to get out of bed and walk around as soon as possible to prevent pneumonia.
- Regular change of surgical dressings. Patients may be given additional dressings for use at home, if needed.

#### *Long-term aftercare*

Long-term aftercare includes several adjustments to the patient’s lifestyle:

- Slow progression from consuming foods and liquids to eating a normal diet. For the first two weeks after surgery, the patient is limited to liquids and foods that have been pureed in a blender. The reintroduction of solid foods takes place gradually over several months. In addition, patients sometimes have unpredictable reactions to specific foods; most of these resolve over time.
- Lifelong changes in eating habits. Patients who have had a VBG must learn to chew food thoroughly and to eat slowly to reduce the risk of nausea and vomiting. They must also be careful to avoid eating too many soft foods or sweets, to reduce the risk of regaining weight.
- A minimum of five years of follow-up visits to the surgeon to monitor weight maintenance and other health concerns. Patients considering bariatric surgery should choose a surgeon with whom they feel comfortable, as they are making a long-term commitment to aftercare with this professional.
- Ongoing support group meetings to deal with the physical and psychological aftereffects of surgery and weight loss.
- Beginning and maintaining an appropriate exercise program.

### Risks

Patients who undergo a VBG are at risk for some of the same complications that may follow any major operation, including **death**, pulmonary embolism, the formation of blood clots in the deep veins of the leg, and infection of the surgical incision. These risks are increased for severely obese patients; for example, the



risk of infection is about 10% for obese patients compared to 2% for patients of normal weight. With specific regard to VBGs, recent studies indicate that the risks of complications after surgery are about the same for open and laparoscopic VBGs. The ASBR reported in 2005 that about 5% of VBGs result in complications; the mortality rate is 0.1%.

### *Specific risks of VBGs*

Specific risks associated with vertical banded gastroplasty include:

- **Incisional hernia.** An incisional hernia is the protrusion of a loop or piece of tissue through a reopened incision. It results from the stress placed on the stitches holding the incision closed in extremely obese patients. Most can be repaired by resuturing the incision. Incisional hernias are more likely to occur with open VBGs than with laparoscopic procedures.
- **Dehiscence.** Dehiscence is the medical term for splitting open; it can occur in a VBG if the staples forming the pouch at the upper end of the stomach come loose.
- **Nausea and vomiting.** Nausea and vomiting usually result from eating more food than the stomach pouch can hold, or eating the food too quickly. In most cases, the vomiting disappears as the patient learns different eating habits.
- **Formation of a stricture at the site of the plastic band.** A stricture is an abnormal narrowing of a body canal or opening. It is also called a stenosis.
- **Lodging of a food particle, pill, or capsule within the band or ring.** If the object does not move further down the digestive tract within 24 hours, it must be removed by an endoscope.
- **Damage to the spleen.** The spleen lies very close to the stomach and can be injured in the process of bariatric surgery. In most cases, it can be repaired during the operation.

### *Long-term risks*

The long-term risks of vertical banded gastroplasty include:

- **Regaining weight.** Patients who have had a VBG are more likely to regain lost weight than those who have had gastric bypass surgery. This is partly because the patient's digestive tract continues to absorb nutrients in food in normal fashion. Because the stomach pouch in a VBG is small, many patients are tempted to eat ice cream and high-calorie liquids that pass quickly through the pouch. A 10-year follow-up study of 70 patients who had had a VBG found

that only 20% of the patients had lost and kept off the loss of 50% of their excess body weight.

- **Ongoing vomiting and heartburn.** About 20% of patients with VBGs report long-term digestive difficulties.
- **Psychological problems.** Some people have difficulty adjusting to the changes in their outward appearance and to others' changed reactions to them. Others experience feelings of depression, which are thought to be related to biochemical changes resulting from the weight loss.

### **Normal results**

The most rapid weight loss following a VBG takes place in the first six months. It usually takes between 18 and 24 months after the operation for patients to lose 50% of their excess body weight, which is the measurement used to define success in bariatric surgery. At this point, most patients feel much better physically and psychologically; diabetes, high blood pressure, urinary stress incontinence, and other complications associated with severe obesity have either improved or completely resolved.

The primary drawback of VBG is its relatively high rate of failure in maintaining the patient's weight loss over a five-year period. The most common form of revision surgery for a failed VBG is the Roux-en-Y **gastric bypass**. For this reason, some bariatric surgeons recommend VBGs for patients at the lower end of the severe obesity spectrum—those with BMIs between 35 and 40. The chief advantage of VBGs over malabsorptive types of weight loss surgery is that there is little risk of malnutrition or vitamin deficiencies.

Although bariatric surgeons advise patients to wait for two years after a VBG to have **plastic surgery** procedures, it is not unusual for patients to require operations to remove excess skin from the upper arms, abdomen, and other parts of the body that had large accumulations of fatty tissue.

### **Morbidity and mortality rates**

According to the American Society of Bariatric Surgery, the rates of postsurgical complications are about 2% for leaks leading to infection and a need to reoperate; 1.5% for dehiscence; 1% for injury to the spleen; and 1% for pulmonary embolisms.

### **Alternatives**

#### *Established surgical alternatives*

The primary restrictive alternative to a VBG is implanting a Lap-Band, which is an adjustable band

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A VBG is performed in a hospital whether the operation is an open or a laparoscopic gastroplasty. It is done by a bariatric surgeon, who is a medical doctor (MD) or doctor of osteopathy (DO) who has completed at least three years' training in general surgery after medical school and internship. Most bariatric surgeons have had additional training in gastrointestinal or biliary surgery before completing a fellowship in bariatric surgery with an experienced practitioner in this subspecialty.

In addition to demonstrating the technical skills necessary to perform a VBG, bariatric surgeons seeking hospital privileges must show that they are competent to provide the psychological and nutritional assessments and counseling included in weight loss surgery programs.

that the surgeon positions around the upper end of the stomach to form the small pouch instead of using staples. The Lap-Band was approved by the Food and Drug Administration (FDA) for use in the United States in 2001. It can be implanted with the laparoscopic technique. When the band is in place, it is inflated with saline solution. It can be tightened or loosened after the operation through a portal under the skin. Although the Lap-Band eliminates the risk of dehiscence, it produces such side effects as vomiting, heartburn, abdominal cramps, or enlargement of the stomach pouch due to the band slipping out of place. In one American study, 25% of patients eventually had the band removed.

The other major type of obesity surgery combines restriction of the size of the stomach with a malabsorptive approach. The combination surgery that is considered the safest and performed most frequently in the United States is the Roux-en-Y gastric bypass. In this procedure, the surgeon forms a stomach pouch and then divides the small intestine, connecting one part of it to the new pouch and reconnecting the other portion to the intestines at some distance from the stomach. The food bypasses the section of the stomach and the small intestine, where most nutrients are absorbed. The procedure takes its name from Cesar Roux, a Swiss surgeon who first performed it, and the "Y" shape formed by the reconnected intestines.

## QUESTIONS TO ASK THE DOCTOR

- Do I meet the eligibility criteria for bariatric surgery?
- Would you recommend a vertical banded gastroplasty (VBG) for me, a gastric bypass operation, IGS, or staged surgery?
- Am I a candidate for a laparoscopic VBG?
- How long have you been practicing bariatric surgery?
- How many VBGs do you perform each year?

### Experimental procedures

A newer technique in obesity surgery is known as gastric pacing or implantable gastric stimulation (IGS). In IGS, the surgeon implants electrodes in the muscle of the stomach wall that deliver a mild electrical current. These electrical impulses regulate the pace of stomach contractions so that the patient feels full on smaller amounts of food. Preliminary results from a team of Italian researchers on patients followed since 1995 indicate that gastric pacing is both safe and effective. As of 2005, published reports of two ongoing clinical trials of IGS in the United States involving over 130 patients showed that IGS is a safe and effective procedure in selected patients.

Another experimental surgical alternative in obesity surgery is staged surgery. This approach involves a first-stage less invasive procedure—usually a Lap-Band—that helps the patient reduce his or her weight to a safer level. Once the patient has lost some weight, the more complex Roux-en-Y gastric bypass is performed.

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**ORGANIZATIONS**

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- American Society for Metabolic and Bariatric Surgery. 100 SW 75th Street, Suite 201, Gainesville, FL 32607. (352) 331-4900. <http://www.asbs.org> (accessed April 18, 2008).
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Iowa City, IA 52242. (319) 384-7359. <http://www.healthcare.uiowa.edu/surgery/ibsr/> (accessed April 18, 2008).

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Rebecca Frey, PhD

## Vital signs

**Definition**

Vital signs, or signs of life, include the following objective measures for a person: temperature, respiratory rate, heart beat (pulse), and blood pressure. When these values are not zero, they indicate that a person is alive. All of these vital signs can be observed, measured, and monitored. This will enable the assessment of the level at which an individual is functioning. Normal ranges of measurements of vital signs change with age and medical condition.

**Purpose**

The purpose of recording vital signs is to establish a baseline on admission to a hospital, clinic, professional office, or other encounter with a health care provider. Vital signs may be recorded by a nurse, physician, physician's assistant, or other health care professional. The health care professional has the responsibility of interpreting data and identifying



**A nurse taking a patient's vital signs.** (*moodboard / Alamy*)

any abnormalities from a person's normal state, and of establishing if current treatment or medications are having the desired effect.

Abnormalities of the heart are diagnosed by analyzing the heartbeat (or pulse) and blood pressure. The rate, rhythm and regularity of the beat are assessed, as well as the strength and tension of the beat, against the arterial wall.

Vital signs are usually recorded from once hourly to four times hourly, as required by a person's condition.

The vital signs are recorded and compared with normal ranges for a person's age and medical condition. Based on these results, a decision is made regarding further actions to be taken.

All persons should be made comfortable and reassured that recording vital signs is normal part of health checks, and that it is necessary to ensure that the state of their health is being monitored correctly. Any abnormalities in vital signs should be reported to the health care professional in charge of care.

## Description

### Temperature

Temperature is recorded to check for fever (pyrexia or a febrile condition), or to monitor the degree of hypothermia.

Manufacturer guidelines should be followed when recording a temperature with an electronic **thermometer**. The result displayed on the liquid crystal display (LCD) screen should be read, then recorded in a person's medical record. Electronic temperature monitors do not have to be cleaned after use. They have protective guards that are discarded after each use. This practice ensures that infections are not spread.

## KEY TERMS

**Auscultation**—The process of listening to sounds that are produced in the body. Direct auscultation uses the ear alone, such as when listening to the grating of a moving joint. Indirect auscultation involves the use of a stethoscope to amplify sounds from within the body, such as those coming from the heart or intestines.

**Blood pressure**—The pressure exerted by arterial blood on the walls of arteries. This depends on the strength of the heart beat, elasticity of the arterial walls, and volume and viscosity (resistance to flow) of blood. The pressure of blood in the arteries measured in millimeters of mercury by a sphygmomanometer or by an electronic device.

**Hypothermia** —An abnormally low body temperature.

**Pyrexia**—Fever or a febrile condition.

**Respiration**—The exchange of gases between red blood cells and the atmosphere.

**Stethoscope**—A Y-shaped instrument that amplifies body sounds such as heartbeat, breathing, and air in the intestine. Used in auscultation.

An alcohol or mercury thermometer can be used to monitor a temperature by three methods:

- Axillary, under the armpit. This method provides the least accurate results.
- Orally, under the tongue. This method is never used with infants or very young children because they may accidentally bite or break the thermometer. They also have difficulty holding oral thermometers under their tongues long enough for their temperatures to be accurately measured.
- Rectally, inserted into the rectum. This method provides the most accurate recording of recording the temperature. It is most often used for infants. A recent study reported that rectal thermometers were more accurate than ear thermometers in detecting high fevers. With the ability to detect low-grade fevers, rectal thermometers can be useful in discovering serious illnesses, such as meningitis or pneumonia. The tip of a rectal thermometer is usually blue, which distinguishes it from the silver tip of an oral, or axillary thermometer.

To record the temperature using an alcohol or mercury thermometer, one should shake down the thermometer by holding it firmly at the clear end and



flicking it quickly a few times, with the silver end pointing downward. The health care provider who is taking the temperature should confirm that the alcohol or mercury is below a normal **body temperature**.

To record an axillary temperature, the silver tip of the thermometer should be placed under the right armpit. The arm clamps the thermometer into place, against the chest. The thermometer should stay in place for three to four minutes. After the appropriate time has elapsed, the thermometer should be removed and held at eye level. During this waiting period, the body temperature will be measured. The alcohol or mercury will have risen to a mark that indicates the temperature of a person.

To record an oral temperature, the axillary procedure should be followed, except that the silver tip of the thermometer should be placed beneath the tongue for three to four minutes, then read as described previously.

In both cases, the thermometer should be wiped clean with an antiseptic and stored in an appropriate container to prevent breakage.

To record a rectal temperature, a rectal thermometer should be shaken down, as described previously. A small amount of water-based lubricant should be placed on the colored tip of the thermometer. Infants must be placed on their stomachs and held securely in place. The tip of the thermometer is inserted into the rectum no more than 0.5 in (1.3 cm) and held there for two to three minutes. The thermometer is removed, read as before, and wiped with an antibacterial wipe. It is then stored in an appropriate container to prevent breakage, because ingestion of mercury can be fatal.

### *Respiratory rate*

An examiner's fingers should be placed on the person's wrist, while the number of breaths or respirations in one minute is recorded. Every effort should be made to prevent people from becoming aware that their breathing is being checked. Respiration results should be noted in the medical chart.

### *Heartbeat (pulse)*

The pulse can be recorded anywhere that a surface artery runs over a bone. The radial artery in the wrist is the point most commonly used to measure a pulse. To measure a pulse, one should place the index, middle, and ring fingers over the radial artery. It is located above the wrist, on the anterior or front surface of the thumb side of the arm. Gentle pressure should be applied, taking care to avoid obstructing blood flow. The rate, rhythm, strength, and tension of the pulse

should be noted. If there are no abnormalities detected, the pulsations can be counted for half a minute, and the result doubled. However, any irregularities discerned indicate that the pulse should be recorded for one minute. This will eliminate the possibility of error. Pulse results should be noted in the health chart.

### *Blood pressure*

To record blood pressure, a person should be seated with one arm bent slightly, and the arm bare or with the sleeve loosely rolled up. With an aneroid or automatic unit, the cuff is placed level with the heart and wrapped around the upper arm, one inch above the elbow. Following the manufacturer's guidelines, the cuff is inflated and then deflated while an attendant records the reading.

If the blood pressure is monitored manually, a cuff is placed level with the heart and wrapped firmly but not tightly around the arm one inch above the elbow over the brachial artery. Wrinkles in the cuff should be smoothed out. Positioning a **stethoscope** over the brachial artery in front of the elbow with one hand and listening through the earpieces, the cuff is inflated well above normal levels (to about 200 mmHg), or until no sound is heard. Alternatively, the cuff should be inflated 10 mm Hg above the last sound heard. The valve in the pump is slowly opened. Air is allowed to escape no faster than 5 mmHg per second to deflate the pressure in the cuff to the point where a clicking sound is heard over the brachial artery. The reading of the gauge at this point is recorded as the systolic pressure.

The sounds continue as the pressure in the cuff is released and the flow of blood through the artery is no longer blocked. At this point, the noises are no longer heard. The reading of the gauge at this point is noted as the diastolic pressure. "Lub-dub" is the sound produced by the normal heart as it beats. Every time this sound is detected, it means that the heart is contracting once. The noises are created when the heart valves click to close. When one hears "lub," the atrioventricular valves are closing. The "dub" sound is produced by the pulmonic and aortic valves.

With children, the clicking noise does not disappear but changes to a soft muffled sound. Because sounds continue to be heard as the cuff deflates to zero, the reading of the gauge at the point where the sounds change is recorded as the diastolic pressure.

Blood pressure readings are recorded with the systolic pressure first, then the diastolic pressure (e.g., 120/70).

Blood pressure should be measured using a cuff that is correctly sized for the person being evaluated. Cuffs that are too small are likely to yield readings that can be 10 to 50 millimeters (mm) Hg too high. Hypertension (high blood pressure) may be incorrectly diagnosed.

### Preparation

As there may be no recorded knowledge of a person's previous vital signs for comparison, it is important that a health care professional be aware that there is a wide range of normal values that can apply to persons of different ages. The health care professional should obtain as detailed a medical history from the person as soon as possible. Any known medical or surgical history, prior measurements of vital signs, and details of current medications should be recorded, as well. Physical exertion prior to measurement of vital signs, such as climbing stairs, may affect the measurements. This should be avoided immediately before the measurement of one's blood pressure. Tobacco, caffeinated drinks, and alcohol should be avoided for 30 minutes prior to recording.

A person should be sitting down or lying comfortably to ensure that the readings are taken in a similar position each time. There should be little excitement, which can affect the results. The equipment required include a watch with a second hand, an electronic or other form of thermometer, an electronic or manual **sphygmomanometer** with an appropriate sized cuff, and a stethoscope.

### Normal results

A normal body temperature taken orally is 98.6°F (37°C), with a range of 97.8–99.1°F (36.5–37.2°C). A fever is a temperature of 101°F (38.3°C) or higher in an infant younger than three months or above 102°F (38.9°C) for older children and adults. Hypothermia is recognized as a temperature below 96°F (35.5°C).

Respirations are quiet, slow, and shallow when the adult is asleep, and rapid, deeper, and noisier during and after activity.

Average respiration rates at rest are:

- Infants: 34–40 per minute.
- Children five years of age: 25 per minute.
- Older children and adults: 16–20 per minute.

Tachypnea is rapid respiration above 20 per minute.

The strength of a heart beat is raised during conditions such as fever and lowered by conditions such as

shock or elevated intracranial pressure. The average heart rate for older children (aged 12 and older) and adults is approximately 72 beats per minute (bpm). Tachycardia is a pulse rate over 100 bpm, while bradycardia is a pulse rate of under 60 bpm.

Blood pressure is recorded for older children and adults. A normal adult blood pressure reading is 120/80.

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#### ORGANIZATIONS

- American Academy of Family Physicians, 11400 Tomahawk Creek Parkway, Leawood, KS 66211 2672. (913) 906 6000. E mail: fp@aafp.org. <http://www.aafp.org>.
- American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL 60007 1098. (847) 434 4000. Fax: (847) 434 8000. E mail: kidsdoc@aap.org. <http://www.aap.org/default.htm>.
- American College of Physicians. 190 N. Independence Mall West, Philadelphia, PA 19106 1572. (800) 523 1546, x2600 or (215) 351 2600. <http://www.acponline.org>

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Water pills see **Diuretics**

## Webbed finger or toe repair

### Definition

Webbed finger or toe repair refers to corrective or **reconstructive surgery** performed to repair webbed fingers or toes, also called syndactyly. The long and ring fingers or the second and third toes are most often affected. Generally, syndactyly repairs are done between the ages of six months and two years.

### Purpose

Webbing, or syndactyly, is a condition characterized by the incomplete separation or union of two or more fingers or toes, and usually only involves a skin connection between the two (simple syndactyly), but may—rarely—also include fusion of bones, nerves, blood vessels, and tendons in the affected digits (complex syndactyly). Webbing may extend partially up between the digits, frequently just to the first joint, or may extend the entire length of the digits. Polysyndactyly describes both webbing and the presence of an extra number of fingers or toes. The condition usually develops within six weeks after birth. Syndactyly can also occur in victims of fires, as the intense heat can melt the skin and fuse the epidermis and dermis of the phalanges, fingers, or toes. Burn victim syndactyly is always less invasive because bone fusion is not present in these cases. The purpose of repair surgery is to improve the appearance of the hand or foot and to prevent progressive deformity from developing as the child grows.

### Demographics

In the United States, approximately one infant in every 2,000 births is born with webbed fingers or toes.

Both hands are involved in 50% of cases; the middle finger and ring finger in 41%; the ring finger and little finger in 27%; the index finger and middle finger in 23%; and the thumb and index finger in 9%.

### Description

Polydactyly can be corrected by surgical removal of the extra digit or partial digit. Syndactyly can also be corrected surgically. This is usually accomplished with the addition of a skin graft from the groin.

There are several ways to perform this type of surgery; the design of the operation depends both on the features of the hand or foot and the surgeon's experience. The surgery is usually performed with zig-zag cuts that cross back and forth across the fingers or toes so that the scars do not interfere with growth of the digits.

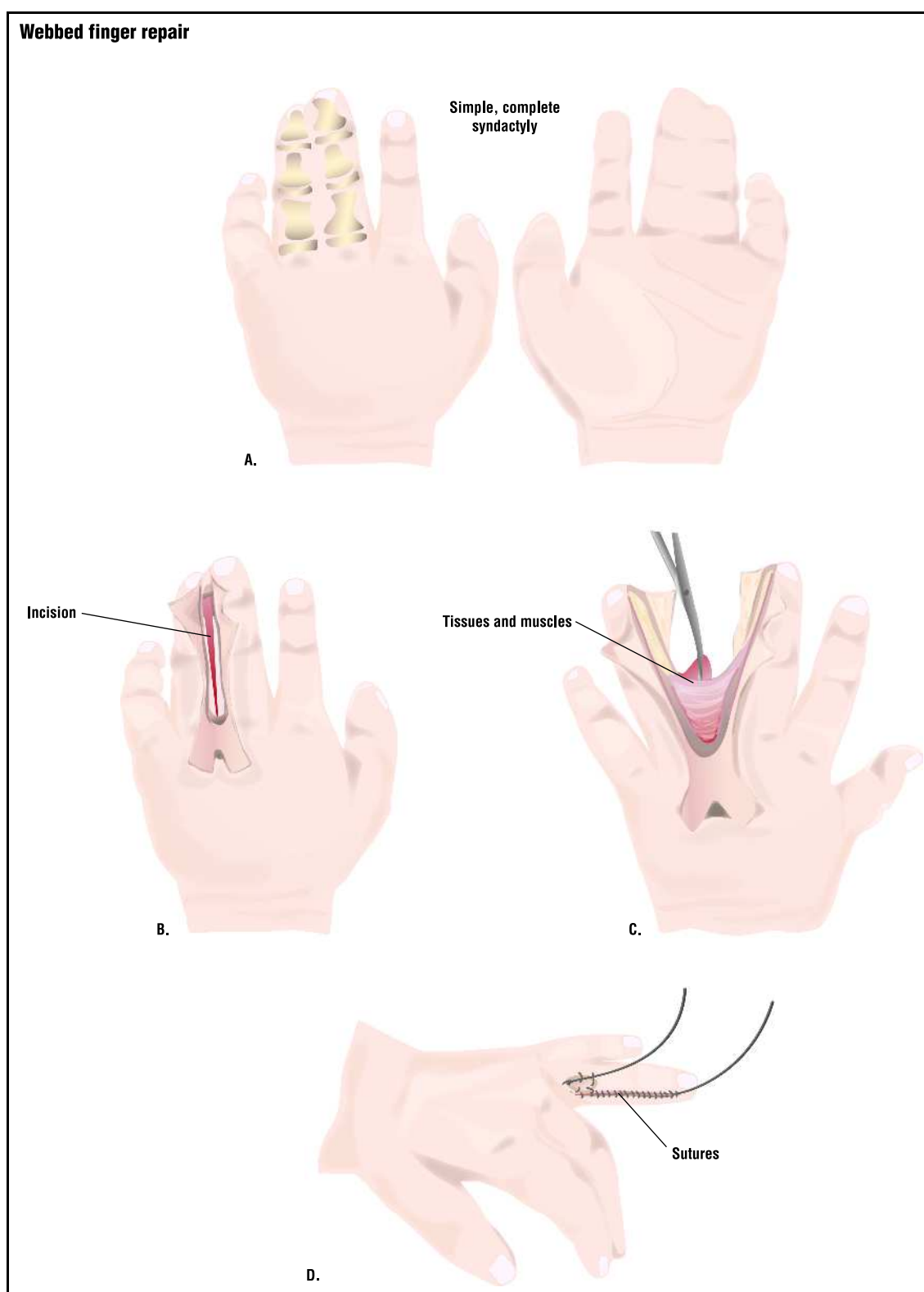
The procedure is performed under **general anesthesia**. The skin areas to be repaired are marked and the surgeon then proceeds to incise the skin, lifting small flaps at the sides of the fingers or toes and in the web. These flaps are sutured into position, leaving absent areas of skin. These areas may be filled in with full thickness skin grafts, usually taken from the skin in the groin area. The hand or foot is then immobilized with bulky **dressings**, or a cast. Webbed or toe repair surgery usually takes two to four hours.

### Diagnosis/Preparation

Syndactyly may be diagnosed during an examination of an infant or child, with the aid of x rays. In its most common form, it is seen as webbing between the second and third toes. This form is often inherited. Syndactyly can also occur as part of a pattern of other congenital defects involving the skull, face, and bones.

An infant with webbed fingers or toes may have other symptoms that, when observed together, define a specific syndrome or medical condition. For example, syndactyly is a characteristic of Apert syndrome,





This webbed finger shows a simple, complete syndactyly, meaning the bones for two fingers are complete, and only the soft tissues form the webbed section (A). To repair this, an incision is made in the skin of the webbing (B). Tissues and muscles are severed (C), and the two separated fingers are stitched (D). (Illustration by GGS Information Services. Cengage Learning, Gale.)

## KEY TERMS

**Congenital**—Condition or disorder present at birth.

**Graft**—The implantation of a portion of living flesh or skin in a lesion to form an organic union.

**Polysyndactyly**—Condition involving both webbing and the presence of an extra number of fingers or toes.

**Syndactyly**—Union or webbing of two or more fingers or toes, which usually only involves a skin connection between the two.

**Syndromes**—A set of signs or a series of events occurring together that often point to a single disease or condition as the cause.

Poland syndrome, Jarcho-Levin syndrome, oral-facial-digital syndrome, Pfeiffer syndrome, and Edwards syndrome. Diagnosis of a syndrome is made on family history, medical history, and thorough physical evaluation. The medical history questions documenting the condition in detail usually include:

- Which fingers (toes) are involved?
- Are any other family members affected by the same condition?
- What other symptoms or abnormalities are also present?

To prepare for surgery, seven to 10 days before surgery, the child visits the family physician or pediatrician for a general **physical examination** and blood tests. The child cannot have solid food after midnight before surgery. Breast milk, formula, or milk (no pablum or other cereal may be added) up to six hours before the scheduled start of surgery is allowed, and then only clear fluids up to three hours before surgery. Thereafter, the child may not have anything else to eat or drink.

## Aftercare

Hospital stays of one or two days are common for webbed finger or toe repair surgery. There is usually some swelling and bruising. Pain medications are given to alleviate any discomfort. The **bandages** must be kept clean and dry and must remain for two to three weeks for proper healing and protection. Skin grafts and the hand or foot may become very dry, so it is encouraged to dampen them with a good moisturizer such as Lubriderm or Nivea. Small children with hand syndactylies may have a cast put on that extends above the flexed elbow. Sometimes, the cast extends beyond

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Webbed finger or toe repair surgery is usually performed in a children's hospital by a pediatric surgeon or orthopedic surgeon specializing in syndactyly surgery.

If prenatal screening indicates syndactyly in the fetus, arrangements are usually made so that the baby is delivered at a hospital with a pediatric surgeon on staff.

the fingers or toes. This protects the repaired areas from trauma.

The treating physician should be informed of any post-operative swelling, severe pain, fever, or fingers that tingle, are numb, or have a bluish discoloration.

## Risks

Webbed finger or toe repair surgery carries the risks associated with any anesthesia, such as adverse reactions to medications, breathing problems, and sore throat from intubation. Risks associated with any surgery are excessive bleeding and infection.

Specific risks associated with the repair surgery include possible loss of skin graft and circulation damage from the cast or bandages.

## Normal results

The results of webbed finger or toe repair depend on the degree of fusion of the digits and the repair is usually successful. When joined fingers share a single fingernail, the creation of two normal-looking nails is rarely possible. One nail will look more normal than the other. Some children may require a second surgery, depending on the type of syndactyly. If polydactyly or syndactyly are just cosmetic and not symptomatic of a condition or disorder, the outcome of surgery is usually very good. If it is symptomatic, the outcome will rely heavily on the management of the disorder.

## Alternatives

Syndactyly does not generally pose any health risk, so that it is not mandatory that the repair be performed. However, if the thumb is joined, or if the fingers are joined out toward their tips, they will grow in a progressively worsening bend over time.

## QUESTIONS TO ASK THE DOCTOR

- What will happen during the surgery?
- Does my baby have any other birth defect?
- How long will it take to recover from surgery?
- Will my baby have normal fingers/toes?
- How many webbed finger/toe repair surgeries do you perform each year?
- Will the syndactyly return?

### Resources

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- The American Academy of Orthopaedic Surgeons. 6300 North River Road, Rosemont, IL 60018 4262. (847) 823 7186; (800) 346 AAOS. [www.aaos.org](http://www.aaos.org).
- The American Society for Surgery of the Hand. 6300 North River Road, Suite 600, Rosemont, IL 60018 4256. (847) 384 8300. [www.assh.org](http://www.assh.org).
- Office of Rare Diseases (NIH). 6100 Executive Boulevard, Room 3A07, MSC 7518 Bethesda, MD 20892 7518. (301) 402 4336. <[rarediseases.info.nih.gov/info\\_diseases.html](mailto:rarediseases.info.nih.gov/info_diseases.html)>.

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## Weight management

### Definitions

Weight management refers to a set of practices and behaviors that are necessary to keep one's weight at a healthful level. It is preferred to the term "dieting," because it involves more than regulation of food intake or treatment of overweight people. People diagnosed with eating disorders that are not obese or overweight still need to practice weight management. Some healthcare professionals use the term "nutritional disorders" to cover all disorders related to weight.

The term "weight management" also reflects a change in thinking about treatment of obesity and overweight during the past 20 years. Before 1980, treatment of overweight people focused on weight loss, with the goal of helping the patient reach an ideal weight as defined by standard life insurance height-weight charts. In recent years, however, researchers have discovered that most of the negative health consequences of obesity are improved or controlled by a relatively modest weight loss, perhaps as little as 10% of the patient's body weight. It is not necessary for the person to reach the ideal weight to benefit from weight management. Some nutritionists refer to this treatment goal as the "10% solution." Second, the fact that most obese people who lose large amounts of weight from reduced-calorie diets regain it within five years has led nutrition experts to emphasize weight management rather than weight loss as an appropriate outcome of treatment.

### *Overweight and obese*

Overweight and obese are not the same thing. People who are overweight weigh more than they should compared with set standards for their height. The excess weight may come from muscle tissue, body water, or bone, as well as from fat. A person who is obese has too much fat in comparison to other types of body tissue; hence, it is possible to be overweight without being obese.

## KEY TERMS

**Anorexia nervosa**—An eating disorder marked by refusal to eat, intense fear of obesity, and distortions of body image.

**Appetite suppressant**—A medication given to reduce the desire to eat.

**Bariatrics**—The branch of medicine that deals with the prevention and treatment of obesity and related disorders.

**Binge**—A time-limited bout of excessive indulgence in eating; consuming a larger amount of food within a limited period of time than most people would eat in similar circumstances.

**Binge eating disorder**—An eating disorder in which the person binges but does not try to get rid of the food afterward by vomiting, using laxatives, or exercising.

**Body mass index (BMI)**—A measurement that has replaced weight as the preferred determinant of obesity. The BMI can be calculated (in American units) as 703.1 times a person's weight in pounds divided by the square of the person's height in inches.

**Bulimia nervosa**—An eating disorder marked by episodes of binge eating followed by purging, over-exercising, or other behaviors intended to prevent weight gain.

**Ephedra**—A herb used in traditional Chinese medicine to treat asthma and hay fever. It should never be used for weight management.

**Hoodia**—A succulent African plant resembling a cactus said to contain a natural appetite suppressant.

**Obesity**—Excessive weight gain due to accumulation of fat in the body, sometimes defined as a BMI of 30 or higher, or body weight greater than 30% above one's desirable weight on standard height-weight tables.

**Prevalence**—The number of cases of a disease or disorder that are present in a given population at a specific time.

**Sedentary**—Characterized by inactivity and lack of exercise. A sedentary lifestyle is a major risk factor for becoming overweight or obese.

There are several ways to determine whether someone is obese. Some measures are based on the relationship between the person's height and weight. The older measurements of this correlation are the so-called height-weight tables that list desirable weights for a given height. A more accurate measurement of obesity is body mass index, or BMI. The BMI is an indirect measurement of the amount of body fat. The BMI is calculated in American measurements by multiplying a person's weight in pounds by 703.1, and dividing that number by the person's height in inches squared. A BMI between 19 and 24 is considered normal; 25–29 is overweight; 30–34 is moderately obese; 35–39 is severely obese; and 40 or higher is defined as morbidly obese. More direct methods of measuring body fat include measuring the thickness of the skin fold at the back of the upper arm, and bioelectrical impedance analysis (BIA). Bioelectrical impedance analysis measures the total amount of water in the body using a special instrument that calculates the different degrees of resistance to an electrical current in different types of body tissue. Fatty tissue has a higher resistance to the current than body tissues containing larger amounts of water. A higher percentage of body water indicates a greater amount of lean tissue.

### Eating disorders

Eating disorders are a group of psychiatric disturbances defined by unhealthy eating or weight management practices. Anorexia nervosa is an eating disorder in which people restrict their food intake severely, refuse to maintain a normal body weight, and express intense fear of becoming obese. Bulimia nervosa is a disorder marked by episodes of binge eating followed by attempts to avoid weight gain from the food by abusing **laxatives**, forcing vomiting, or over-exercising. A third type, binge eating disorder, is found in some obese people, as well as in people of normal weight. In binge eating disorder, the person has an eating binge but does not try to get rid of the food after eating it. Although most patients diagnosed with anorexia or bulimia are women, 40% of patients with binge eating disorder are men.

### Purpose

The purpose of weight management is to help each patient achieve and stay at the best weight possible in the context of their overall health, occupation, and living situation. A second purpose is the prevention and treatment of diseases and disorders associated with obesity or with eating disorders. These disorders include depression and other psychiatric disturbances,



in addition to the physical problems associated with nutritional disorders.

### Demographics and statistics

Obesity has become a major public health concern in the United States in the last decade. As of 2007, obesity ranks second only to smoking as a major cause of preventable deaths. It is estimated that 300,000 people die in the United States each year from weight-related causes. The proportion of overweight adults in the general population has continued to rise since the 1960s. According to the National Health and Nutrition Examination Survey (NHANES) of 2004, almost two-thirds of American adults are overweight, and almost a third is obese. In addition, there has been a 42% increase in the rate of childhood obesity since 1980.

The prevalence of obesity in the United States varies somewhat according to sex, age, race, and socioeconomic status. Among adults, 35% of women are considered obese, compared to 31% of men. The rate of obesity increases as people get older; those aged 55 or older are more than twice as likely to be obese as those in their 20s. African American men have the same rate of obesity as Caucasian men; however, African American women are almost twice as likely as Caucasian women to be obese by the time they reach middle age. The same ratio holds true for socioeconomic status; people in the lowest third of the income and educational level distribution are twice as likely to be obese as those with more education and higher income.

From the economic standpoint, obesity costs the United States more than \$117 billion each year. This amount includes the direct costs of hospital care and medical services, which come to \$61 billion annually, or 7% of all healthcare costs. Another \$56 billion represents the indirect costs of obesity, such as disabilities related to overweight or work days lost to obesity-related illnesses.

Obesity is considered responsible for:

- 88–97% of cases of type 2 diabetes
- 57–70% of cases of coronary heart disease
- 70% of gallstone attacks
- 35% of cases of hypertension
- 11% of breast cancers
- 10% of colon cancers

In addition, obesity intensifies the pain of osteoarthritis and gout; increases the risk of complications in pregnancy and childbirth; contributes to depression and other mental disorders; and makes a person a

poor candidate for surgery. Many surgeons refuse to operate on patients who weigh more than 300 lb (136 kg).

Although fewer people suffer from eating disorders than from obesity, the National Institutes of Mental Health (NIMH) reports that 10 million adults in the United States meet the diagnostic criteria for anorexia or bulimia. Although eating disorders are stereotyped as affecting only adolescent or college-aged women, as of 2007 at least 10% of people with eating disorders are males—and the proportion of males to females is rising. Moreover, the number of women over 45 years of age who are diagnosed with eating disorders is also rising; many doctors attribute this startling new trend to fear of aging, as well as fear of obesity.

The long-term health consequences of eating disorders include gum disease and loss of teeth, irregular heart rhythm, disturbances in the chemical balance of the blood, and damage to the digestive tract. At least 50,000 people die each year in the United States as the direct result of an eating disorder; anorexia is the leading cause of **death** in women between the ages of 17 and 25.

### Description

To understand the goals and structure of nutritionally sound weight management programs, it is helpful to look first at the causes of being overweight, obesity, and eating disorders.

#### *Causes of nutrition-related disorders*

**GENETIC/BIOLOGIC.** Studies of twins separated at birth and research with genetically altered mice have shown that there is a genetic component to obesity. Some researchers think that there are also genetic factors involved in eating disorders.

**LIFESTYLE-RELATED.** The ready availability of relatively inexpensive, but high-caloric snacks and “junk food” is considered to contribute to the high rates of obesity in developed countries. In addition, the fast pace of modern life encourages people to select quick-cooking processed foods that are high in calories, rather than making meals that are more healthful but take longer to prepare. Lastly, changes in technology and transportation patterns mean that people today do not do as much walking or hard physical labor as earlier generations did. This sedentary or inactive lifestyle makes it easier for people to gain weight.

**SOCIOCULTURAL.** In recent years, many researchers have examined the role of advertising and the mass media in encouraging unhealthy eating patterns. On

the one hand, advertisements for such items as fast food, soft drinks, and ice cream often convey the message that food can be used to relieve stress, reward, or comfort oneself, or substitute for a fulfilling human relationship. On the other hand, the media also portray unrealistic images of human physical perfection. Their emphasis on slenderness as essential to beauty, particularly in women, is often cited as a major factor in the increase of eating disorders over the past three decades.

Another sociocultural factor that contributes to obesity among some Hispanic and Asian groups is the belief that children are not healthy unless they look plump. Overfeeding in infancy and early childhood, unfortunately, makes weight management in adolescence and adult life much more difficult.

**MEDICATIONS.** Recent research has found that a number of prescription medications can contribute to weight gain. These drugs include steroid hormones, antidepressants, benzodiazepine tranquilizers, lithium, and antipsychotic medications.

### *Aspects of weight management*

Since the late 1980s, nutritionists and healthcare professionals had come to recognize that successful weight management programs have three characteristics, including:

- They present weight management as a lifetime commitment to healthful patterns of eating and exercise, rather than emphasize strict dieting alternating with carelessness about eating habits.
- They are tailored to each person's age, general health, living situation, and other individual characteristics.
- They recognize that the emotional, psychological, and spiritual dimensions of human life are as important to maintaining a healthy lifestyle as the medical and nutritional facets.

**NUTRITION.** The nutritional aspect of weight management programs includes education about healthful eating, as well as modifying the person's food intake.

**DIETARY REGULATION.** Most weight-management programs are based on a diet that supplies enough vitamins and minerals; 50–63 grams of protein each day; an adequate intake of carbohydrates (100 g) and dietary fiber (20–30 g); and no more than 30% of each day's calories from fat. Good weight-management diets are intended to teach people how to make wise food choices and to encourage gradual weight loss. Some diets are based on fixed menus, while others are based on food exchanges. In a food-exchange

diet, a person can choose among several items within a particular food group when following a menu plan. For example, if a person's menu plan allows for two items from the vegetable group at lunch, they can have one raw and one cooked vegetable, or one serving of vegetable juice along with another vegetable.

**NUTRITIONAL EDUCATION.** Nutritional counseling is important to successful weight management because many people, particularly those with eating disorders, do not understand how the body uses food. They may also be trying to manage their weight in unhealthy ways. One recent study of adolescents found that 32% of the females and 17% of the males were using such potentially dangerous methods of weight control as smoking, fasting, over-the-counter (OTC) diet pills, or laxatives.

### *Exercise*

Regular physical **exercise** is a major part of weight management because it increases the number of calories used by the body and because it helps the body to replace fat with lean muscle tissue. Exercise also serves to lower emotional stress levels and to promote a general sense of well-being. People should consult a doctor before beginning an exercise program, however, to make sure that the activity that interests them is safe relative to any other health problems they may have. For example, people with osteoarthritis should avoid high-impact sports that are hard on the knee and ankle joints. Good choices for most people include swimming, walking, cycling, and yoga or other stretching exercises.

### *Psychological/psychiatric*

Both obesity and eating disorders are associated with a variety of psychiatric disorders, most commonly major depression and substance abuse. Almost all obese people feel harshly judged and criticized by others, and fear of obesity is a major factor in the development of both anorexia and bulimia. Many people find medications and/or psychotherapy to be a helpful part of a weight management program.

**MEDICATIONS.** In recent years, doctors have been cautious about prescribing appetite suppressants, which are drugs given to reduce the desire for food. In 1997, the Food and Drug Administration (FDA) banned the sale of two drugs: fenfluramine and phentermine (known as "fen-phen") when they were discovered to cause damage to heart valves. A newer appetite suppressant, known as sibutramine (Meridia), was approved as safe in 1997. The drug is being

monitored by the FDA as of 2007, however, because of reports linking it to heart failure, kidney failure, and stomach problems. Another new drug that is sometimes prescribed for weight management is called orlistat (Xenical). It works by lowering the amount of dietary fat that is absorbed by the body. However, it can cause significant diarrhea or intestinal gas.

People with eating disorders are sometimes given antidepressant medications, most often fluoxetine (Prozac) or venlafaxine, to relieve the symptoms of depression or anxiety that often accompany eating disorders.

**COGNITIVE-BEHAVIORAL THERAPY.** Cognitive-behavioral therapy (CBT) is a form of psychotherapy that has been shown to be effective in reinforcing the changes in food selection and eating patterns that are necessary to successful weight management. In this form of therapy, usually offered in specialized clinics, patients learn to modify their eating habits by keeping diaries and records of what they eat, what events or feelings trigger overeating, and any other patterns that they notice about their choice of foods or eating habits. They also examine their attitudes toward food and weight management, and work to change any attitudes that are self-defeating or interfere with a healthy lifestyle. Most CBT programs also include nutritional education and counseling. As of 2007, however, some researchers maintain that more work needs to be done on the use of CBT in real-world settings, not just university-related specialized clinics.

**WEIGHT-MANAGEMENT GROUPS.** Many doctors and nutritional counselors suggest that patients attend a weight-management group for social support. Social support is essential in weight management, because many who suffer from obesity or an eating disorder struggle with intense feelings of shame. Many isolate themselves from others because they are afraid of being teased or criticized for their appearance. Such groups as Overeaters Anonymous (OA) or Take Off Pounds Sensibly (TOPS) help members in several ways: They help to reduce the levels of shame and anxiety that most members feel; they teach strategies for coping with setbacks in weight management; they provide settings for making new friends; and they help people learn to handle problems in their workplace or in relationships with family members.

**ANTI-DISCRIMINATION GROUPS.** Another approach to weight-related psychological issues is tackling public discrimination against overweight people, including educational and employment discrimination as well as verbal harassment and teasing. The two major groups in the United States are the Council on

Size and Weight Discrimination (CSWD) and the National Association to Advance Fat Acceptance (NAAFA). The CSWD describes itself as “a not-for-profit group which works to change people’s attitudes about weight. We act as consumer advocates for larger people, especially in the areas of medical treatment, job discrimination, and media images.” NAAFA states its goals as “eliminat[ing] discrimination based on body size and provid[ing] fat people with the tools for self-empowerment through public education, advocacy, and member support.”

### *Surgical*

As of 2007, bariatric surgery is the most successful approach to weight management for people who are morbidly obese (BMI of 40 or greater), or severely obese with additional health complications. Surgical treatment of obesity usually results in a large weight loss that is successfully maintained for longer than five years. The most common surgical procedures for weight management are **vertical banded gastroplasty** (VBG), sometimes referred to as “stomach stapling,” and **gastric bypass**. Vertical banded gastroplasty works by limiting the amount of food the stomach can hold, while gastric bypass works by preventing normal absorption of the nutrients in the food.

### *Complementary and alternative medicine (CAM) approaches*

Some forms of complementary and alternative medicine are beneficial additions to weight management programs.

**MOVEMENT THERAPIES.** Movement therapies include a number of forms of exercise, such as tai chi, yoga, dance therapy, Trager work, and the Feldenkrais method. Many of these approaches help people improve their posture and move their bodies more easily as well as keeping active. Tai chi and yoga, for example, are good for people who must avoid high-impact physical workouts. Yoga can also be adapted to a person’s individual needs or limitations with the help of a qualified teacher following a doctor’s recommendations. Books and videos on yoga and weight management are available through most bookstores or the American Yoga Association.

**SPIRITUAL AND RELIGIOUS PRACTICE.** Prayer, meditation, and regular religious worship have been linked to reduced emotional stress in people struggling with weight issues. In addition, many people find that spiritual practice helps them to keep a healthy perspective on weight management, so that it does not crowd out other important interests and concerns in their lives.

**HERBAL PREPARATIONS.** The one type of alternative treatment that people should be extremely cautious about making part of a weight management program is over-the-counter herbal preparations advertised as “fat burners,” muscle builders, or appetite suppressants. Within a two-week period in early 2003, the national media carried accounts of death or serious illness from taking these substances. One is ephedra, an herb used in traditional Chinese medicine that can cause strokes, heart attacks, seizures, and psychotic episodes. The other is usnic acid, a compound derived from lichens that can cause liver damage.

Another herbal preparation that has received considerable media attention since 2004 is hoodia (*Hoodia gordonii*), a succulent plant similar to a cactus that is native to South Africa and Namibia. Used for generations by the native inhabitants of these parts of Africa to treat indigestion, hoodia was studied by several pharmaceutical companies in the early 2000s as a natural appetite suppressant. In 2002, one such company stopped its research into hoodia on the grounds that it has potentially severe side effects on the liver. Nonetheless, hoodia has been featured on such popular television shows as *60 Minutes*, and is marketed as of 2007 in tablets, shakes, teas, and other diet products. As of 2007, however, there is no scientific evidence that hoodia is effective in curbing appetite, and is not recommended by any professional medical or nutrition society.

### Normal results

As of 2007, much more research needs to be done to improve the success of weight management programs. A position paper published by the American Dietetic Association in the summer of 2002 summarizes the present situation: “Although our knowledge base has greatly expanded regarding the complex causation of increased body fat, little progress has been made in long-term maintenance interventions, with the exception of surgery.” A study published in the *Journal of the American Medical Association* in 2003 showed that neither subjects randomly assigned to a commercial weight loss program nor those assigned to a self-help weight loss program lost more than a modest amount of weight and succeeded in keeping it off over a two-year period. Most adults in weight maintenance programs find it difficult to change eating patterns learned over a lifetime. Furthermore, their efforts are all too often undermined by friends or relatives, as well as by media messages that encourage overeating or the use of food as a mood-enhancing drug. More effective weight maintenance programs may well depend on broad-based changes in society.

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## Whipple procedure

### Definition

A Whipple procedure, or pancreaticoduodenectomy, is a surgical procedure which is most often performed to treat pancreatic cancer. The operation may also be performed for cancer of the duodenum, cholangiocarcinoma (cancer of the bile duct), cancer of the ampulla (the area where the bile and pancreatic ducts enter the small intestine), and for chronic pancreatitis and benign (noncancerous) tumors involving the pancreatic head.

During the course of a Whipple procedure, the surgeon removes the head of the pancreas, the majority of the first part of the small intestine (the duodenum), part of the bile duct, and in some cases part of the stomach. Variations on the operation may include removal of the body of the pancreas and/or the entire gall bladder.

### Purpose

The Whipple procedure is the most common operation performed for treatment of cancer of the pancreas. The pancreas is an organ located near the liver on the right side of the body. It produces both digestive juices and hormones that are involved in regulation of blood sugar. Pancreatic cancer most often affects what is called the exocrine pancreas, which is the portion of the pancreas involved in producing digestive juices.

Because it initially causes only vague symptoms, pancreatic cancer is often not diagnosed until later stages of the disease. Additionally, it spreads very quickly, so when the disease is often quite widespread by the time it is finally diagnosed. Symptoms of pancreatic cancer can include pain in the upper abdomen, often radiating to the back; jaundice (yellow eyes and skin); decreased appetite; weight loss; and depression.

### Demographics

The American Cancer Society estimates that approximately 37,680 people will be diagnosed with pancreatic cancer in the United States in 2008. About 34,290 people will die of pancreatic cancer in 2008, making pancreatic cancer the fourth leading cause of cancer death in the United States. Most people who are diagnosed with pancreatic cancer are over age 60. Men and women are about equally at risk. Risk factors for the development of pancreatic cancer include smoking, history of diabetes, family history, and a personal history of chronic pancreatitis. Researchers



**Whipple procedure.** (Barry Slaven, MD, PhD / Phototake. Reproduced by permission.)

are still examining the possibility that other factors, such as certain workplace exposures or a high fat diet, may also increase an individual's risk of pancreatic cancer.

### Description

A Whipple procedure is a lengthy operation, taking about four to six hours. **General anesthesia** is required. A classic operation requires a large abdominal incision through which the operation occurs. There are some centers that offer **laparoscopic** Whipple procedure performed with or without **robotic assistance**. This minimally invasive method of surgery is performed through four small incisions with the use of a fiberoptic scope and miniaturized surgical instruments.

After the head of the pancreas has been removed during the operation, three important connections (anastomoses) must be performed. The intestine must be connected to the remains of the pancreas, to the bile duct, and to the stomach. These anastomoses must be very carefully achieved, since any leak may allow

pancreatic juices to enter the abdomen, risking severe complications.

### Diagnosis/Preparation

The patient meets with the operating physician prior to surgery to discuss the details of the surgery and receive instructions on **preoperative** and **postoperative care**. Blood tests to evaluate bleeding time and an EKG to evaluate cardiac function may be performed several days prior to the operation. Directly preceding surgery, an intravenous (IV) line is placed to administer fluid and medications, and the patient is given a **bowel prep** to cleanse the bowel and prepare it for surgery.

### Aftercare

Recuperation from Whipple procedure may be slow and difficult. Depending on the type of surgery (traditional open incision or minimally invasive), inpatient stay will range from five to 14 days. Because of the high likelihood of gastroparesis (slow gastric emptying), patients will remain on intravenous feeding



**Surgeons performing a Whipple procedure, the removal of the pancreatic head.** (Barry Slaven, MD, PhD/Phototake. Reproduced by permission.)

for five or six days following the operation. A nasogastric tube may be required to remove excess stomach acid and juices that accumulate. Advancement of diet through clear liquids, full liquids, soft foods, to regular diet will be slow and the timeframe will depend on the patient's tolerance of each new step. Some patients take as long as 4-6 weeks to have normal stomach emptying return. A feeding tube that delivers a nutritional formula directly into the jejunum may be used if recovery is overly slow.

### Risks

Risks associated with the Whipple procedure include excessive bleeding, infection, and complications due to general anesthesia. Delayed gastric emptying after eating affects about 19% of patients. Leakage of pancreatic juices into the abdomen is a serious problem, since these digestive juices are strong enough to actually begin to digest the internal organs themselves. This can result in perforations (holes) in the intestine, stomach, or other nearby organs; abnormal communication between organs (fistulas); or necrosis (cell death) within an affected organ. Some patients may develop diabetes following Whipple procedure. Weight loss of 5-10% of original body weight is common after the operation, as is the need to take oral enzyme supplements to aid digestion.

### Normal results

Although the recuperative time may be long, most patients return to their usual level of functioning and their usual quality of life after a Whipple procedure. However, the risk for further advancement of pancreatic cancer is very high. Many patients receive

KEY TERMS
<b>Anastomosis</b> —A surgically created joining or opening between two organs or body spaces.
<b>Fistula</b> —An abnormal connection between two organs, or between an organ and the outside of the body.
<b>Jaundice</b> —A yellowish cast to the whites of the eyes and/or the skin, caused by excess bilirubin circulating in the bloodstream.

chemotherapy and radiation for further treatment of the cancer.

### Morbidity and mortality rates

The Whipple procedure has a high morbidity and mortality rate. It requires the expertise of a surgeon who has performed a large number of these types of procedures. Even when highly skilled surgeons in cancer centers operate, 2-5% of patients die due to surgical complications. When less skilled surgeons perform this procedure, or when it is undertaken at smaller hospitals rather than major medical centers, the death rate from surgical complications may be as high as 15%. The complication rate is very high as well, between 30-50%. Possible complications include leakage from the anastomoses (connections) between organs, infection, bleeding, and slow gastric (stomach) emptying following meals. Risk of death from advancement of the original pancreatic cancer also is quite high, with only about 20% of all Whipple procedure patients surviving for five years after their initial diagnosis. Patients with no lymph node involvement at the time of surgery may have a higher five-year survival rate (about 40%). However, patients who receive chemotherapy but no surgery have only a 5% survival rate at five years.

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## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

A Whipple procedure is performed in a hospital operating room. It is considered one of the most technically difficult operations, and should be performed by a very experienced, skilled surgeon who has successfully performed many of these same procedures. Some of the doctors who perform these operations include general surgeons, surgical gastroenterologists, and surgical oncologists.

## QUESTIONS TO ASK THE DOCTOR

- Why is a Whipple procedure being recommended?
- What type of Whipple procedure would work best for me?
- What are the risks and complications associated with the recommended procedure?
- Are any nonsurgical treatment alternatives available?
- How soon after surgery may I resume my normal diet and activities?
- If the Whipple procedure is being done to treat pancreatic cancer, will I require any other treatment?

## White blood cell count and differential

### Definition

A white blood cell (WBC) count determines the concentration of white blood cells in the patient's blood. A differential determines the percentage of each of the five types of mature white blood cells.

### Purpose

A WBC count is included in general health examinations and to help investigate a variety of illnesses. An elevated WBC count occurs in infection, allergy, systemic illness, inflammation, tissue

injury, and leukemia. A low WBC count may occur in some viral infections, immunodeficiency states, and bone marrow failure. The WBC count provides clues about certain illnesses, and helps physicians monitor a patient's recovery from others. Abnormal counts that return to normal indicate that the condition is improving, while counts that become more abnormal indicate that the condition is worsening. The differential will reveal which WBC types are affected most. For example, an elevated WBC count with an absolute increase in lymphocytes having an atypical appearance is most often caused by infectious mononucleosis. The differential will also identify early WBCs, which may be reactive (e.g., a response to acute infection) or the result of a leukemia.

### Precautions

Many medications affect the WBC count. Both prescription and non-prescription drugs, including herbal supplements, should be noted. Normal values for both the WBC count and differential are age-related.

Sources of error in manual WBC counting are due largely to variance in the dilution of the sample and the distribution of cells in the chamber, as well as the small number of WBCs that are counted. For electronic WBC counts and differentials, interference may be caused by small fibrin clots, nucleated red blood cells (RBCs), platelet clumping, and unlysed RBCs. Immature WBCs and nucleated RBCs may cause interference with the automated differential count. Automated cell counters may not be acceptable for counting WBCs in other body fluids, especially when the number of WBCs is less than 1,000/ $\mu$ L or when other nucleated cell types are present.

### Description

White cell counts are usually performed using an automated instrument, but may be done manually using a microscope and a counting chamber, especially when counts are very low, or if the patient has a condition known to interfere with an automated WBC count.

An automated differential may be performed by an electronic cell counter or by an image analysis instrument. When the electronic WBC count is abnormal or a cell population is flagged, meaning that one or more of the results is atypical, a manual differential is performed. The WBC differential is performed manually by microscopic examination of a blood sample that is spread in a thin film on a glass slide. White blood cells are identified by their size, shape, and texture.



Type of WBC and normal differential count	Elevated	Decreased
Neutrophils 55–70%	Neutrophilia Physical or emotional stress Acute suppurative infection Myelocytic leukemia Trauma Cushing's syndrome Inflammatory disorders Metabolic disorders Lymphocytosis Chronic bacterial infection Viral infection Lymphocytic leukemia Multiple myeloma Infectious mononucleosis Radiation Infectious hepatitis Monocytosis Chronic inflammatory disorders Viral infections Tuberculosis Chronic ulcerative colitis Parasites Eosinophilia Parasitic infections Allergic reactions Eczema Leukemia Autoimmune diseases	Neutropenia Aplastic anemia Dietary deficiency Overwhelming bacterial infection Viral infections Radiation therapy Addison's disease Drug therapy: myelotoxic drugs (as in chemotherapy) Lymphocytopenia Leukemia Sepsis Immunodeficiency diseases Lupus erythematosus Later stages of HIV infection Drug therapy: adrenocorticosteroids, antineoplastic Radiation therapy Monocytopenia Drug therapy: prednisone
Lymphocytes 20–40%		
Monocytes 2–8%		
Eosinophils 1–4%		Eosinopenia Increased adrenocortical production
Basophils 0.5–1.0%	Basophilia Myeloproliferative disease (e.g., myelofibrosis, polycythemia rubra vera) Leukemia	Basopenia Acute allergic reactions Hyperthyroidism Stress reactions

SOURCE: Pagana, K.D. and T.J. Pagana. *Mosby's Diagnostic and Laboratory Test Reference*. 3rd ed. St. Louis: Mosby, 1997.

(Cengage Learning, Gale.)

The manual WBC differential involves a thorough evaluation of a stained blood film. In addition to determining the percentage of each mature white blood cell, the following tests are performed as part of the differential:

- Evaluation of RBC morphology. This includes grading of the variation in RBC size (anisocytosis) and shape (poikilocytosis); reporting the type and number of any abnormal or immature RBCs; and counting the number of nucleated RBCs per 100 WBCs.
- An estimate of the WBC count is made and compared with the automated or chamber WBC count. An estimate of the platelet count is made and compared with the automated or chamber platelet count. Abnormal platelets, such as clumped platelets or excessively large platelets, are noted on the report.
- Any immature WBCs are included in the differential count of 100 cells, and any inclusions or abnormalities of the WBCs are reported.

### Preparation

This test requires a 3.5 mL sample of blood. Vein puncture with a needle is usually performed by a nurse or phlebotomist, a person trained to draw blood. There is no restriction on diet or physical activity.

### Aftercare

Discomfort or bruising may occur at the puncture site. Pressure to the puncture site until the bleeding stops reduces bruising; warm packs relieve discomfort. Some people feel dizzy or faint after blood has been drawn and should be allowed to lie down and relax until they are stable.

## KEY TERMS

**Band cell**—An immature neutrophil at the stage just preceding a mature cell. The nucleus of a band cell is unsegmented.

**Basophil**—Segmented white blood cell with large dark blue-black granules that releases histamine in allergic reactions.

**Cytoplasm**—The part of a cell outside of the nucleus.

**Differential**—Blood test that determines the percentage of each type of white blood cell in a person's blood.

**Eosinophil**—Segmented white blood cell with large orange-red granules that increases in response to parasitic infections and allergic reactions.

**Lymphocyte**—Mononuclear white blood cell that is responsible for humoral (antibody mediated) and cell mediated immunity.

**Monocyte**—Mononuclear phagocytic white blood cell that removes debris and microorganisms by phagocytosis and processes antigens for recognition by immune lymphocytes.

**Nucleus**—The part of a cell that contains the DNA.

**Neutrophil**—Segmented white blood cell normally comprising 50–70% of the total. The cytoplasm contains both primary and secondary granules that take up both acidic and basic dyes of the Wright stain. Neutrophils remove and kill bacteria by phagocytosis.

**Phagocytosis**—A process by which a white blood cell envelopes and digests debris and microorganisms to remove them from the blood.

### Risks

Other than potential bruising at the puncture site, and/or dizziness, there are no complications associated with this test.

### Normal results

Normal values vary with age. White blood cell counts are highest in children under one year of age, and then decrease somewhat until adulthood. The increase is largely in the lymphocyte population. Adult normal values include:

- WBC count: 4,500–11,000/ $\mu$ L
- polymorphonuclear neutrophils: 1800–7800/ $\mu$ L; (50–70%)

- band neutrophils: 0–700/ $\mu$ L; (0–10%)
- lymphocytes: 1,000–4,800/ $\mu$ L; (15–45%)
- monocytes: 0–800/ $\mu$ L; (0–10%)
- eosinophils: 0–450/ $\mu$ L; (0–6%)
- basophils: 0–200/ $\mu$ L; (0–2%)

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## Wound care

### Definition

A wound is a disruption in the continuity of cells—anything that causes cells that would normally be connected to become separated. Wound healing is the restoration of that continuity. Several effects may result from the occurrence of a wound: immediate loss of all or part of organ functioning, sympathetic stress response, hemorrhage and blood clotting, bacterial contamination, and **death** of cells. The most important factor in minimizing these effects and promoting successful care is careful prevention of infection, which can be accomplished using sterile techniques when treating a wound.

### Description

Wound healing is a biological process that begins with trauma and ends with scar formation. There are

two types of tissue injury: full and partial thickness. Partial thickness injury is limited to the outermost layers of skin, with no damage to the dermal blood vessels. Healing occurs by regeneration of the outer layers of tissue. Full thickness injury involves loss of the dermis, extends to deeper tissue layers, and disrupts blood vessels. Wound healing involves the synthesis of several types of tissue and scar formation.

The three phases of repair are lag, proliferative, and remodeling. Shortly after an injury, blood flow ceases when a clot is formed. The initial clot acts like a magnet for the migration of more platelets and protein strands, called fibrin, which seal the wound from the inside. Within the first four hours of injury, certain white blood cells called neutrophils begin to appear. These inflammatory cells kill microbes, and prevent infection of the wound. Next, white blood cells called leukocytes also arrive and act to kill microbes and break down wound debris. The inflammatory response is dependent on the depth and volume of tissue loss from the injury. Leukocytes also secrete cytokines that initiate the proliferative phase of repair.

During the proliferative phase, synthetic cells, or fibroblasts, proliferate and synthesize new connective tissue, replacing the fibrin matrix. At this time, an efficient nutrient supply develops through the arborization (terminal branching) of adjacent blood vessels. This in-growth of new blood vessels is called angiogenesis. This new and very vascular connective tissue is referred to as granulation tissue. In this process, acute inflammation releases cytokines, promoting fibroblast infiltration of the wound site, and then creating a high density of cells. Collagen is the major connective tissue protein produced and released by fibroblasts. The connective tissue physically supports the new blood vessels that form, and endothelial cells promote in-growth of new vessels. These new blood vessels are necessary to meet the nutritional needs of the wound healing process. The mark of wound closure is when a new epidermal cover seals the defect. The process of wound healing continues beneath the new surface. This is the remodeling or maturation phase and is the third phase of healing.

The first principle of wound care is the removal of nonviable tissue, including dead tissue, slough, foreign debris, and residual material from **dressings**. Removal of nonviable tissue is referred to as **debridement**; removal of foreign matter is referred to as cleansing. Chronic wounds are colonized with bacteria, but not necessarily infected. A wound is colonized when a limited number of bacteria are present in the wound and are of no consequence in the healing process. A wound is infected when the bacterial burden

## KEY TERMS

**Allograft**—Skin donated from another person to treat burns.

**Asepsis**—Freedom from infection or infectious material; also, the absence of viable pathogenic organisms. Asepsis can be accomplished using aseptic techniques, which are the use of surgical practices that restrict microorganisms in the environment and prevent contamination of the surgical wound; they include sterilization of instruments and the wearing of sterile caps, gloves, and masks.

**Cadaver skin**—Skin donated from another person to treat burns.

**Cytokine**—A protein that regulates the duration and intensity of the body's immune response.

**Dermis**—The thick layer of skin below the epidermis.

**Epidermis**—The outermost layer of the skin.

**Exudate**—Fluid, cells, or other substances that are slowly discharged by tissue, especially due to injury or inflammation.

**Fibroblast**—An undifferentiated connective tissue cell that is capable of forming collagen fibers.

**Hemostasis**—Slowing down or stopping bleeding.

**Langerhans' cells**—Cells in the epidermis that help protect the body against infection.

**Melanocytes**—Cells within the epidermis that give skin its color

**Neutrophil**—A type of white blood cell.

**Scar tissue**—Scar tissue is the fibrous tissue that replaces normal tissue destroyed by injury or disease.

overwhelms the immune response of the host and bacteria grow unchecked. Clinical signs of infection are redness of the skin around the wound, purulent (pus-containing) drainage, foul odor, and edema.

The second principle of wound care is to provide a moist environment. This has been shown to promote re-epithelialization and healing. Exposing wounds to air dries the surface and may impede the healing process. Gauze dressings provide a moist environment provided they are kept moist in the wound. These are referred to as wet-to-dry dressings. Generally, a saline-soaked gauze dressing is loosely placed into the wound and covered with a dry gauze dressing to prevent drying and contamination. It also supports autolytic debridement (the body's own capacity to dissolve dead

tissue), absorbs exudate (thick layer of discharge), and traps bacteria in the gauze, which are removed when the dressing is changed.

Preventing further injury is the third principle of wound care. This involves elimination or reduction of the condition that allowed the wound to develop. Factors that contribute to the development of chronic wounds include losses in mobility, mental status changes, deficits of sensation, and circulatory deficits. Patients must be properly positioned to eliminate continued pressure to the chronic wound. Pressure-reducing devices, such as mattresses, cushions, supportive boots, foam wedges, and fitted shoes can be used to keep pressure off wounds.

Providing nutrition, specifically protein for healing, is the fourth principle of healing. Protein is essential for wound repair and regeneration. Without essential amino acids, angiogenesis, fibroblast proliferation, collagen synthesis, and scar remodeling will not occur. Amino acids also support the immune response. Adequate amounts of carbohydrates and fats are needed to prevent the amino acids from being oxidized for caloric needs. Glucose is also needed to meet the energy requirements of the cells involved in wound repair.

## Diagnosis/Preparation

Effective wound care begins with an assessment of the entire patient. This includes obtaining a complete **health history** and a physical assessment. Assessing the patient assists in identifying causes and contributing factors of the wound. When examining the wound, it is important to document its size, location, appearance, and the surrounding skin. The healthcare professional also examines the wound for exudate, dead tissue, signs of infection, and drainage, and documents how long the patient has had the wound. It is also important to know what treatment, if any, the patient has previously received for the wound.

Actual components of wound care include cleaning, dressing, determining frequency of dressing changes, and reevaluation. Dead tissue and debris can impede healing; the goal of cleaning the wound is its removal. When cleaning the wound, protective goggles should be worn and sterile saline solution should be used. Providone iodine, sodium hypochlorite, and hydrogen peroxide should never be used, as they are toxic to cells.

Gentle pressure should be used to clean the wound if there is no dead tissue. This can be accomplished by utilizing a syringe to apply the cleaning solution. If the wound has dead tissue, more pressure may be needed.

Whirlpools can also be used for wounds having a thick layer of discharge, known as exudate. At times, chemical or surgical debridement may be needed to remove debris.

Dressings are applied to wounds to provide the proper environment for healing, to absorb drainage, to immobilize the wound, to protect the wound and new tissue growth from mechanical injury and bacterial contamination, to prevent bleeding, and to provide mental and physical patient comfort. There are several types of dressings and most are designed to maintain a moist wound bed, including:

- **Alginate.** Made of non-woven fibers derived from seaweed, alginate forms a gel as it absorbs exudate. It is used for wounds with moderate-to-heavy exudate or drainage, and is changed every 12 hours to three days, depending on when the exudate penetrates the secondary dressing.
- **Composite dressings.** Combining physically distinct components into a single dressing, composite dressings provide bacterial protection, absorption, and adhesion. The frequency of dressing changes vary.
- **Foam.** Made from polyurethane, foam comes in various thicknesses having different absorption rates. It is used for wounds with moderate-to-heavy exudate or drainage. Dressing change is every three to seven days.
- **Gauze.** Available in a number of forms, including sponges, pads, ropes, strips, and rolls, gauze can be impregnated with petroleum jelly, antimicrobials, and saline. Frequent changes are needed because gauze has limited moisture retention properties, and there is little protection from contamination. With removal of a dried dressing, there is a risk of wound damage to the healing skin surrounding the wound. Gauze dressings are changed two to three times a day.
- **Hydrocolloid.** Made of gelatin or pectin, hydrocolloid is available as a wafer, paste, or powder. While absorbing exudate, the dressing forms a gel. Hydrocolloid dressings are used for light-to-moderate exudate or drainage. This type of dressing is not used for wounds with exposed tendon or bone, third-degree burns, or in the presence of bacterial, fungal, or viral infection or active cellulitis or vasculitis because it is almost totally occlusive. Dressings are changed every three to seven days.
- **Hydrogel.** Composed primarily of water, hydrogel dressings are used for wounds with minimal exudate. Some are impregnated in gauze or non-woven sponge. Dressings are changed one or two times a day.
- **Transparent film.** An adhesive, waterproof membrane that keeps contaminants out while allowing oxygen and water vapor to cross through, it is used primarily for wounds with minimal exudate. It is also used as a secondary material to secure non-adhesive gauzes. Dressings are changed every three to five days if the film is used as a primary dressing.

In cases where a wound is particularly severe, large, or, if it is a third-degree burn, cellular wound healing products may be used to close the wound and speed recovery. In some cases (i.e., a third-degree burn), a skin graft will often be used. Although most surgeons prefer to use skin donated from another person (known as cadaver skin, or human allograft), skin donations are not always available. Then surgeons must rely on other available products such as cellular wound dressings for the treatment of burns. For **skin grafting** of full-thickness burn wounds, surgeons use healthy skin from another part of the person's own body (autografting) as a permanent treatment. Surgeons may use cellular wound dressings as a temporary covering when the skin damage is so extensive that there is not enough healthy skin available to graft initially. This helps prevent infection and fluid loss until autografting can be performed.

The survival rate for burn patients has increased considerably through the process of quickly removing dead tissue and immediately covering the wound. Burns covering half the body were routinely fatal 20 years ago, but today even people with extensive and severe burns have a good chance of survival, according to the American Burn Association.

### *Cellular wound dressings*

In recent years, the technology of burn and wound care using cellular wound dressings and grafts has helped to transform the treatment of burns and chronic wounds by decreasing the risk of infection, protecting against fluid loss, requiring fewer skin grafts, and promoting and speeding the healing process. These dressings provide a cover that keeps fluids from evaporating and prevents blood from oozing out once the dead skin has been removed. Some of these products grow in place and expand natural skin when it heals.

Cellular wound dressings may look and feel like skin, but they do not function exactly the same as skin because they are missing hair follicles, sweat glands, melanocytes, and Langerhans' cells. Some cellular wound dressings have a synthetic top layer structured like an epidermis. It peels away over time, or is replaced with healthy skin through skin grafting.



How these products are involved in wound repair is a subject of great scientific interest; it is known that they promote a higher rate of healing than does standard wound care.

People with severe wounds, chronic wounds, burns, and ulcers can benefit from cellular wound dressings. Several artificial skin products for non-healing wounds or burns include:

- Apligraf is a two-layer wound dressing that contains live human skin cells combined with cow collagen. It delivers live cells from a different donor (circumcised infant foreskin). Thousands of pieces of Apligraf are produced in the laboratory from one small patch of cells from a single donor.
- Dermagraft is made from human cells placed on a dissolvable mesh material. The mesh material is gradually absorbed and the human cells grow and replace the damaged skin after being placed on the wound or ulcer.
- Biobrane is used as a temporary dressing for a variety of wounds, including ulcers, lacerations, and full-thickness burns. It may also be used on wounds that develop on areas from which healthy skin is transplanted to cover damaged skin. It consists of an ultrathin silicone film and nylon fabric. As the wound heals, or until autografting becomes possible, the Biobrane is trimmed away.
- TransCyte is used as a temporary covering over full-thickness and some partial-thickness burns until autografting is possible, as well as a temporary covering for some burn wounds that heal without autografting. It consists of human cells from circumcised infant foreskin, and is grown on nylon mesh, combined with a synthetic epidermal layer. TransCyte starts with living cells, but these cells die when it is shipped in a frozen state to burn treatment facilities. The product is then thawed and stretched over a burn site. In one to two weeks, the TransCyte starts peeling off, and the surgeon trims it away as it peels.
- Integra Dermal Regeneration Template is used to treat full-thickness and some partial-thickness burns. Integra consists of two layers. The bottom layer, made of shark cartilage and collagen from cow tendons, acts as a matrix onto which a person's own cells migrate over two to three weeks. A new dermis is created as the cells gradually absorb the cartilage and collagen. The top layer is a protective silicone sheet that is peeled off after several weeks, while the bottom layer is a permanent cover. A very thin layer of the person's own skin is then grafted onto the neo-dermis.

- OrCel is also made from circumcised infant foreskin, grown on a cow collagen matrix, and used to treat donor sites in burn patients. It is also used to help treat epidermolysis bullosa, a rare skin condition in children.

## Risks

Various risks from wounds include:

- Hematoma. Dressings should be inspected for hemorrhage at intervals during the first 24 hours after surgery. A large amount of bleeding should be reported to a healthcare professional immediately. Concealed bleeding sometimes occurs in the wound, beneath the skin. If the clot formed is small, it will be absorbed by the body, but if large, the wound bulges and the clot must be removed for healing to continue.
- Infection. The second most frequent nosocomial (hospital-acquired) infection in hospitals is surgical wound infections with *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*. Prevention is accomplished with meticulous wound management. Cellulitis is a bacterial infection that spreads into tissue planes; systemic antibiotics are usually prescribed to treat it. If the infection is in an arm or leg, elevation of the limb reduces dependent edema and heat application promotes blood circulation. Abscess is a bacterial infection that is localized and characterized by pus. Treatment consists of surgical drainage or excision with the concurrent administration of antibiotics.
- Dehiscence (disruption of the surgical wound) and evisceration (protrusion of wound contents). This condition results from sutures giving way, from infection, distention, and coughs. Dehiscence results in pain; the surgeon should be called immediately. Prophylactically, an abdominal binder may be utilized.
- Keloid, which refers to excessive growth of scar tissue. Careful wound closure, hemostasis, and pressure support are used to ward off this complication.

## Normal results

The goals of wound care include reducing risks that inhibit wound healing, enhancing the healing process, and lowering the incidence of wound infections.

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## Wound culture

### Definition

A wound culture is a diagnostic laboratory test in which microorganisms—such as bacteria or fungi from an infected wound, are grown in the laboratory on nutrient-enriched substance called media—then identified. Wound cultures always include aerobic

(with oxygen) culture, but direct smear evaluation by Gram stain and anaerobic (without oxygen) culture are not performed on every wound. These tests are performed when indicated or requested by the physician.

### Purpose

The purpose of a wound culture is to isolate and identify bacteria or fungi causing an infection of the wound. Only then can **antibiotics** that will be effective in destroying the organism be identified.

### Preparation

A biopsy sample is usually preferred by clinicians, but this is a moderately invasive procedure and may not always be feasible. The health-care professional prepares the patient by cleansing the affected area with a sterile solution, such as saline. **Antiseptics** such as ethyl alcohol are not recommended, because they kill bacteria and cause the culture results to be negative. The patient is given a local anesthetic and the tissue is removed by the practitioner, who uses a cutting sheath. Afterwards, pressure is applied to the wound to control bleeding.

Needle aspiration is less invasive and is a good technique to use in wounds where there is little loss of skin, such as in the case of puncture wounds. The skin around the wound is cleaned with an antiseptic to kill bacteria on the skin's surface, and a small needle is inserted. To obtain a sample of the fluid to be biopsied, the clinician pulls back on the plunger, then changes the angle of the needle two or three times to remove fluid from different areas of the wound. This procedure may be painful for the patient, so many initial cultures are done with the swab technique.

For a sample to be collected using the swab technique some of the wound must be exposed. A small sterile swab is inserted into the wound, or rubbed on top of the wound, rotated, and moved back and forth to collect as much fluid as possible from the wound. This is usually the least painful of the collection techniques, although it cannot be used with every type of wound. After completion of any of the three procedures, the wound should be cleaned thoroughly and bandaged.

### Description

Wounds are injuries to body tissues caused by physical trauma or disease processes that may include surgery, diabetes, burns, punctures, gunshots, lacerations, bites, bed sores, and broken bones. Types of wounds may include:

## KEY TERMS

**Aerobe**—Bacteria that require oxygen to live.

**Agar**—A gelatinous material extracted from red algae that is not digested by bacteria. It is used as a support for growth in plates.

**Anaerobe**—Bacteria that live only where there is no oxygen.

**Antibiotic**—A medicine that can be used topically or taken orally, intramuscularly, or intravenously to limit the growth of bacteria.

**Antimicrobial**—A compound that prevents the growth of microbes which may include bacteria, fungi, and viruses.

**Antimycotic**—A medicine that can be used to kill yeast and fungus.

**Antiseptic**—A compound that kills all bacteria, also known as a bactericide.

**Broth**—A growth mixture for bacteria. Different compounds, such as sugars or amino acids, may be added to increase the growth of certain organisms. Also known as media.

**Exudate**—Any fluid that has been released by tissue or its capillaries due to injury or inflammation.

**Normal flora**—The mixture of bacteria normally found at specific body sites.

**Purulent**—Containing, consisting of or forming pus.

**Pus**—A fluid that is the product of inflammation and infection containing white blood cells and debris of dead cells and tissue.

- **Abraded or abrasion:** Caused by scraping, such as falling on concrete.
- **Contused or contusion:** A bruise or bleeding into the tissue.
- **Incised or incision:** A wound formed by a clean cut, as by a sharp instrument like a knife.
- **Lacerated or laceration:** A wound caused by heavy pressure, causing tearing of the skin or other tissues.
- **Nonpenetrating:** An injury caused without disruption of the surface of the body. These wounds are usually in the thorax or abdomen and can also be termed blunt trauma wounds.
- **Open:** A wound in which tissues are exposed to the air.
- **Penetrating:** Disruption of the body surface and extension into the underlying tissue.

- **Perforating:** A wound with an exit and an entry, such as a gunshot wound.
- **Puncture:** A wound formed when something goes through the skin and into the body tissues. This wound has a very small opening, but can be very deep.

The chance of a wound becoming infected depends on the nature, size, and depth of the wound, its proximity to and involvement of nonsterile areas, such as the skin and gastrointestinal (GI) tract, the opportunity for organisms from the environment to enter the wound, and the immunologic, nutritional, and general health status of the person. In general, acute (sudden onset) wounds are more prone to infection than chronic (long-lasting) wounds. Wounds with a large loss of body surface, such as abrasions, are also easily infected. Puncture wounds can permit the growth of microorganisms because there is a break in the skin with minimal bleeding; they are also difficult to clean. Deep wounds, closed off from oxygen, are an ideal breeding environment for anaerobic infections. Foul-smelling odors, gas, or dead tissue at the infection site are signs of an infection caused by anaerobic bacteria. Surgical wounds can also cause infection by introducing bacteria from one body compartment into another.

Diagnosing infection in a wound may be difficult. One of the chief signs the clinician looks for is slow healing. Within hours of injury, most wounds display a release of fluid, called exudate. This fluid contains compounds that aid in healing, and is normal. It should not be present 48–72 hours after injury. Exudate indicative of infection may be thicker than the initial exudate and may also be purulent (containing pus) and foul smelling. Clinicians will look at color, consistency, and the amount of exudate to monitor early infection. In addition, infected wounds may display skin discoloration, swelling, warmth to touch, and an increase in pain.

Wound infection prevents healing, and the bacteria or yeast can spread from wounds to other body parts, including the blood. Infection in the blood is termed septicemia and can be fatal. Symptoms of a systemic infection include a fever and rise in white blood cells (WBCs), along with confusion and mental status changes in the elderly. It is important to treat the infected wound early with a regimen of antibiotics to prevent further complications.

Wound infections often contain multiple organisms, including both aerobic and anaerobic gram-positive cocci and Gram-negative bacilli and yeast. The most common pathogens isolated from wounds

are *Streptococcus* group A, *Staphylococcus aureus*, *Escherichia coli*, *Proteus*, *Klebsiella*, *Pseudomonas*, *Enterobacter*, Enterococci, *Bacteroides*, *Clostridium*, *Candida*, *Peptostreptococcus*, *Fusobacterium*, and *Aeromonas*.

The tissue used for the tests is obtained by three different methods: tissue biopsy, needle aspiration, or the swab technique. The biopsy method involves the removal of tissue from the wound using a cutting sheath. The swab technique is most commonly used, but contains the least amount of specimen.

Wound specimens are cultured on both nonselective enriched and selective media. Cultures are examined each day for growth and any colonies are Gram stained and subcultured (i.e., transferred) to appropriate media. The subcultured isolates are tested via appropriate biochemical identification panels to identify the species present. In some cases sensitivity testing will also be done. Sensitivity testing exposes the grown colonies to one or more antibiotics and monitors the response. This helps determine which antibiotics will be effective at treating the infection. The selection of antibiotics for testing depends on the organism isolated.

### Normal results

The initial Gram-stain result is available the same day, or in less than an hour, if requested by the doctor. An early report, known as a preliminary report, is usually available after one day. After that, preliminary reports will be posted whenever an organism is identified. Cultures showing no growth are signed out after two to three days unless a slow-growing mycobacterium or fungus is found. These organisms take several weeks to grow and are held for four to six weeks. The final report includes complete identification, an estimate of the quantity of the microorganisms, and a list of the antibiotics to which each organism is sensitive and resistant.

### Risks

The physician may choose to start the person on an antibiotic before the specimen is collected for culture. This may alter results, since antibiotics in the person's system may prevent microorganisms present in the wound from growing in culture. In some cases, the patient may begin antibiotic treatment after the specimen is collected. The antibiotic chosen may or may not be appropriate for one or more organisms recovered by culture.

Clinicians must be very careful when finishing a wound culture collection to make ensure that the wound has been cleaned thoroughly and is bandaged

properly. It is important to watch for bleeding and further infection from the procedure. In addition, patients may be in pain from the manipulation, so giving pain-killing drugs, such as **acetaminophen**, may be advised.

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## Wrist replacement

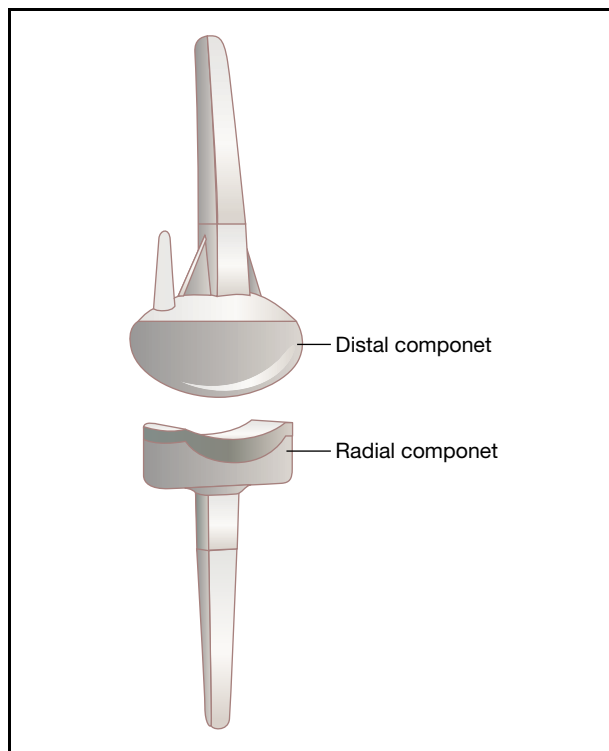
### Definition

Wrist replacement surgery is performed to replace a wrist injured or damaged beyond repair. An artificial wrist joint replacement is implanted.

### Purpose

Traumatic injuries or severe degenerative diseases affecting the wrist (such as osteoarthritis and rheumatoid arthritis with bony destruction) may require replacement of the painful wrist joint with an artificial wrist joint. The purpose of wrist replacement surgery is to restore wrist motion for activities of daily living and non-contact sports. A wrist replacement recovers lost strength by restoring length to the muscles and tendons of the fingers and wrist, and maintains a useful arc of motion and provides the stability required for an active life.





**Two pieces of an artificial wrist joint.** (Illustration by Electronic Illustrators Group.)

### Description

Surgery to replace a wrist starts with an incision through the skin on the back of the wrist. The surgeon then moves the tendons extending over the back of the wrist out of the way to access the joint capsule on the back of the wrist joint, which is then opened to expose the wrist joint area. A portion of the carpal bones and the end of the radius and ulna are then removed from the wrist to allow room for the new artificial wrist joint. The bones of the hand and the radius bone of the forearm are prepared with the use of special instruments to form holes in the bones; the stems of the artificial joint components can then fit in. Next, the components are inserted into the holes. After obtaining a proper fit, the surgeon verifies the range of motion of the joint to ensure that it moves correctly. Finally, the surgeon cements the two sides of the joint and replaces the tendons back into their proper position before closing the wound.

A total wrist replacement implant consists of the following components:

- An ellipsoid head that simulates the curvature of the natural wrist joint and allows for a functional range of motion. This ensures that the patient may flex and extend the wrist and move it side-to-side.

### KEY TERMS

**Arthritis**—An inflammatory condition that affects joints.

**Carpal bones**—Eight wrist bones arranged in two rows that articulate proximally with the radius and indirectly with the ulna, and distally with the five metacarpal bones.

**Metacarpal bones**—Five cylindrical bones extending from the wrist to the fingers.

**Osteoarthritis**—Non-inflammatory degenerative joint disease occurring mostly in older persons accompanied by pain and stiffness, especially after prolonged activity.

**Radius**—One of the two forearm bones. The largest portion of the radius is at the wrist joint where it articulates with the carpal bones of the hand. Above, the radius articulates with the humerus at the elbow joint.

**Rheumatoid arthritis**—Chronic inflammatory disease in which there is destruction of joints.

**Tendon**—A fibrous, strong, connective tissue that connects muscle to bone.

**Ulna**—One of the two bones of the forearm. The largest section articulates with the humerus at the elbow joint and the smallest portion of the ulna articulates with the carpal bones in the wrist.

- An offset radial stem that anchors the implant in the forearm. The special shape of this component is designed to assist the function of the tendons used to extend the wrist and to ensure the stability of the implant.
- An elongated radial tray surface with a molded bearing usually made of polyethylene. This component is required to distribute forces over the entire surface of the artificial joint.
- A fixation stem that is secured to the patient's bone to add stability and eliminate rotation of the artificial joint within the bone.
- A curved metacarpal stem that secures the artificial wrist within the hand.

### Diagnosis/Preparation

The orthopedic surgeon who will perform the surgery will usually require a complete **physical examination** of the patient by the primary care physician to ensure that the patient will be in the best possible condition to undergo the surgery. The patient

## WHO PERFORMS THE PROCEDURE AND WHERE IS IT PERFORMED?

Wrist replacement surgery is performed by an orthopedic surgeon in an orthopedic hospital or in a specialized clinic.

may also need to see the physical therapist responsible for managing rehabilitation after wrist replacement. The therapist prepares the patient before surgery to ensure readiness for rehabilitation post-surgery. The purpose of the preoperative examination is also for the physician to prerecord a baseline of information that will include measurements of the patient's current pain levels, functional wrist capacity, and the range of motion and strength of each hand.

Before surgery, patients are advised to take all of their normal medications, with the exception of blood thinners such as **aspirin**, ibuprofen, and other anti-inflammatory drugs that may cause greater blood loss during surgery. Patients may eat as they please the night before surgery, including solid food, until midnight. After midnight, patients should not eat or drink anything unless told otherwise by their doctor.

### Aftercare

Following surgery, the patient's wrist, hand, and lower arm are placed into a bulky bandage and a splint. A small plastic tube may be inserted to drain any blood that gathers under the incision to prevent excessive swelling (hematoma). The tube is usually removed within 24 hours. Sutures may be removed 10–14 days after surgery.

### Risks

Some of the most common risks associated with wrist replacement surgery are:

- **Infection.** Infection can be a very serious complication following wrist replacement surgery. Infection following wrist replacement occurs in approximately 1–2% of cases. Some infections may appear before the patient leaves the hospital, while others may not become apparent for months, or even years, after surgery.
- **Loosening.** There is also a risk that the artificial joints may eventually fail, due to a loosening process where the metal or cement meets the bone. There

## QUESTIONS TO ASK THE DOCTOR

- Will the surgery restore my wrist flexibility?
- How long will rehabilitation require?
- What are the chances of infection?
- Is alternative treatment available?
- How much wrist replacement surgery do you perform each year?
- What appearance will my wrist have after surgery?

have been great advances in extending how long an artificial joint will last, but most will eventually loosen and require revision surgery. The risk of loosening is much greater in younger, more active people. A loose artificial wrist is a problem because of the resulting pain. Once the pain becomes unbearable, another operation is usually required to either revise the wrist replacement or perform a wrist fusion.

- **Nerve injury.** All of the nerves and blood vessels that go to the hand travel across the wrist joint. Wrist replacement surgery is performed very close to these structures, introducing a risk of injury either to the nerves or the blood vessels.

### Normal results

Wrist replacement surgery often succeeds at restoring wrist function. On average, a wrist replacement is expected to last for 10–15 years.

### Alternatives

An alternative to wrist replacement is wrist fusion (arthrodesis). Wrist fusion surgery eliminates pain by allowing the bones that make up the joint to grow together, or fuse, into one solid bone. The surgery reduces pain, but also reduces the patient's ability to move the wrist. Wrist fusions were very common before the invention of artificial joints, and they are still performed often.

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- Academic Orthopaedic Society (AOS). 6300 N. River Rd., Suite 505, Rosemont, IL 60018. (847) 318 7330. <http://www.aos.org/>.
- Academy of General Dentistry, 211 East Chicago Avenue, Chicago, IL 60611. (312) 440 4300. <http://www.agd.org>.
- Accreditation Association for Ambulatory Health Care (AAAHC). 3201 Old Glenview Road, Suite 300, Wilmette, IL 60091 2992. (847) 853 6060. <http://www.aahc.org>.
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- ALS Association. 27001 Agoura Road, Suite 150 Calabasas Hills, CA 91301 5104. (800) 782 4747. <http://www.alsa.org>.
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- American Academy of Allergy, Asthma and Immunology. 611 East Wells Street, Milwaukee, WI 53202. Telephone: (414) 272 6071. Web site: <http://www.aaaai.org>.
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- American Association for Cardiovascular and Pulmonary Rehabilitation (AACVPR). 7600 Terrace Avenue, Suite 203, Middleton, Wisconsin 53562. (608) 831 6989. Email: [aacvpr@tmahq.com](mailto:aacvpr@tmahq.com). <http://www.aacvpr.org>.
- American Association for Clinical Chemistry. 1850 K Street, NW, Suite 625, Washington, DC 20006. (800) 892 1400. <http://www.aacc.org>.
- American Association for Hand Surgery. 20 North Michigan Avenue, Suite 700, Chicago, IL 60602. (312) 236 3307; Fax: (312) 782 0553. Email: [contact@handsurgery.org](mailto:contact@handsurgery.org). <http://www.handsurgery.org>.
- American Association for Respiratory Care (AARC). 11030 Ables Lane, Dallas, TX 75229. (972) 243 2272. Email: [info@aacrc.org](mailto:info@aacrc.org). <http://www.aarc.org>.
- American Association for the Surgery of Trauma. 633 N Saint Clair St, Suite 2400, Chicago, Illinois 60611. (312)202 5252, (800)789 4006. Fax: (312)202 5013. <http://www.aast.org/index.aspx>.
- American Association for Thoracic Surgery (AATS). 900 Cummings Center, Suite 221 U, Beverly, MA 01915. (978) 927 8330. Fax: (978) 524 8890. Email: [aats@prri.com](mailto:aats@prri.com). [www.aats.org](http://www.aats.org).
- American Association for Vascular Surgery (AAVS). 900 Cummings Center, #221 U, Beverly, MA 01915. [www.aavs.vascularweb.org](http://www.aavs.vascularweb.org).
- American Association of Ambulatory Surgical Centers (AAASC). P. O. Box 23220, San Diego, CA 92193. (800) 237 3768. <http://www.aaasc.org>.
- American Association of Blood Banks (AABB). 8101 Glenbrook Road, Bethesda, MD 20814 2749. (301) 907 6977 Fax: (301) 907 6895. <http://www.aabb.org>.
- American Association of Clinical Endocrinologists (AACE). 1000 Riverside Ave., Suite 205, Jacksonville, FL 32204. (904) 353 7878. <http://www.aace.com/>.
- American Association of Critical Care Nurses (AACN). 101 Columbia, Aliso Viejo, CA 92656 4109. (800) 889 AACN [(800) 889 2226] or (949) 362 2000. <http://www.aacn.org>.
- American Association of Endocrine Surgeons (AAES). MetroHealth Medical Center, H920, 2500 MetroHealth Drive, Cleveland, OH 44109 1908. (216) 778 4753. <http://www.endocrinesurgeons.org>.
- American Association of Endodontists, 211 E. Chicago Ave., Suite 1100, Chicago, IL 60611 2691. (800) 872 3636 or (312) 266 7255. Fax: (866) 451 9020 or (312) 266 9867. Email: [info@aae.org](mailto:info@aae.org). <http://www.aae.org>.
- American Association of Gynecologic Laparoscopists. 6757 Katella Avenue. Cypress, CA, 90630 5105. (800) 554 AAGL, (800) 554 2245, (714) 503 6200. <http://www.aagl.org/>.
- American Association of Hip and Knee Surgeons (AAHKS). 704 Florence Drive, Park Ridge, IL 60068 2104. (847) 698 1200. <http://www.aahks.org>.
- The American Association of Immunologists (AAI). 9650 Rockville Pike, Bethesda, MD 20814. (301) 634 7178. [www.12.17.12.70/aa/default/asp..](http://www.12.17.12.70/aa/default/asp..)
- American Association of Kidney Patients. 3505 E. Frontage Rd., Suite 315, Tampa, FL 33607. (800) 749 2257. Fax: 813 636 8122. Email: [info@aakp.org](mailto:info@aakp.org). <http://www.aakp.org>.
- American Association of Managed Care Nurses. 4435 Waterfront Drive, Suite 101, Glen Allen, VA 23060. (804) 747 9698. <http://www.aamcn.org/>.
- American Association of Neurological Surgeons. 5550 Meadowbrook Drive, Rolling Meadows, IL 60008. (888) 566 AANS (2267). Fax: (847) 378 0600. Email: [info@aans.org](mailto:info@aans.org). <http://www.neurosurgery.org/aans/index.asp>.
- American Association of Neuromuscular and Electrophysiological Medicine (AANEM). 421 First Avenue SW, Suite 300 East, Rochester, MN 55902. (507) 288 0100. Fax: (507) 288 1225. Email: [aanem@aanem.org](mailto:aanem@aanem.org). <http://www.aanem.org/index.cfm>.
- American Association of Nurse Anesthetists (AANA). 222 South Prospect Avenue, Park Ridge, IL 60068 4001.

- (847) 692 7050; Fax: (847) 692 6968. Email: info@aana.com. <http://www.aana.com>.
- American Association of Oral and Maxillofacial Surgeons. 9700 West Bryn Mawr Avenue, Rosemont, IL 60018 5701. (847) 678 6200. <http://www.aaoms.org>.
- American Association of Orthopaedic Surgeons. <http://www.aaos.org/>.
- American Association of Retired Persons (AARP). 601 E. Street NW, Washington, DC 20049. (800) 424 3410. <http://www.aarp.org/>.
- American Association of Retired Persons. 601 E. Street NW, Washington, DC 20049. (888) 687 2277. <http://www.aarp.org>.
- American Association of Tissue Banks. 1320 Old Chain Bridge Road, Suite 450, McLean, VA 22101. (703) 827 9582. Fax: (703) 356 2198. Email: aatb@aatb.org. <http://www.aatb.org>.
- American Bar Association. 321 N Clark St., Chicago, IL 60610. 800 285 2221. <http://www.abanet.org/home.html>.
- American Board of Anesthesiology. 4101 Lake Boone Trail, Suite 510, Raleigh, NC 27607 7506. (919) 881 2570. Fax: (919) 881 2575. <http://www.theaba.org>.
- American Board of Medical Specialties (ABMS). 1007 Church St., Suite 404, Evanston, IL 60201. (866) ASK ABMS. (847) 491 9091. <http://www.abms.org>.
- American Board of Neurological Surgery. 6550 Fannin Street, Suite 2139 Houston, TX 77030. (713) 441 6015. <http://www.abns.org>.
- The American Board of Obstetrics and Gynecology. 2915 Vine Street, Suite 300, Dallas, TX 75204. (214) 871 1619; Fax: (214) 871 1943. Email: info@abog.org. <http://www.abog.org>.
- American Board of Ophthalmology. 111 Presidential Boulevard, Suite 241, Bala Cynwyd, PA 19004 1075. (610) 664 1175. info@abop.org. <http://www.abop.org>.
- American Board of Oral and Maxillofacial Surgery. 625 North Michigan Avenue, Suite 1820, Chicago, IL 60611. (312) 642 0070; FAX: (312) 642 8584. [www.aboms.org](http://www.aboms.org).
- American Board of Plastic Surgery. 7 Penn Center, Suite 400, 1635 Market St., Philadelphia, PA 19103 2204. (215) 587 9322. <http://www.abplsurg.org> (accessed March 11, 2008).
- American Board of Surgery. 1617 John F. Kennedy Boulevard, Suite 860, Philadelphia, PA 19103. (215) 568 4000. Fax: (215) 563 5718. <http://www.absurgery.org>.
- American Board of Surgery. 1617 John F. Kennedy Blvd., Suite 860, Philadelphia, PA 19103 1847. (215) 568 4000. Fax: (215) 563 5718. <http://www.absurgery.org>.
- American Board of Urology (ABU). 2216 Ivy Road, Suite 210, Charlottesville, VA 22903. (434) 979 0059. <http://www.abu.org>.
- American Board of Vascular Surgery (ABVS). 900 Cummings Center. #221 U Beverly, MA 01915. <http://abvs.org>.
- American Burn Association. 625 North Michigan Avenue, Suite 1530, Chicago, IL 60611. (312) 642 9260. [www.ameriburn.org](http://www.ameriburn.org).
- American Cancer Society. 1875 Connecticut Avenue, NW, Suite 730, Washington, DC 20009. (800) ACS 2345. <http://www.cancer.org>.
- American Chiropractic Association. 1701 Clarendon Blvd., Arlington, VA 22209. (800) 986 4636. <http://www.amerchiro.org>.
- American Chronic Pain Association (ACPA). P.O. Box 850, Rocklin, CA 95677 0850. (800) 533 3231. <http://www.theacpa.org/index.asp>.
- American Cleft Palate Craniofacial Association. 104 South Estes Drive, Suite 204, Chapel Hill, NC 27514. (919) 933 9044. [www.cleftline.org](http://www.cleftline.org).
- American College of Cardiology. Heart House, 2400 N Street, NW, Washington, DC 20037. (202) 375 6000. <http://www.acc.org>.
- American College of Chest Physicians. 3300 Dundee Road, Northbrook, IL 60062 2348. (847) 498 1400. <http://www.chestnet.org>.
- American College of Clinical Pharmacology. 3 Ellinwood Court, New Hartford, NY 13413 1105. (315) 768 6117. Fax: (315) 768 6119. <http://www.accp1.org>.
- American College of Clinical Pharmacy. 13000 W. 87th St. Parkway, Lenexa KS 66215 4530. (913) 492 3311. Fax: (913) 492 0088. Email: accp@accp.com. <http://www.accp.com>.
- American College of Emergency Physicians (ACEP). 1125 Executive Circle, Irving, TX 75038 2522. (800) 798 1822 or (972) 550 0911. <http://www.acep.org/>.
- American College of Eye Surgeons. 2665 Oak Ridge Court, Suite A, Fort Myers, FL 33901. (239) 275 8881. <http://www.acesabes.org/>.
- American College of Foot and Ankle Surgeons. 8725 West Higgins Road, Suite 555, Chicago, IL 60631 2724. (773) 693 9300, (800) 421 2237. Email: info@acfas.org. <http://www.acfas.org>.
- American College of Gastroenterology. P.O. Box 342260, Bethesda, MD 20827 2260. (301) 263 9000. <http://www.acg.gi.org>.
- American College of Healthcare Executives. One North Franklin, Suite 1700, Chicago, IL 60606 4425. (312) 424 2800. Fax: 312 424 0023. <http://www.ache.org/>.
- American College of Nurse Practitioners. 503 Capitol Ct. NE #300, Washington, DC 20002. (202) 546 4825. [acnp@nurse.org](mailto:acnp@nurse.org).
- American College of Nurse Midwives. 8403 Colesville Road, Suite 1550, Silver Spring, MD 20910. (240) 485 1800. <http://www.midwife.org>.
- American College of Obstetricians and Gynecologists. 409 12th St., SW, P.O. Box 96920, Washington, DC 20090 6920. (202) 638 5577. <http://www.acog.org>.
- American College of Phlebology. 100 Webster Street, Suite 101, Oakland, CA 94607 3724. (510) 834 6500. <http://www.phlebology.org>.
- American College of Physicians American Society of Internal Medicine. Washington Office: 2011 Pennsylvania Avenue NW, Suite 800, Washington, DC 20006 1837. (202) 261 4500 or (800) 338 2746. <http://www.acponline.org>.



- American College of Physicians. 190 N. Independence Mall West, Philadelphia, PA 19106 1572. (800) 523 1546, x2600 or (215) 351 2600. <http://www.acponline.org>.
- American College of Physicians. 190 N. Independence Mall West, Philadelphia, PA 19106 1572. (215) 351 2400, (800) 523 1546. <http://www.acponline.org>.
- American College of Radiology. 1891 Preston White Drive, Reston, VA 20191 4397. (800) 227 5463. (703) 648 8900. <http://www.acr.org>.
- American College of Sports Medicine. 401 West Michigan Street, Indianapolis, IN 46202 3233 (Mailing Address: P.O. Box 1440, Indianapolis, IN 46206 1440). (317) 637 9200. Fax: (317) 634 7817. <http://www.acsm.org>.
- American College of Surgeons. 633 N. Saint Clair Street, Chicago, IL 60611 3231. (312) 202 5000. Fax: (312) 202 5001. Email: [postmaster@facs.org](mailto:postmaster@facs.org). <http://www.facs.org>.
- American Council on Exercise (ACE). 4851 Paramount Drive, San Diego, CA 92123. (888) 825 3636. <http://www.acefitness.org/default.aspx>.
- American CPR Training. 444 Sante Fe Drive #127, Encinitas, CA 92024 5134. (760) 944 1048. <http://www.cprtrainingclasses.com>.
- American Dental Association. 211 E. Chicago Avenue, Chicago, IL 60611. (312) 440 2500. Fax: (312) 440 7494. <http://www.ada.org>.
- American Diabetes Association. National Call Center. 1701 North Beauregard Street, Alexandria, VA 22311. (800) 342 2383. Email: [AskADA@diabetes.org](mailto:AskADA@diabetes.org). <http://www.diabetes.org>.
- American Dietetic Association. Headquarters: 120 South Riverside Plaza, Suite 2000. Chicago, IL 60606 6995. (800) 877 1600. Washington, D.C., Office: 1120 Connecticut Avenue NW, Suite 480. Washington, D.C. 20036. (800) 877 0877. <http://www.eatright.org>.
- American Epilepsy Society. 342 North Main Street, West Hartford, CT 06117 2507. (860) 586 7505. <http://www.aesnet.org/>.
- The American Fertility Association. 305 Madison Avenue Suite 449, New York, NY 10165. (888) 917 3777. <http://www.afafamilymatters.com/>.
- American Gastroenterological Association (AGA). 4930 Del Ray Avenue, Bethesda, MD 20814. (301) 654 2055. Fax: (301) 654 5920. <http://www.gastro.org>.
- American Health Lawyers Association. Suite 600, 1025 Connecticut Avenue NW, Washington, DC 20036 5405. (202) 833 1100. <http://www.healthlawyers.org>.
- American Hearing Research Foundation. 8 S. Michigan Avenue, Suite 814, Chicago, IL 60603. (312) 726 9670. <http://www.americanhearing.org>.
- American Heart Association (AHA). 7272 Greenville Ave. Dallas, TX 75231. (800) 242 8721 or (214) 373 6300. <http://www.americanheart.org>.
- American Herbal Products Association. 8484 Georgia Avenue, Suite 370, Silver Spring, MD 20910. (301) 588 1171. <http://www.ahpa.org>.
- American Hospital Association (AHA). One North Franklin, Chicago, IL 60606 3421. (312) 422 3000 fax: (312) 422 4796. <http://www.aha.org>.
- American Institute of Ultrasound in Medicine. 14750 Sweitzer Lane, Suite 100, Laurel, MD 20707 5906. (301) 498 4100 or (800) 638 5352. <http://www.aium.org>.
- American Kidney Fund (AKF). 6110 Executive Boulevard, Suite 1010. Rockville, MD 20852. (800) 638 8299, (301) 881 3052. Email: [helpline@akfinc.org](mailto:helpline@akfinc.org). <http://www.akfinc.org>.
- American Lithotripsy Society. 305 Second Avenue, Suite 200, Waltham, MA 02451.
- American Liver Foundation. 75 Maiden Lane, Suite 603, New York, NY. 10038. (800) 465 4837 or (888) 443 7872. Fax: (212) 483.8179. Email: [info@liverfoundation.org](mailto:info@liverfoundation.org). <http://www.liverfoundation.org>.
- American Lung Association and American Thoracic Society. 1740 Broadway, New York, NY 10019 4374. (800) 586 4872 or (212) 315 8700. <http://www.lungusa.org> and. <http://www.thoracic.org>.
- American Medical Association. 515 N. State Street, Chicago, IL 60610. (312) 464 5000. <http://www.ama-assn.org>.
- American Medical Informatics Association. 4915 St. Elmo Avenue, Suite 401, Bethesda, MD 20814. (301) 657 1291. Fax: (301) 657 1296. <http://www.amia.org>.
- American Medical Technologists. 710 Higgins Road, Park Ridge, IL 60068 5765. (847) 823 5169. [www.amtl.com](http://www.amtl.com).
- American Nurses Association. 8515 Georgia Avenue, Suite 400, Silver Spring, MD 20910. (800) 274 4ANA (4262). <http://www.nursingworld.org>.
- American Obesity Association. 1250 24th Street, NW, Suite 300, Washington, DC 20037. (202) 776 7711. <http://www.obesity.org>.
- American Optometric Association. 243 North Lindbergh Blvd., St. Louis, MO 63141. (314) 991 4100. <http://www.aoanet.org>.
- American Orthopaedic Foot & Ankle Society. 2517 Eastlake Avenue East, Seattle, WA 98102. <http://www.aofas.org>.
- American Osteopathic Association (AOA). 142 East Ontario Street, Chicago, IL 60611. (800) 621 1773 or (312) 202 8000. <http://www.aoanet.org>.
- American Osteopathic College of Otolaryngology Head and Neck Surgery. 405 W. Grand Avenue, Dayton, OH 45405. (937) 222 8820 or (800) 455 9404. Fax: (937) 222 8840. Email: [info@aocoohns.org](mailto:info@aocoohns.org).
- American Osteopathic College of Radiology. 119 East Second St., Milan, MO 63556. (660) 265 4011. [www.aocr.org](http://www.aocr.org).
- American Pain Society. 4700 West Lake Ave., Glenview, IL 60025. (847) 375 4715. <http://www.ampainsoc.org>.
- American Pediatric Surgical Association (APSA). 60 Revere Drive, Suite 500, Northbrook, IL 60062. (847) 480 9576. Fax: (847) 480 9282 Email: [eapsa@eapsa.org](mailto:eapsa@eapsa.org).
- The American Physical Therapy Association (APTA). 1111 North Fairfax Street, Alexandria, VA 22314. (703) 684 APTA or (800) 999 2782. <http://www.apta.org>.
- American Podiatric Medical Association. 9312 Old Georgetown Road, Bethesda, MD 20814 1621. (301) 581 9200. <http://www.apma.org>.

- American Podiatric Medical Association. 9312 Old Georgetown Road, Bethesda, MD 20814. (301) 581 9200. <http://www.apma.org>.
- American Professional Wound Care Association (APWCA). 853 Second Street Pike, Suite #A 1, Richboro, PA 18954. (215) 364 4100. Fax: (215) 364 1146. Email: [wounds@apwca.org](mailto:wounds@apwca.org). <http://www.apwca.org>.
- American Prostate Society. P. O. Box 870, Hanover, MD 21076. (800) 308 1106. <http://www.ameripros.org>.
- American Psychiatric Association. 1000 Wilson Boulevard, Suite 1825, Arlington, VA 22209 3901. (703) 907 7300. Email: [apa@psych.org](mailto:apa@psych.org). <http://www.psych.org>.
- American Psychological Association. 750 First Street, NE, Washington, DC 20002 4242. (202) 336 5500, (800) 374 2721. <http://www.apa.org>.
- American Red Cross National Headquarters. 2025 E Street, NW. Washington, DC 20006. (703) 206 6000. <http://www.redcross.org>.
- American Registry of Diagnostic Medical Sonographers (ARDMS). 51 Monroe Street, Plaza East One, Rockville, MD 20850 2400. (800) 541 9754, (301) 738 8401. Fax: (301) 738 0312. <http://www.ardms.org>.
- American Shoulder and Elbow Surgeons. 6300 N. River Road, Suite 727, Rosemont, IL 60018. (847) 698 1629. <http://www.ases-assn.org>.
- American Sleep Apnea Association. 1424 K Street NW, Suite 302, Washington, DC 20005. (202) 293 3650. <http://www.sleepapnea.org>.
- American Society for Aesthetic Plastic Surgery. 11081 Winners Circle, Los Alamitos, CA 90720. (800) 364 2147 or (562) 799 2356. <http://www.surgery.org>.
- American Society for Bariatric Surgery. 7328 West University Avenue, Suite F, Gainesville, FL 32607. (352) 331 4900. <http://www.asbs.org>.
- American Society for Blood and Marrow Transplantation (ASBMT). 85 W. Algonquin Road, Suite 550 Arlington Heights, IL 60005. (847) 427 0224. [mail@asbmt.org](mailto:mail@asbmt.org).
- American Society for Bone and Mineral Research. 2025 M Street, NW, Suite 800, Washington, DC 20036 3309. (202) 367 1161. <http://www.asbmr.org/>.
- American Society for Clinical Laboratory Science. 6701 Democracy Boulevard, Suite 300. Bethesda, MD 20817. (301) 657 2768. Fax: (301) 657 2909. Email: [ascls@ascls.org](mailto:ascls@ascls.org). <http://www.ascls.org>.
- The American Society for Clinical Pathology. 1225 New York Ave., NW, Suite 250, Washington, DC 20005. (202) 347 4450. <http://www.ascp.org>.
- American Society for Colposcopy and Cervical Pathology. 152 West Washington Street, Hagerstown, MD 21740. (301) 733 3640, (800) 787 7227. <http://www.ascp.org>.
- American Society for Dermatologic Surgery (ASDS). 5550 Meadowbrook Dr., Suite 120, Rolling Meadows, IL 60008. (847) 956 0900. Fax: 8470 956 0999. <http://www.asds-net.org>.
- American Society for Gastrointestinal Endoscopy (ASGE). 1520 Kensington Rd., Suite 202, Oak Brook, IL 60523. (630) 573 0600, (866) 353 ASGE (2743). Fax: (630) 573 0691. Email: [info@asge.org](mailto:info@asge.org). <http://www.asge.org>.
- American Society for Laser Medicine and Surgery. 2404 Stewart Square, Wausau, WI 54401. (715) 845 9283. <http://www.aslms.org>.
- American Society for Metabolic and Bariatric Surgery. 100 SW 75th Street, Suite 201, Gainesville, FL 32607. (352) 331 4900. <http://www.asbs.org>.
- American Society for Microbiology. 1752 N Street, NW, Washington, DC 20036. (202) 737 3600. <http://www.asm.org>.
- American Society for Mohs Surgery. Private Mail Box 391, 5901 Warner Avenue, Huntington Beach, CA 92649 4659. (714) 840 3065. (800) 616 ASMS (2767). [www.mohssurgery.org](http://www.mohssurgery.org).
- American Society for Reconstructive Microsurgery. 20 North Michigan Ave., Suite 700, Chicago, IL 60602. (312) 456 9579. <http://www.microsurg.org>.
- American Society for Reproductive Medicine. 1209 Montgomery Highway, Birmingham, AL 35216 2809. (205) 978 5000. <http://www.asrm.com>.
- American Society for Surgery of the Hand. 6300 North River Road, Suite 600, Rosemont, IL 60018 4256. (847) 384 8300. [www.assh.org](http://www.assh.org).
- The American Society of Anesthesiologists (ASA). 520 North Northwest Highway, Park Ridge, IL 60068 2573. (847) 825 5586. Fax: (847) 825 1692. Email: [mail@asahq.org](mailto:mail@asahq.org). <http://www.asahq.org>.
- American Society of Bariatric Physicians (ASBP). 5453 East Evans Place, Denver, CO 80222 5234. (303) 770 2526. <http://www.asbp.org>.
- American Society of Cataract and Refractive Surgery (ASCRS). 4000 Legato Road, Suite 700, Fairfax, VA 22033. (703) 591 2220. Fax: (703) 591 0614. <http://www.ascrs.org>.
- American Society of Clinical Oncology (ASCO). 1900 Duke Street, Suite 200, Alexandria, VA 22314. (703) 299 0150. [www.asco.org](http://www.asco.org).
- American Society of Clinical Pathologists. Corporate Headquarters: 33 West Monroe Street, Suite 1600. Chicago, IL 60603. (312) 541 4999. Fax: (312) 541 4998. Board of Registry (Certification Maintenance, Exam Application and Eligibility, International Certification): (800) 267 2727, option 2, 2. Fax: (312) 541 4845. Email: [bor@ascp.org](mailto:bor@ascp.org). Indianapolis (Check Path, Cytology, GYN, Non GYN, Proficiency Testing): 8900 Keystone Crossing, Suite 620. Indianapolis, IN 46240. (317) 569 9470. Fax: (317) 569 0221. Washington (Advocacy, ePolicy, Government Relations): 1225 New York Avenue, NW, Suite 250. Washington, DC 20005. (202) 347 4450. Fax: (202) 347 4453. <http://www.ascp.org>.
- American Society of Colon and Rectal Surgeons. 85 W. Algonquin Rd., Suite 550. Arlington Heights, IL 60005. (847) 290 9184. Fax: (847) 290 9203. Email: [ascrs@fascrs.org](mailto:ascrs@fascrs.org). <http://www.fascrs.org>.
- American Society of Echocardiography. 1500 Sunday Drive, Suite 102, Raleigh, NC 27607. (919) 861 5574. <http://www.asecho.org>.

- American Society of Electroneurodiagnostic Technologists Inc, 204 W. 7th Carroll, IA 51401. (712) 792 2978. <http://www.aset.org/>.
- American Society of Health System Pharmacists (ASHP). 7272 Wisconsin Avenue, Bethesda, MD 20814. (301) 657 3000; toll free: (866) 279 0681 (United States and Canada only); International: 001 301 664 8700. [www.ashp.org](http://www.ashp.org).
- American Society of Nephrology. 1725 I Street, NW, Suite 510. Washington, DC 20006. (202) 659 0599. Fax: (202) 659 0709. Email: [email@asn.org](mailto:email@asn.org). <http://www.asn.org>.
- The American Society of Perianesthesia Nurses (ASPN). 10 Melrose Avenue, Suite 110, Cherry Hill, NJ 08003 3696. (877) 737 9696 or (856) 616 9600. Fax: (856) 616 9601. Email: [aspan@aspan.org](mailto:aspan@aspan.org). <http://www.aspan.org>.
- American Society of Plastic and Reconstructive Surgeons. 444 E. Algonquin Road, Arlington Heights, IL 60005. (847) 228 9900. <http://www.plasticsurgery.org>.
- American Society of Plastic Surgeons, Plastic Surgery Educational Foundation. 444 E. Algonquin Rd., Arlington Heights, IL 60005. Public Relations: (847) 228 9900. Email: [media@plasticsurgery.org](mailto:media@plasticsurgery.org). <http://www.plasticsurgery.org>.
- American Society of Radiologic Technologists. 15000 Central Ave. SE. Albuquerque, NM 87123 3909. (800) 444 2778, (505) 298 4500. Fax: (505) 298 5063. Email: [customerinfo@asrt.org](mailto:customerinfo@asrt.org). <http://www.asrt.org>.
- American Society of Transplant Surgeons (ASTS). 2461 South Clark St., Suite 640, Arlington, VA 22202. (703) 414 7870. <http://www.ast.org>.
- American Society of Transplantation (AST). 15000 Commerce Parkway, Suite C. Mt. Laurel, NJ, 08054. (856) 439 9986. Fax: (856) 439 9982. Email: [ast@ahint.com](mailto:ast@ahint.com). <http://www.ast.org>.
- American Society Parenteral and Enteral Nutrition. 8630 Fenton St., Suite 412, Silver Springs, Maryland 20910. (301) 587 6315. Fax: (301) 587 2365. [www.clinnutr.org](http://www.clinnutr.org).
- American Speech Language Hearing Association. 2200 Research Boulevard, Rockville, MD 20850 3289. (800) 638 8255. <http://www.asha.org>.
- American Urological Association Foundation. 1000 Corporate Boulevard, Linthicum, MD 21090. 1 866 RING AUA (1 866 746 4282). (410) 689 3700. Fax: (410) 689 3800. Email: [aualfoundation@aualfoundation.org](mailto:aualfoundation@aualfoundation.org). <http://www.aualfoundation.org>. <http://www.urologyhealth.org>.
- American Yoga Association. P.O. Box 19986. Sarasota, FL 34276. Email: [info@americanyogaassociation.org](mailto:info@americanyogaassociation.org). <http://www.americanyogaassociation.org>.
- Anesthesia Patient Safety Foundation (APSF). Building One, Suite Two, 8007 South Meridian Street, Indianapolis, IN 46217 2922. [www.apsf.org](http://www.apsf.org).
- Applied Biometrics. 501 East Highway Thirteen, Suite 108, Burnsville, MN 55337. (952) 890 1123
- Arthritis Foundation. P.O. Box 7669, Atlanta, GA 30357 0669. (800) 283 7800. <http://www.arthritis.org>.
- Associated Jehovah's Witnesses for Reform on Blood (AJWRB). P. O. Box 190089, Boise, ID 83719 0089. <http://www.ajwr.org>.
- Association for Applied Psychotherapy and Biofeedback. 10200 W. 44th Avenue, Suite 304, Wheat Ridge, CO 80033. (303) 422 8436. <http://www.aapb.org>.
- Association for Research in Otolaryngology. 19 Mantua Rd., Mt. Royal, NJ 08061. (856) 423 0041. (301) 733 3640. <http://www.aro.org/index.html>.
- Association of periOperative Registered Nurses (AORN). 2170 South Parker Road, Suite 300. Denver, CO 80231. (800) 755 2676. (303) 755 6304. Fax: (303) 750 3212. Email: [custsvc@aorn.org](mailto:custsvc@aorn.org). <http://www.aorn.org>.
- Association of Surgical Technologists. 6 West Dry Creek Circle, Suite 200, Littleton, CO 80120 8031. (303) 694 9130. Fax: (303) 694 9169. <http://www.ast.org>.
- Association of Thyroid Surgeons. 717 Buena Vista St., Ventura, CA 93001. Fax: (509) 479 8678. Email: [info@thyroidsurgery.org](mailto:info@thyroidsurgery.org). [www.thyroidsurgery.org](http://www.thyroidsurgery.org).
- Association of Women's Health, Obstetric, and Neonatal Nurses. 2000 L St., NW, Suite 740, Washington, DC 20036. (202) 261 2400, (800) 673 8499. <http://www.awhonn.org>.
- Asthma and Allergy Foundation of America. 1125 15th Street NW, Suite 502, Washington, DC 20005. Telephone: (800) 727 8462. Web site: <http://www.aafa.org>.

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**B**

- Better Hearing Institute. 515 King Street, Suite 420, Alexandria, VA 22314. (703) 684 3391.
- Biofeedback Certification Institute of America. 10200 W. 44th Avenue, Suite 310, Wheat Ridge, CO 80033. (303) 420 2902. <http://www.bcia.org>.
- BMT Infonet (Blood and Marrow Transplant Information Network). 2900 Skokie Valley Road, Suite B, Highland Park, IL 60035. (847) 433 3313, (888) 597 7674. [help@bmtinfonet.org](mailto:help@bmtinfonet.org). <http://www.bmtinfonet.org>.
- Brain Injury Association. 1608 Spring Hill Road, Suite 110, Vienna, VA 22182. (703) 761 0750. <http://www.biausa.org>.
- Breast Cancer Network of Strength Headquarters (formerly known as Y ME National Breast Cancer Organization). 212 W. Van Buren, Suite 1000, Chicago, IL 60607 3903. (312) 986 8338. Fax: (312) 294 8597. <http://www.networkofstrength.org>.
- British Association of Oral and Maxillofacial Surgeons, Royal College of Surgeons. 35 43 Lincoln's Inn Fields, London, UK WC2A 3PN. [www.baoms.org.uk](http://www.baoms.org.uk).

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**C**

- California Association for Adult Day Services. 921 11th Street Suite 1101, Sacramento, CA 95814. (916) 552 7400. Fax: (916) 552 7404. Email: [caads@caads.org](mailto:caads@caads.org). <http://www.caads.org>.

- Canadian Association of Gastroenterology (CAG). 2902 South Sheridan Way, Oakville, ON L6J 7L6 (888) 780 0007 or (905) 829 2504. [www.cag-acg.org](http://www.cag-acg.org).
- Canadian Institute for Health Information/Institut canadien d'information sur la santé (CIHI). 377 Dalhousie Street, Suite 200, Ottawa, ON K1N 9N8. (613) 241 7860. <http://secure.cihi.ca/cihiweb>.
- Canadian Ophthalmological Society (COS). 610 1525 Carl ing Avenue, Ottawa ON K1Z 8R9 Canada. <http://www.eyesite.ca>.
- Canadian Prostate Cancer Network. P. O. Box 1253, Lake field, ON K0L 2H0 Canada. (705) 652 9200. <http://www.cpcn.org>.
- Cancer Information Service. National Cancer Institute, Public Inquiries Office. 6116 Executive Boulevard, Room 3036A. Bethesda, MD 20892 8322. (800) 4 CANCER (800 422 6237). TTY: (800) 332 8615. <http://www.cancer.gov>.
- Cancer Research Institute. 681 Fifth Avenue, New York, NY 10022. (800) 992 2623. <http://www.cancerresearch.org>.
- Cancercare. Health Resources and Services Administration. 5600 Fishers Lane, Rm. 14 45, Rockville, MD 20857. (301) 443 3376. (800) 813 HOPE (4673). <http://www.cancercare.org>.
- Cardiac Arrhythmia Research and Education Foundation (C.A.R.E.). 2082 Michelson Dr. #301, Irvine, CA 92612. (800) 404 9500. [www.longqt.com/](http://www.longqt.com/).
- Cardiac Electrophysiology Society. <http://www.cardiaceps.org/>.
- Center for Biologics Evaluation and Research (CBER), U.S. Food and Drug Administration (FDA). 1401 Rockville Pike, Rockville, MD 20852 1448. (800) 835 4700 or (301) 827 1800. <http://www.fda.gov/cber>.
- Center for Devices and Radiological Health. United States Food and Drug Administration. 1901 Chapman Ave., Rockville, MD 20857. (301) 443 4109. <http://www.fda.gov/cdrh>.
- Center for Emergency Medicine of Western Pennsylvania. 230 McKee Place, Suite 500, Pittsburgh, PA 15213. (412) 647 5300. <http://www.centerem.org>.
- Center for Fetal Diagnosis and Treatment, Children's Hos pital of Philadelphia. 34th Street and Civic Center Boulevard, Philadelphia, PA 19104 4399. (800) IN UTERO. <http://fetalsurgery.chop.edu>.
- Center for Hip and Knee Replacement, Columbia Univer sity. Department of Orthopaedic Surgery, Columbia Presbyterian Medical Center, 622 West 168th Street, PH11 Center, New York, NY 10032. (212) 305 5974. [www.hipnknee.org](http://www.hipnknee.org).
- Center for Male Reproductive Medicine. 2080 Century Park East, Suite 907, Los Angeles, CA 90067. (310) 277 2873. [www.malereproduction.com](http://www.malereproduction.com).
- Center for Medicare Advocacy, P.O. Box 350, Willimantic, CT 06226. (860) 456 7790 or (202) 216 0028. <http://www.medicareadvocacy.org>.
- Center for Uterine Fibroids, Brigham and Women's Hospi tal. 623 Thorn Building, 20 Shattuck Street, Boston, MA 02115. (800) 722 5520. <http://www.fibroids.net>.
- Centers for Disease Control and Prevention (CDC). 1600 Clifton Rd, Atlanta, GA 30333. (404) 498 1515, (800) 311 3435. <http://www.cdc.gov>.
- Centers for Disease Control and Prevention (CDC). Cancer Prevention and Control Program. 4770 Buford High way, NE, MS K64, Atlanta, GA 30341. (888) 842 6355. <http://www.cdc.gov/cancer/comments.htm>.
- Centers for Disease Control and Prevention (CDC). Divi sion of Diabetes Translation, National Center for Chronic Disease Prevention and Health Promotion. TISB Mail Stop K 13, 4770 Buford Highway NE, Atlanta, GA 30341 3724. (770) 488 5080. <http://www.cdc.gov/diabetes>.
- Centers for Disease Control and Prevention, Division of Reproductive Health. 4770 Buford Highway, NE, Mail Stop K 20, Atlanta, GA 30341 3717. (770) 488 5200. <http://www.cdc.gov/reproductivehealth>.
- Centers for Medicare & Medicaid Services. 7500 Security Boulevard, Baltimore MD 21244 1850. (800) MEDI CARE (800 633 4227). TTY: (877) 486 2048. <http://www.cms.hhs.gov/>.
- Centre for Minimal Access Surgery (CMAS). 50 Charlton Avenue E., Hamilton, Ontario L8N 4A6 Canada. (905) 522 1155 x 5144. <http://www.cmas.ca/>.
- Charles P. Felton National Tuberculosis Center, 2238 Fifth Avenue, First Floor, New York, NY 10037. (212) 939 8254. <http://www.harlemtbcenter.org/>.
- Children's Health Information Network. 1561 Clark Drive, Yardley, PA 19067. (215) 493 3068. <http://www.tchin.org>.
- Children's Hospice International (CHI). 1101 King Street, Suite 360, Alexandria, VA 22314. (703) 684 0330 or (800) 2 4 CHILD. <http://www.chionline.org>.
- Children's Organ Transplant Association, Inc. 2501 West COTA Drive, Bloomington, IN 47403. (800) 366 2682. <http://www.cota.org>.
- The Cleveland Clinic Heart and Vascular Institute, The Cleveland Clinic Foundation. 9500 Euclid Avenue, F25, Cleveland, Ohio, 44195. (216) 445 9288. <http://www.clevelandclinic.org/heartcenter>.
- The Cleveland Clinic Heart Center, The Cleveland Clinic Foundation. 9500 Euclid Avenue, F25, Cleveland, OH 44195. (800) 223 2273 ext. 46697 or (216) 444 6697. <http://www.clevelandclinic.org/heartcenter>.
- The Coalition on Donation. 700 North 4th Street, Rich mond, VA 23219. (804) 782 4920. <http://www.organtransplants.org/donor/coalition/>.
- College of American Pathologists. 325 Waukegan Rd., Northfield, IL 60093 2750. (800) 323 4040. <http://www.cap.org/apps/cap.portal>.
- Colorectal Cancer Network (CCNetwork). P.O. Box 182, Kensington, MD 20895 0182. (301) 879 1500. <http://clickonium.com/colorectal-cancer.net/html>.
- Congenital Heart Anomalies Support, Education & Resources, Inc. 2112 North Wilkins Road, Swanton, OH 43558. (419) 825 5575. <http://www.csun.edu/~hfmth006/chaser>.
- Council for Refractive Surgery Quality Assurance. 8543 Everglade Drive, Sacramento, CA 95826 0769.



(916) 381 0769. Email: [info@usaeyes.org](mailto:info@usaeyes.org).  
[www.usaeyes.org](http://www.usaeyes.org).

Council on Size and Weight Discrimination (CSWD). P. O. Box 305, Mt. Marion, NY 12456. (845) 679 1209. <http://www.cswd.org/index.html>.

Crohn's and Colitis Foundation of America. 386 Park Ave. S., 17th Floor, New York, NY 10016. (800) 932 2423. [www.ccfa.org](http://www.ccfa.org).

## D

DES Action USA. 158 S. Stanwood Rd., Columbus, OH 43209. (800) 337 9288. <http://www.desaction.org>.

Diabetic Retinopathy Foundation. 350 North LaSalle, Suite 800, Chicago, IL 60610. [www.retinopathy.org](http://www.retinopathy.org).

Division of Blood Diseases and Resources. The National Heart, Lung and Blood Institute (NHLBI). Two Rockledge Center, Suite 10138, 6701 Rockledge Drive, MSC 7950, Bethesda, MD 20892 7950. <http://www.nhlbi.nih.gov/about/dbdr>.

Division of Transplantation, Health Resources and Services Administration (HRSA). 5600 Fishers Lane, Rm. 14 45, Rockville, MD 20857. 301 443 3376. <http://www.organdonor.gov/>.

## E

e Healthcare Solutions, Inc., 953 Route 202 North, Branchburg, N.J. 08876. (908) 203 1350. Fax: (908) 203 1307. [info@ehealthcaresolutions.com](mailto:info@ehealthcaresolutions.com). <http://www.digitalhealthcare.com/>.

EA/TEF Child and Family Support Connection. 111 West Jackson Blvd., Suite 1145, Chicago, IL 60604. (312) 987 9085. [www.eatef.org](http://www.eatef.org).

Emphysema Anonymous, Inc. P.O. Box 3224, Seminole FL 34642. (813) 391 9977.

Endometriosis Association. 8585 North 76th Place, Milwaukee, WI 53223. (414) 355 2200. <http://www.endometriosisassn.org>.

Epilepsy Foundation of America. 8301 Professional Place, Landover MD 20785. (800) 332 1000. <http://www.epilepsyfoundation.org>.

The European Institute of TeleSurgery (EITS). Hôpitaux Universitaires 1, place de l'Hôpital 67091 Strasbourg Cedex, France. +33 (0)3 88 11 90 00. <http://www.eits.fr/homepage.php>.

Extracorporeal Life Support Organization (ELSO). 1327 Jones Dr., Ste. 101, Ann Arbor, MI 48105. (734) 998 6600. <http://www.else.med.umich.edu/>.

Eye Bank Association of America. 1015 Eighteenth Street NW, Suite 1010, Washington, D.C. 20036. (202) 775 4999. <http://www.restoresight.org>.

## F

FACES: The National Craniofacial Association. P. O. Box 11082, Chattanooga, TN 37401. (800) 332 2373. <http://www.facescranio.org>.

Federal Bureau of Investigation (FBI), Laboratory Division. J. Edgar Hoover Building, 935 Pennsylvania Avenue, NW, Washington, DC 20535 0001. [www.fbi.gov/hq/lab/labhome.htm](http://www.fbi.gov/hq/lab/labhome.htm).

Federal Drug Administration (FDA), 5600 Fishers Ln., Rockville, MD 20857. (800) 532 4440. <http://www.fda.gov>.

Federated Ambulatory Surgery Association (FASA). 700 North Fairfax Street, #306, Alexandria, VA 22314. (703) 836 8808. <http://www.fasa.org>.

Federation of State Medical Boards. P.O. Box 619850, Dallas, TX 75261 9850. (817) 868 4000. Fax: (817) 868 4099. <http://www.fsmb.org>.

Fetal Treatment Center, University of California San Francisco. 513 Parnassus Ave., HSW 1601, San Francisco, CA 94143 0570. (800) RX FETUS or (415) 353 8489. <http://www.fetus.ucsf.edu>.

Franklin Institute Science Museum. 222 North 20th Street, Philadelphia, PA, 19103. (215) 448 1200. <http://sln2.fi.edu/biosci/heart.html>.

## G

The Glaucoma Foundation. 116 John Street, Suite 1605, New York, NY 10038. (212) 285 0080 or (800) 452 8266. Email: [info@glaucomafoundation.org](mailto:info@glaucomafoundation.org). <http://www.glaucomafoundation.org>.

The Glaucoma Research Foundation. 490 Post Street, Suite 1427, San Francisco, CA 94102. (415) 986 3162 or (800) 826 6693. <http://www.glaucoma.org>.

Gynecologic Surgery Society. 2440 M Street, NW, Suite 801, Washington, DC 20037. (202) 293 2046. <http://www.gynecologicsurgerysociety.org>.

## H

Harry Benjamin International Gender Dysphoria Association, Inc. (HBI-GDA). 1300 South Second Street, Suite 180, Minneapolis, MN 55454. (612) 625 1500. <http://www.hbigda.org>.

Health Canada/Santé Canada. A.L. 0900C2, Ottawa, Canada K1A 0K9. (613) 957 2991. <http://www.hc-sc.gc.ca>.

Health Insurance Association of America. 601 Pennsylvania Avenue, NW, South Building, Washington, DC 20004 1204. (202) 778 3200. <http://www.hiaa.org>.

Hearing Loss Link. 2600 W. Peterson Ave., Ste. 202, Chicago, IL 60659. (312) 743 1032, (312) 743 1007 (TDD).

Hepatitis Foundation International (HFI). 504 Blick Drive, Silver Spring, MD. 20904 2901. (800) 891 0707 or (301) 622 4200. Fax: (301) 622 4702. Email: [hfi@comcast.net](mailto:hfi@comcast.net). <http://www.hepfi.org>.

Hospice Foundation of America. 2001 S. Street NW, Suite 300, Washington, DC 20009. (800) 854 3402. (202) 638 5419. Fax: (202) 638 5312. Email: [jon@hospicefoundation.org](mailto:jon@hospicefoundation.org). <http://www.hospicefoundation.org>.

ICU USA. 29 Summerhill, Suite 100, St. Louis, MO 63017. (866) 377 4442. Email: [charlie.owen@icu-usa.com](mailto:charlie.owen@icu-usa.com). <http://www.icu-usa.com>.

Immune Tolerance Network (ITN). 5743 South Drexel Avenue, Suite 200, Chicago, IL 60637. (773) 834 5341. <http://www.immunetolerance.org>.

Infusion Nurses Society. 315 Norwood Park South, Norwood, MA 02062. (781) 440.9408. <http://www.insl.org>.

Institute for Bone and Joint Disorders. 2222 East Highland Avenue, Phoenix, AZ 85016; 602 553 3113. <http://www.ibjd.com>.

Institute of Medicine (IOM). The National Academies. 500 Fifth Street, NW, Washington, DC 20001. [www.iom.edu](http://www.iom.edu).

Inter Institutional Collaborating Network on End of Life Care (IICN). (415) 863 3045. <http://www.growthhouse.org>.

International Association for the Study of Pain (IASP). 111 Queen Anne Avenue North, Suite 501, Seattle, WA 98109 4955. (206) 283 0311. <http://www.iasp-pain.org/AM/Template.cfm?Section=Home>.

International Association of Laryngectomees (IAL). <http://www.larynxlink.com/>.

International Bariatric Surgery Registry (IBSR). University of Iowa Hospitals and Clinics, 200 Hawkins Drive, Iowa City, IA 52242. (319) 384 7359. <http://www.healthcare.uiowa.edu/surgery/ibsr/>.

International Bone Marrow Transplant Registry/Autologous Blood and Marrow Transplant Registry N. America. Health Policy Institute, Medical College of Wisconsin, 8701 Watertown Plank Road, P.O. Box 26509, Milwaukee, WI 53226. (414) 456 8325. [ibmtr@mcw.edu](mailto:ibmtr@mcw.edu).

International Cesarean Awareness Network. 1304 Kingsdale Ave., Redondo Beach, CA 90278. (310) 542 6400. <http://www.ican-online.org>.

International Council on Infertility Information Dissemination, Inc. P.O. Box 6836, Arlington, VA 22206. (703) 379 9178. <http://www.inciid.org>.

International Craniofacial Institute, Cleft Lip & Palate Treatment Center. Medical City Dallas. 7777 Forest Lane, Suite C 717, Dallas, TX 75230. (972) 566 6555, (800) 344 4068. Fax: (972) 566 6017. Email: [info@craniofacial.net](mailto:info@craniofacial.net). <http://www.craniofacial.net>.

International EECF Therapists Association. P.O. Box 650005, Vero Beach, FL 32965 0005. (800) 376 3321, ext. 140. <http://www.ietonline.com>.

International Foundation for Functional Gastrointestinal Disorders (IFFGD). P.O. Box 170864, Milwaukee, WI 53217 8076. (888) 964 2001 or (414) 964 1799. fax: (414) 964 7176. <http://www.iffgd.org>.

International Pancreas Transplant Registry (IPTR). University of Minnesota Department of Surgery, Mayo Mail Code 280, 420 Delaware Street SE, Minneapolis, MN 55455 0392. <http://www.iptr.umn.edu/>.

International Radiosurgery Support Association (IRSA). 3005 Hoffman Street, Harrisburg, PA 17110. (717) 260 9808. [www.irsa.org](http://www.irsa.org).

Interstitial Cystitis Association. 51 Monroe Street, Suite 1402, Rockville, MD 20850. (301) 610 5300. <http://www.ichelp.org>.

Johns Hopkins Radiosurgery. Weinberg 1469, 600 North Wolfe Street, Baltimore, MD 21287. (410) 614 2886. [www.hopkinsmedicine.org/radiosurgery/treatmentoptions/stereotacticradiosurgery.cfm](http://www.hopkinsmedicine.org/radiosurgery/treatmentoptions/stereotacticradiosurgery.cfm).

Joint Commission (on Accreditation of Health Care Organizations). One Renaissance Blvd. Oakbrook Terrace, IL 60181. (630) 792 5000. Fax: (630) 792 5005.

Kaiser Family Foundation. 2400 Sand Hill Road, Menlo Park, CA 94025, Phone: (650) 854 9400. Fax: (650) 854 4800. <http://www.kff.org/>.

League of Intravenous Therapy Education. Empire Building, Suite 3, 3001 Jacks Run Road. White Oak, PA 15131. (412) 678 5025. <http://www.lite.org/>.

Leukemia & Lymphoma Society. 1311 Mamaroneck Avenue, White Plains, NY 10605. (914) 949 5213. Fax: (914) 949 6691. <http://www.leukemia.org>.

The Lymphoma Research Foundation of America. 8800 Venice Boulevard, Suite 207, Los Angeles, CA 90034. (800) 500 9976. (310) 204 7040. [helpline@lymphoma.org](mailto:helpline@lymphoma.org). <http://www.lymphoma.org>.

March of Dimes Birth Defects Foundation. 1275 Mamaroneck Avenue; White Plains, NY. Telephone (914) 428 7100. <http://www.modimes.org>.

Mayo Clinic. 200 First St. S.W., Rochester, MN 55905. (507) 284 2511. <http://www.mayoclinic.com>.

Medline Plus a service of the National Library of Medicine and the National Institutes of Health, 8600 Rockville Pike, Bethesda, MD 20894. <http://www.nlm.nih.gov/medlineplus/>.

Midlife Women's Network. 5129 Logan Ave. S., Minneapolis, MN 55419. (800) 886 4354.

Midwives Alliance of North America. 611 Pennsylvania Avenue, SE, #1700, Washington, DC 20003 4303. (888) 923 MANA. <http://www.mana.org>.

Mitral Valve Repair Center at Mount Sinai Hospital. 1190 Fifth Avenue, New York, NY 10029 (212) 659 6820. <http://www.mitralvalverepair.org>.

Muscular Dystrophy Association. 3300 E. Sunrise Drive, Tucson, AZ 85718. (800) 572 1717. <http://www.mdausa.org>.

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## N

National Abortion Federation. 1660 L Street, NW, Suite 450, Washington, DC 20036. (202) 667 5881. <http://www.prochoice.org>.

National Accrediting Agency for Clinical Laboratory Sciences. 8410 W Bryn Mawr Ave., Suite 670, Chicago, IL 60631. (773) 714 8880. Fax: (773) 714 8886. Email: [info@naaccls.org](mailto:info@naaccls.org). <http://www.naaccls.org>.

National Adult Day Services Association. 85 South Washington, Suite 316, Seattle, WA 98104. (877) 745 1440. Fax: (206) 461 3218. Email: [info@nadsa.org](mailto:info@nadsa.org). <http://www.nadsa.org>.

National Alliance of Breast Cancer Organizations (NABCO). 9 East 37th Street, 10th Floor, New York, NY 10016. (888) 80 NABCO. <http://www.nabco.org>.

National Amputation Foundation. 40 Church Street, Malverne, NY 11565. (516) 887 3600. [www.nationalamputation.org/](http://www.nationalamputation.org/).

National Association for Continence (NAFC). P.O. Box 1019, Charleston, SC 29402 1019. (800) BLADDER, (843) 377 0900. Fax: (843) 377 0905. Email: [memberservices@nafc.org](mailto:memberservices@nafc.org). <http://www.nafc.org>.

National Association for Home Care & Hospice. 228 7th Street, SE, Washington, DC 20003. (202) 547 7424. Fax: (202) 547 3540. <http://www.nahc.org>.

National Association for the Deaf. 814 Thayer Ave., Silver Spring, MD 20910. (301) 587 1788, (301) 587 1789 (TDD). <http://www.nad.org>.

National Association for Women's Health. 300 W. Adams Street, Suite 328, Chicago, IL 60606 5101. (312) 786 1468. <http://www.nawh.org>.

National Association of Emergency Medical Technicians (NAEMT). P. O. Box 1400, Clinton, MS 39060 1400. (800) 34 NAEMT. [www.naemt.org](http://www.naemt.org).

National Association of Insurance Commissioners. 2301 McGee Street, Suite 800, Kansas City, MO 64108. (816)842 3600. <http://www.naic.org/>.

National Association of Neonatal Nurses. 4700 West Lake Ave., Glenview, IL 60025 1485. (847) 375 3660 or (800) 451 3795. <http://www.nann.org>.

National Association to Advance Fat Acceptance (NAAFA). P.O. Box 22510, Oakland, CA 94609. (916) 558 6880. <http://www.naafa.org/>.

National Blood Data Resource Center (NBDRC). 8101 Glenbrook Road, Bethesda, MD 20814 2749. (301) 215 6506. <http://www.nbdrc.org>.

National Bone Marrow Transplant Link. 20411 W. 12 Mile Road, Suite 108, Southfield, MI 48076. (800) LINK BMT (800 546 5268).

National Breast Cancer Coalition. 1101 17th Street, NW, Suite 1300, Washington, DC 20036. (800) 622 2838. Fax: (202) 265 6854. <http://www.stopbreastcancer.org>.

National Cancer Institute, Public Inquiries Office. Cancer Information Service. 6116 Executive Boulevard, Room 3036A. Bethesda, MD 20892 8322. (800) 4 CANCER (800 422 6237). TTY: (800) 332 8615. <http://www.cancer.gov>.

National Center for Complementary and Alternative Medicine (NCCAM) Clearinghouse. P.O. Box 7923, Gaithersburg, MD 20898. (888) 644 6226. TTY: (866) 464 3615. Fax: (866) 464 3616. <http://www.nccam.nih.gov>.

National Center for Health Statistics (NCHS). 3311 Toledo Road, Hyattsville, MD 20782. (800) 232 4636. <http://www.cdc.gov/nchs/>.

National Center for Infectious Disease, Centers for Disease Control and Prevention. Mailstop C 14, 1600 Clifton Road NE, Atlanta, GA 30333. (800) 232 4636. <http://www.cdc.gov/ncidod>.

National Center for Policy Analysis. 12770 Coit Rd., Suite 800, Dallas, TX 75251 1339. Phone: (972) 386 6272. Fax: (972) 386 0924. <http://www.ncpa.org>.

National Center on Sleep Disorders Research. Two Rock ledge Centre, Suite 10038, 6701 Rockledge Drive, MSC 7920, Bethesda, MD 20892 7920. (301) 435 0199. <http://www.nhlbi.nih.gov/about/ncsdr/index.htm>.

National Cholesterol Education Program: National Heart, Lung, and Blood Institute (NHLBI), National Institutes of Health. PO Box 30105, Bethesda, MD, 20824 0105. (301) 251 1222. <http://www.nhlbi.nih.gov/about/ncep/>.

National Committee for Quality Assurance. 1100 13th St., NW, Suite 1000, Washington, DC 20005. (202) 955 3500. <http://www.ncqa.org>.

National Comprehensive Cancer Network. 50 Huntingdon Pike, Suite 200, Rockledge, PA 19046. (215) 728 4788. Fax: (215) 728 3877. Email: [information@nccn.org](mailto:information@nccn.org). <http://www.nccn.org/>.

National Diabetes Information Clearinghouse. 1 Information Way, Bethesda, MD 20892 3560. (800) 860 8747. Fax: (703) 738 4929. Email: [ndic@info.niddk.nih.gov](mailto:ndic@info.niddk.nih.gov). <http://diabetes.niddk.nih.gov/about/index.htm>.

National Digestive Diseases Information Clearinghouse (NDDIC). 2 Information Way, Bethesda, MD 20892 3570. (800) 891 5389. <http://digestive.niddk.nih.gov>.

National Digestive Diseases Information Clearinghouse. 2 Information Way, Bethesda, MD 20892 3570. (800) 891 5389. Fax: (703) 738 4929. Email: [nddic@info.niddk.nih.gov](mailto:nddic@info.niddk.nih.gov). <http://digestive.niddk.nih.gov/about/index.htm>.

The National Down Syndrome Society (NDSS). 666 Broadway, New York, NY 10012. (212) 460 9330 or (800) 221 4602. [www.ndss.org](http://www.ndss.org).

National Eye Institute. 2020 Vision Place Bethesda, MD 20892 3655. (301) 496 5248. <http://www.nei.nih.gov>.

- National Foundation for Transplants. Corporate Headquarters. 5350 Poplar Ave., Suite 430, Memphis, TN 38119. (800) 489 3863. (901) 684 1697. Fax: (901) 684 1128. <http://www.transplants.org>.
- National Health Service of Great Britain. NHS Direct. Riverside House. 2a Southwark Bridge Road, London, England, SE1 9HA. <http://www.nhsdirect.nhs.uk/>.
- National Heart, Lung and Blood Institute (NHLBI). Building 31, Room 5A48, 31 Center Drive MSC 2486, Bethesda, MD 20892. (301) 592 8573. TTY: (240) 629 3255. Fax: (240) 629 3246. <http://www.nhlbi.nih.gov>.
- National Hospice & Palliative Care Organization (NHPCO). 1700 Diagonal Road, Suite 625, Alexandria, VA 22314. (703) 837 1500. Fax: (703) 837 1233. Email: [nhpco\\_info@nhpco.org](mailto:nhpco_info@nhpco.org). <http://www.nhpco.org>.
- The National Institute for Jewish Hospice (NIJH). 732 University Street, North Woodmere, NY 11581. (800) 446 4448. <http://www.nijh.org/>.
- National Institute of Arthritis and Musculoskeletal and Skin Diseases Information Clearinghouse. 1 AMS Circle, Bethesda, MD 20892 3675. (301) 495 4484 or (877) 226 4267; Fax: (301) 718 6366; TTY: (301) 565 2966. <http://www.nih.gov/niams>.
- National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). Building 31. Rm 9A06. 31 Center Drive, MSC 2560, Bethesda, MD 20892 2560. (301) 496.3583. <http://www2.niddk.nih.gov/>.
- The National Institute of Neurological Disorders and Stroke (NINDS). National Institutes of Health, Bethesda, MD 20892. <http://www.ninds.nih.gov>.
- National Institute of Occupational Safety and Health (NIOSH). [cited March 13, 2003]. [www.cdc.gov/niosh/2000/135.html](http://www.cdc.gov/niosh/2000/135.html).
- National Institute on Aging. Building 31, Room 5C27, 31 Center Drive, MSC 2292, Bethesda, MD 20892. (301) 496 1752, (800) 222 2225. TTY: (800) 222 4225. Fax: (301) 496 1072. <http://www.nia.nih.gov/>.
- National Institute on Deafness and Other Communication Disorders (NIDCD), National Institutes of Health. 31 Center Drive, MSC 2320, Bethesda, MD 20892 2320. (301) 496 7243. TTY: (301) 402 0252. Fax: (301) 402 0018. Email: [nidcdinfo@nidcd.nih.gov](mailto:nidcdinfo@nidcd.nih.gov). <http://www.nidcd.nih.gov>.
- National Institutes of Health. 9000 Rockville Pike, Bethesda, MD 20892. (301) 496 4000. TTY (301) 402 9612. Email: [NIHinfo@od.nih.gov](mailto:NIHinfo@od.nih.gov). <http://www.nih.gov>.
- National Jewish Medical and Research Center. Lung Line. 14090 Jackson Street, Denver, Colorado 80206. <http://www.nationaljewish.org>.
- National Kidney and Urologic Diseases. 3 Information Way, Bethesda, MD 20892 3580. (800) 891 5390. <http://kidney.niddk.nih.gov>.
- National Kidney Foundation. 30 East 33rd Street, New York, NY 10016. (800) 622 9010, (212) 889 2210. Fax: (212) 689 9261. <http://www.kidney.org>.
- National Library of Medicine. 8600 Rockville Pike, Bethesda, MD 20894. (888) 346 3656. <http://www.nlm.nih.gov>.
- National Lymphedema Network. 2211 Post St., Suite 404, San Francisco, CA 94115 3427. (800) 541 3259 or (415) 921 1306. <http://www.wenet.net/~lymphnet>.
- National Marrow Donor Program. Suite 500, 3001 Broadway Street Northeast, Minneapolis, MN 55413 1753. (800) MARROW 2. <http://www.marrow.org>.
- National Organ and Tissue Donation Initiative. <http://www.organdonor.gov>.
- National Organization for Rare Disorders (NORD). 55 Kenosia Avenue, P. O. Box 1968, Danbury, CT 06813 1968. (203) 744 0100. <http://www.rarediseases.org>.
- National Parkinson's Disease Foundation. Bob Hope Parkinson Research Center, 1501 N.W. 9th Avenue, Bob Hope Road, Miami, FL 33136 1494. (305) 547 6666. (800) 327 4545. Fax: (305) 243 4403. <http://www.parkinson.org>.
- National Patient Advocate Foundation. 725 15th St. NW, 10th Floor, Washington, DC 20005, Phone: (202) 347 8009. Fax: (202) 347 5579. Email: [action@npaf.org](mailto:action@npaf.org). <http://www.npaf.org>.
- National Patient Safety Foundation (NPSF). 132 MASS MoCA Way, North Adams, MA 01247. (413) 663 8900. <http://www.npsf.org/>.
- National Pressure Ulcer Advisory Panel. 12100 Sunset Hills Road, Suite 130, Reston, VA 20190. (703)464 4849. <http://www.npuap.org>.
- National Prison Hospice Association (NPHA). P. O. Box 4623, Boulder, CO 80306. (303) 447 8051. <http://www.npha.org>.
- National Scoliosis Foundation. 5 Cabot Place, Stoughton, MA 020724. (800) 673 6922. <http://www.scoliosis.org>.
- National Stroke Association. 9707 E. Easter Lane, Englewood, CO 80112. (800) Strokes or (303) 649 9299. <http://www.stroke.org>.
- National Transplant Assistance Fund and Catastrophic Injury Program. 150 N. Radnor Chester Road, Suite F 120, Radnor, PA 19087. (800) 642 8399. <http://www.transplantfund.org/>.
- NCCNHR (formerly the National Citizens' Coalition for Nursing Home Reform). 1828 L Street, NW, Suite 801, Washington, DC 20036. (202) 332 2275. [www.nccnhr.org](http://www.nccnhr.org).
- New England Ophthalmological Society (NEOS). P.O. Box 9165, Boston, MA 02114. (617) 227 6484. <http://www.neos-eyes.org/>.
- North American Society for Head and Neck Pathology. Department of Pathology, H179, P.O. Box 850, Milton S. Hershey Medical Center, Penn State University School of Medicine, Hershey, PA 17033. (717) 531 8246. <http://www.headandneckpathology.com/>.
- North American Society of Pacing and Electrophysiology. 6 Strathmore Rd., Natick, MA 01760 2499. (508) 647 0100. <http://www.naspe.org>.
- North American Spine Society. 22 Calendar Court, 2nd Floor, LaGrange, IL 60525. (877) Spine Dr. Email: [info@spine.org](mailto:info@spine.org). <http://www.spine.org>.



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**O**

- Obesity Society (formerly the American Obesity Association). 8630 Fenton Street, Suite 814, Silver Spring, MD 20910. (301) 563 6526. <http://www.obesity.org>.
- Office of Cancer Complementary and Alternative Medicine, National Cancer Institute. 6116 Executive Boulevard, Suite 609, MSC 8339, Bethesda, MD 20892. (800) 422 6237. <http://www.cancer.gov/cam>.
- Office of Rare Diseases (NIH). 6100 Executive Boulevard, Room 3A07, MSC 7518 Bethesda, MD 20892 7518. (301) 402 4336. [http://www.rarediseases.info.nih.gov/info\\_diseases.html](http://www.rarediseases.info.nih.gov/info_diseases.html).
- Office of Women's Health. U.S. Food and Drug Administration, 5600 Fishers Lane, Rockville, MD 20857. (301) 827 0350. <http://www.fda.gov/womens/default.htm>.
- Oral Cancer Foundation. 3419 Via Lido, #205, Newport Beach, CA 92663. (949) 646 8000. [www.oralcancer.org](http://www.oralcancer.org)
- Orthopedic Trauma Association. 6300 N. River Road, Suite 727, Rosemont, IL 60018 4226. (847) 698 1631. <http://www.ota.org/links.htm>.
- Our Bodies Ourselves Health Resource Center. 34 Plympton Street, Boston, MA 02118. (617) 451 3666. <http://www.ourbodiesourselves.org/>.
- Overeaters Anonymous (OA). World Service Office, P. O. Box 44020, Rio Rancho, NM 87174 4020. (505) 891 2664. <http://www.oa.org>(accessed April 18, 2008).

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**P**

- Partnership for Caring. 1620 Eye St., NW, Suite 202, Washington, DC 20006. (202) 296 8071. Fax: (202) 296 8352. Toll free hotline: (800) 989 9455 (option 3). <http://www.partnershipforcaring.org/>.
- Partnership for Organ Donation. Two Oliver Street, Boston, MA 02109. (617) 482 5746. <http://www.transweb.org/partnership/>.
- Periodontal (Gum) Diseases. National Institute of Dental and Craniofacial Research, National Institutes of Health. Bethesda, MD 20892 2190. (301) 496 4261. <http://www.nidcrinfo.nih.gov..>
- Peripheral Vascular Surgery Society (PVSS). 824 Munras Avenue, Suite C, Monterey, CA 93940. (831) 373 0508. <http://www.pvss.org>.
- Physicians and Nurses for Blood Conservation (PNBC). P. O. Box 217, 6 2400 Dundas Street West, Mississauga, ON L5K 2R8. (905) 608 1647. <http://www.pnbc.ca>.
- Pioneer Network. P.O. Box 18648, Rochester, NY 14618. (585) 271 7570. <http://www.pioneernetwork.net/>.
- Planned Parenthood Federation of America. 434 West 33rd Street, New York, NY 10001. (212) 541 7800. (800) 230 PLAN (230 7526). Fax: (212) 245 1845. Or, 1110 Vermont Ave. NW, Suite 300, Washington, DC 20005. (202) 973 4800. Fax: (202) 296 3242. <http://www.plannedparenthood.org>.

- Prevent Blindness America. 211 West Wacker Drive, Suite 1700, Chicago, IL 60606. (800) 331 2020. <http://www.preventblindness.org>.
- Promoting Excellence in End of Life Care, RWJ Foundation National Program Office, c/o The Practical Ethics Center, The University of Montana, 1000 East Beck with Avenue, Missoula, MT 59812. (406) 243 6601. Fax: (406) 243 6633. Email: [excell@selway.umt.edu](mailto:excell@selway.umt.edu). <http://www.promotingexcellence.org>.
- Prune Belly Syndrome Network. P. O. Box 2125, Evansville, IN 47728 0125. <http://www.prunebelly.org>.

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**R**

- Radiological Society of North America (RSNA). 820 Jorie Blvd., Oak Brook, IL 60523 2251. (630) 571 2670. <http://www.rsna.org/>.
- Rehydration Project. P. O. Box 1, Samara, 5235, Costa Rica. (506) 656 0504. [www.rehydrate.org](http://www.rehydrate.org).
- Rothman Institute of Orthopaedics. 925 Chestnut Street, Philadelphia, PA 19107 4216. (215) 955 3458. <http://www.rothmaninstitute.com>.
- Rush Arthritis and Orthopedics Institute. 1725 West Harrison Street, Suite 1055, Chicago, IL 60612. (312) 563 2420. <http://www.rush.edu>.

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**S**

- Second Wind Lung Transplant Association, Inc. 9030 West Lakeview Court, Crystal River, FL 34428. (888) 222 2690. <http://www.arthouse.com/secondwind>.
- Shape Up America! c/o WebFront Solutions Corporation, 15757 Crabbs Branch Way, Rockville, MD 20855. (301) 258 0540. <http://www.shapeup.org>.
- Shrine and Shriner's Hospitals. 2900 Rocky Point Dr., Tampa, FL 33607 1460. (813) 281 0300. <http://www.shrinershq.org/>.
- Simon Foundation for Continence. P.O. Box 835, Wilmette, IL 60091. (800) 23 SIMON (237 4666) or (847) 864 3913. <http://www.simonfoundation.org>.
- The Society for Clinical Vascular Surgery (SCVS). 900 Cummings Center, #221 U, Beverly, MA 01915. (978) 927 8330. <http://scvs.vascularweb.org/index.html>.
- Society for Gastroenterology Nurses and Associates (SGNA). 401 North Michigan Avenue, Chicago, IL 60611 4267. (800) 245 7462. [www.sgna.org](http://www.sgna.org).
- Society for Pediatric Urology (SPU). C/o HealthInfo, 870 East Higgins Road, Suite 142, Schaumburg, IL 60173. <http://www.spuonline.org>.
- Society for Technology in Anesthesia (STA). PMB 300, 223 North Guadalupe, Santa Fe, NM 87501. (505) 983 4923. <http://www.anestech.org>.
- Society for the Advancement of Blood Management (SABM). 350 Engle Street, Englewood, NJ 07631. (866) 894 3916. <http://www.sabm.org>.
- Society for Vascular Surgery. 633 N. St. Clair, 24th Floor, Chicago, IL 60611. (312) 334 2300, (800) 258 7188.

Fax: (312) 334 2320. Email: [vascular@vascularsociety.org](mailto:vascular@vascularsociety.org). <http://www.vascularweb.org>.

Society of American Gastrointestinal Endoscopic Surgeons (SAGES). 11300 West Olympic Boulevard, Suite 600, Los Angeles, CA 90064. (310) 437 0544. Fax: (310) 437 0585. <http://www.sages.org>.

Society of Critical Care Medicine (SCCM). 701 Lee Street, Suite 200, Des Plaines, IL 60016. (847) 827 6869; Fax: (847) 827 6869. Email: [info@sccm.org](mailto:info@sccm.org). [www.sccm.org](http://www.sccm.org).

Society of Diagnostic Medical Sonography. 2745 Dallas Parkway, Suite 350, Plano, TX 75093 8730. (214) 473 8057, (800) 229 9506. Fax: (214) 473 8563. <http://www.sdms.org/>.

Society of Gynecologic Oncologists. 230 West Monroe Street, Suite 710, Chicago, IL 60606. (312) 235 4060. <http://www.sgo.org>.

Society of Interventional Radiology. 3975 Fair Ridge Drive, Suite 400 North, Fairfax, VA 22033. (800) 488 7284, (703) 691 1805. Fax: (703) 691 1855. <http://www.sirweb.org>.

Society of Laparoendoscopic Surgeons. 7330 SW 62nd Place, Suite 410, Miami, FL 33143 4825. (305) 665 9959. <http://www.sls.org>.

Society of NeuroInterventional Surgery (formerly the American Society of Interventional and Therapeutic Neuroradiology, ASITN). 3975 Fair Ridge Drive, Suite 460 South, Fairfax, VA 22033. (703) 691 2272. Fax: (703) 537 0650. Email: [info@snisonline.org](mailto:info@snisonline.org). <http://www.snisonline.org>.

Society of Nuclear Medicine (SNM). 1850 Samuel Morse Drive, Reston, VA 20190. (703) 708 9000. [www.snm.org](http://www.snm.org).

Society of Surgical Oncology. 85 West Algonquin Rd., Suite 550, Arlington Heights, IL 60005. (847) 427 1400. <http://www.surgonc.org>.

Society of Thoracic Surgeons. 633 N. Saint Clair St., Suite 2320, Chicago, IL 60611 3658. (312) 202 5800. Fax: (312) 202 5801. Email: [sts@sts.org](mailto:sts@sts.org). <http://www.sts.org>.

Society of Toxicology. 1821 Michael Faraday Drive, Suite 300, Reston, VA 20190. (703) 438 3115. <http://www.toxicology.org>.

Society of Urologic Nurses and Associates. East Holly Avenue, Box 56, Pitman, NJ 08071 0056. (609) 256 2335. <http://sunainurse.com/>.

Southern Thoracic Surgical Association. 633 N. Saint Clair St., Suite 2320, Chicago, IL, 60611 3658. (800) 685 7872. [www.stsa.org/](http://www.stsa.org/).

Spina Bifida Association. 4590 MacArthur Boulevard, NW, Washington, DC 20007. (202) 944 3285, (800) 621 3141. Fax: (202) 944 3295. Email: [sbaa@sbaa.org](mailto:sbaa@sbaa.org). <http://www.spinabifidaassociation.org>.

Spine Center. 1911 Arch St., Philadelphia, PA 19103. (215) 665 8300. <http://www.thespinecenter.com>

SurgeryLinx. MDLinx, Inc. 1025 Vermont Avenue, NW, Suite 810, Washington, DC 20005. (202) 543 6544. <http://sgreports.nlm.nih.gov/NN/>.

## T

Texas Heart Institute. 6770 Bertner Avenue, Houston, TX 77030. (832) 355 4011. Or, PO Box 20345, Houston, TX 77225 0345. <http://www.texasheartinstitute.org>.

Tissue Adhesive Center, Surgical Therapeutic Advancement Center. P. O. Box 801370, Charlottesville, VA 22908. (434) 243 0315. <http://www.healthsystem.virginia.edu/internet/stac/overview/home.cfm>.

Transplant Foundation, Inc. 701 SW 27th Ave, Suite 705, Miami, FL 33135. (305) 817 5645 or (866) 900 3172. <http://www.transplantfoundation.org/>.

Transplant Recipients International Organization (TRIO). International Headquarters: 1000 16th Street, NW, Suite 602, Washington, DC 20036 5705. (800) TRIO 386. [http://www.transweb.org/people/recips/resources/support/bkuptrio\\_main.html](http://www.transweb.org/people/recips/resources/support/bkuptrio_main.html).

## U

United Cerebral Palsy. 1660 L Street, NW, Suite 700, Washington, DC 20036. (800) 872 5827 or (202) 776 0406. TTY: (202) 973 7197. Fax: (202) 776 0414. [webmaster@ucp.org](mailto:webmaster@ucp.org). <http://www.UCP.org>.

United Network for Organ Sharing (UNOS). Post Office Box 2484, Richmond, VA 23218. Or, 700 North 4th Street, Richmond, VA 23219. (804) 782 4800, (804) 782 4817. <http://www.unos.org>.

United Ostomy Association, Inc. (UOA). 19772 MacArthur Blvd., Suite 200, Irvine, CA 92612 2405. (800) 826 0826. <http://www.uoa.org..>

United States Administration on Aging. One Massachusetts Ave., Washington, DC 20201. (202) 619 0724. Email: [AoAInfo@aoa.hhs.gov](mailto:AoAInfo@aoa.hhs.gov). <http://www.aoa.gov>.

United States Department of Health and Human Services, 200 Independence Avenue, SW, Washington, DC 20201. (877) 696 6775. <http://www.hhs.gov>.

United States Food and Drug Administration (FDA). 5600 Fishers Lane, Rockville, MD 20857 0001. (888) INFO FDA. <http://www.fda.gov>.

United States Living Will Registry. 523 Westfield Ave., P.O. Box 2789, Westfield, NJ 07091 2789. Toll free: (800) LIV WILL or (800) 548 9455. <http://www.uslivingwillregistry.com/>.

United States Pharmacopoeia (USP). 12601 Twinbrook Parkway, Rockville, MD 20852 1790. (800) 227 8772. <http://www.usp.org>.

United States Renal Data System (USRDS), Coordinating Center. The University of Minnesota, 914 South 8th Street, Suite D 206, Minneapolis, MN 55404. (888) 99USRDS. <http://www.usrds.org>.

University of Maryland Medical Center, R. Adams Cowley Shock Trauma Center. 22 South Greene Street,

Baltimore, MD 21201. (410) 328 2757 or (800) 373 4111. [www.umm.edu/shocktrauma](http://www.umm.edu/shocktrauma).

University of Michigan Kellogg Eye Center Department of Ophthalmology and Visual Sciences. 1000 Wall Street, Ann Arbor, MI 48105. (734) 763 1415. <http://www.kellogg.umich.edu>.

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## V

Valley Baptist Heart and Vascular Institute. 2101 Pease Street, P.O. Drawer 2588. Harlingen, TX 78550. (956) 389 4848.

Vascular Birthmark Foundation. P.O. Box 106, Latham, NY 12110. (877) VBF LOOK (daytime) and (877) VBF 4646 (evenings and weekends). [www.birthmark.org](http://www.birthmark.org).

Vascular Disease Foundation. 3333 South Wadsworth Blvd. B104 37, Lakewood, CO 80227. (303) 949 8337, (866) PADINFO (723 4636). <http://www.vdf.org>.

Vestibular Disorders Association (VEDA). PO Box 4467, Portland, OR 97208 4467. (800) 837 8428. [www.vestibular.org](http://www.vestibular.org).

Visiting Nurse Associations of America (VNAA). 900 19th St, NW, Suite 200, Washington, DC 20006. (202) 384 1420. Fax: (202) 384 1444. Email: [vnaa@vnaa.org](mailto:vnaa@vnaa.org). <http://www.vnaa.org>.

Voice Center at Eastern Virginia Medical School. Norfolk, VA 23507. <http://www.voicecenter.com>.

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## W

The Washington Home Center for Palliative Care Studies (CPCS), 4200 Wisconsin Avenue, NW, 4th Floor, Washington, DC 20016. (202) 895 2625. Fax: (202) 966 5410. Email: [info@medicaring.org](mailto:info@medicaring.org). <http://www.medicaring.org>.

WE MOVE, Worldwide Education and Awareness for Movement Disorders. 204 West 84th Street, New York, NY 10024. (800) 437 MOV2. Fax: (212) 875 8389. <http://www.wemove.org>.

Weight control Information Network (WIN). 1 WIN Way, Bethesda, MD 20892 3665. (877) 946 4627, (202) 828 1025. Fax: (202) 828 1028. <http://win.niddk.nih.gov>.

Wills Eye. 840 Walnut Street, Philadelphia, PA 19107. (215) 928 3000. <http://www.willseye.org>.

Wound Care Institute. 1100 N.E. 163rd Street, Suite #101, North Miami Beach, FL 33162. (305) 919 9192. <http://woundcare.org>.

Wound Healing Society. 13355 Tenth Ave., Suite 108, Minneapolis, MN 55441 5554. [cited April 4, 2003]. <http://www.woundheal.org/>.

The Wound, Ostomy and Continence Nurses Society. 15000 Commerce Parkway, Suite C, Mt. Laurel, NJ 08054. (888) 224 WOCN (9626). <http://www.wocn.org>.

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## Z

Zen Hospice Project. 273 Page Street, San Francisco, CA 94102. (415) 863 2910. <http://www.zenhospice.org>.

## GLOSSARY

### A

**ABDOMEN.** The portion of the body that lies between the thorax and the pelvis. It contains a cavity with many organs.

**ABDOMINAL ANEURYSM.** Aneurysm that involves the descending aorta from the diaphragm to the point at which it separates into two iliac arteries.

**ABDOMINAL AORTIC ANEURYSM.** Occurs when an area in the aorta (the main artery of the heart) is weakened and bulges like a balloon. The abdominal section of the aorta supplies blood to the lower body.

**ABDOMINAL DISTENSION.** Swelling of the abdominal cavity, which creates painful pressure on the internal organs.

**ABDOMINAL HERNIA.** A defect in the abdominal wall through which the abdominal organs protrude.

**ABLATION THERAPY.** A procedure used to treat arrhythmias, especially atrial fibrillation.

**ABLATION.** Removal or destruction of tissue, such as by burning or cutting.

**ABO ANTIGEN.** Protein molecules located on the surfaces of red blood cells that determine a person's blood type: A, B, or O.

**ABO BLOOD GROUPS.** A system in which human blood is classified according to the A and B antigens found in red blood cells. Type A blood has the A antigen, type B has the B antigen, AB has both, and O has neither.

**ABO BLOOD TYPE.** Blood type based on the presence or absence of the A and B antigens on the red blood cells. There are four types: A, B, AB, and O.

**ABSCCESS.** A localized pocket of pus at a site of infection.

**ACCESS SITE.** The vein tapped for vascular access in hemodialysis treatments. For patients with temporary treatment needs, access to the bloodstream is gained by inserting a catheter into the subclavian vein near the patient's collarbone. Patients in long-term dialysis require stronger, more durable access sites, called fistulas or grafts, that are surgically created.

**ACCESSORY ORGAN.** A lump of tissue adjacent to an organ that is similar to it, but which serves no important purpose (if it functions at all). While not necessarily harmful, such organs can cause problems if they are confused with a mass, or in rare cases, if they grow too large or become cancerous.

**ACETABULAR DYSPLASIA.** A type of arthritis resulting in a shallow hip socket.

**ACETABULUM.** The hollow, cuplike portion of the pelvis into which the femoral head is fitted to make the hip joint.

**ACETAMINOPHEN.** A common pain reliever (e.g., Tylenol).

**ACETIC ACID.** Vinegar; very dilute washes of the treated areas with a vinegar solution are suggested by some surgeons after laser skin resurfacing.

**ACHALASIA.** Failure to relax. The term is often applied to sphincter muscles.

**ACID.** Any chemical or compound that lowers the pH of a solution below 7.0, meaning that there is a surplus of hydrogen ions dissociated within that solution.

**ACIDOSIS.** A condition of the blood in which bicarbonate levels are below normal.

**ACL RECONSTRUCTION.** Repairing a tear of the anterior cruciate ligament (ACL) of the knee using arthroscopy and/or open surgery.

**ACOUSTIC WINDOW.** Area through which ultrasound waves move freely.



**ACQUIRED IMMUNODEFICIENCY SYNDROME (AIDS).** A disease syndrome in which the patient's immune cells are destroyed by HIV virus, leaving the patient open to opportunistic infections that a healthy immune system could keep at bay.

**ACROMEGALY.** A condition in which an overactive pituitary gland pumps out an excess amount of growth hormone.

**ACROMIOCLAVICULAR (AC) JOINT.** The shoulder joint. Articulation and ligaments between the collarbone and the acromion of the shoulder blade.

**ACROMIOCLAVICULAR DISLOCATION.** Disruption of the normal articulation between the acromion and the collarbone. The acromioclavicular joint (AC joint) is normally stabilized by several ligaments that can be torn in the process of dislocating the AC joint.

**ACROMION.** The triangular projection of the spine of the shoulder blade that forms the point of the shoulder and articulates with the collarbone.

**ACTINIC KERATOSIS.** A crusty, scaly precancerous skin lesion caused by damage from the sun; frequently treated with cryotherapy.

**ACTIVATED PARTIAL THROMBOPLASTIN TIME (APTT).** A lab test that detects coagulation defects in the intrinsic clotting cascade. Used to regulate heparin dosing.

**ACTIVITIES OF DAILY LIVING (ADLS).** Self-care activities performed during the course of a normal day such as eating, bathing, dressing, toileting, etc.

**ACUITY.** Sharpness or clarity of vision.

**ACUPUNCTURE.** The insertion of tiny needles into the skin at specific spots on the body for curative purposes.

**ACUTE HEMOLYTIC TRANSFUSION REACTION (AHTR).** A severe transfusion reaction with abrupt onset, most often caused by ABO incompatibility. Symptoms include difficulty breathing, fever and chills, pain, and sometimes shock.

**ACUTE MYELOGENOUS LEUKEMIA (AML).** Also called acute myelocytic leukemia, a malignant disorder where myeloid blast cells accumulate in the marrow and bloodstream.

**ACUTE OTITIS MEDIA.** Inflammation of the middle ear with signs of infection lasting less than three months.

**ACUTE PAIN.** Pain that is usually temporary and results from something specific, such as a surgery, an injury, or an infection.

**ACUTE RENAL (KIDNEY) FAILURE.** Abrupt loss of kidney function, possibly temporary.

**ACUTE TUBULAR NECROSIS.** A kidney disease involving damage to the portion of the kidney known as the tubules that causes kidney failure.

**ACUTE.** Rapid onset of a condition. Also, refers to pain in response to injury or other stimulus that resolves when the injury heals or the stimulus is removed.

**ADDICTION.** Compulsive, overwhelming involvement with a specific activity. The activity may be smoking, gambling, alcohol, or may involve the use of almost any substance, such as a drug.

**ADDISON'S DISEASE.** A condition in which the adrenal glands are not functioning properly. Addison's disease can be caused by a problem in the adrenal glands themselves, or in the pituitary gland, which secretes a hormone that affects the adrenal glands.

**ADDISONIAN CRISIS.** A medical emergency resulting from severe adrenal insufficiency. It can be caused by sudden withdrawal from oral glucocorticoid medications, as well as from damage to the adrenal gland itself. Untreated Addisonian crisis can be fatal.

**ADENOCARCINOMA.** Cancer that starts in the lining of the small intestine and is the most common type of cancer of the small intestine. These tumors occur most often in the part of the small intestine nearest the stomach and often grow and block the bowel.

**ADENOIDS.** Clusters of lymphoid tissue located in the upper throat above the roof of the mouth. Some doctors think that removal of the adenoids may lower the rate of recurrent otitis media in high-risk children.

**ADENOMA.** A benign tumor of an endocrine gland.

**ADHESION.** A band of fibrous tissue forming an abnormal bond between two adjacent tissues or organs.

**ADJUVANT THERAPY.** Treatment used to increase the effectiveness of surgery, usually chemotherapy or radiation used to kill any cancer cells that might be remaining.

**ADRENAL GLANDS.** Two glands located next to the kidneys. The adrenal glands produce the hormones epinephrine and norepinephrine and the corticosteroid (cortisone-like) hormones.

**ADRENERGIC.** Characteristic of or releasing epinephrine or related substances. The term often refers to the nerve fibers in the sympathetic nervous system that release norepinephrine as a neurotransmitter.

**ADSORB.** To attract and hold another substance on the surface of a solid material.

**ADVANCE DIRECTIVE, OR ADVANCE MEDICAL DIRECTIVE.** A general term for two types of documents, living wills and medical powers of attorney, that allow people to give instructions about health care in the event that they cannot speak for themselves.

**ADVERSE EVENT.** An undesirable and unintended result of a medical treatment or intervention.

**AEROBE.** Bacteria that require oxygen to live.

**AEROBIC BACTERIA.** Bacteria that can grow freely in oxygen-rich environments.

**AEROBIC EXERCISE.** Any type of exercise that is intended to increase the body's oxygen consumption and improve the functioning of the cardiovascular and respiratory systems.

**AESTHETIC.** Pertaining to beauty. Plastic surgery done to improve the patient's appearance is sometimes called aesthetic surgery.

**AFFECT.** The external manifestation of a mood or state of mind. Affect is usually observed in facial expression or other body language.

**AFFERENT FIBERS.** Nerve fibers that conduct nerve impulses from tissues and organs toward the central nervous system.

**AGAR.** A gelatinous material extracted from red algae that is not digested by bacteria. It is used as a support for growth in plates.

**AGENESIS.** The absence of an organ or body part due to developmental failure.

**AGGLUTINATION.** An immunochemical reaction. It is termed positive when two chemicals that are mixed cause clumps to form.

**AIDS.** Acquired immunodeficiency syndrome. A disease caused by infection with the human immunodeficiency virus (HIV). In people with this disease, the immune system breaks down, opening the door to other infections and some types of cancer.

**AIRWAY.** The passageway through the mouth, nose, and throat that allows air to enter and leave the lungs; the term can also refer to a tube or other artificial device used to create an air passageway into and out of the lungs when the patient is under general anesthesia or unable to breathe properly.

**ALDOSTERONE.** A hormone secreted by the adrenal glands that prompts the kidneys to hold onto sodium.

**ALGORITHM.** A procedure or formula for solving a problem. It is often used to refer to a sequence of steps used to program a computer to solve a specific problem.

**ALKALINE.** Any chemical or compound that raises the pH of a solution above 7.0, meaning that there is a relative shortage of hydrogen ions dissociated within that solution.

**ALKALOID.** Any of a group of bitter-tasting alkaline compounds that contain nitrogen and are commonly found in plants. Alkaloids derived from ergot can be used as uterine stimulants.

**ALKALOSIS.** A condition of the blood and other body fluids in which bicarbonate levels are higher than normal.

**ALLELE.** Types of genes that occupy the same site on a chromosome.

**ALLOGENEIC.** Referring to blood donation or bone-marrow transplants between two different, genetically dissimilar people.

**ALLOGRAFT.** A graft of bone or other tissue taken from a donor.

**ALLOPLAST.** An implant made of an inert foreign material such as silicone or hydroxyapatite.

**ALOPECIA.** Hair loss or baldness.

**ALPHA-FETOPROTEIN (AFP).** A protein normally produced by the liver of a fetus and detectable in maternal blood samples. AFP screening measures the amount of alpha-fetoprotein in the blood. Levels outside the norm may indicate fetal defects.

**ALTERNATIVES TO SURGERY.** Other treatments for the condition or illness that do not involve surgery; these are usually tried before surgery is an option.

**ALTITUDE SICKNESS.** A set of symptoms that people who normally live at low altitudes may have when they climb mountains or travel to high altitudes. The symptoms include nosebleed, nausea, and shortness of breath.

**ALVEOLAR ARCH.** An arch formed by the ridge of the alveolar process of the mandible (jawbone) or maxilla.

**ALZHEIMER'S DISEASE.** Progressive dementia characterized by worsening memory and other cognitive impairment.

**AMBULATE OR AMBULATION.** To move from place to place (walk).

**AMBULATORY CARE.** An outpatient facility; designed for patients who do not require inpatient hospital treatment or care.

**AMBULATORY MONITORS.** Small portable electrocardiograph machines that record the heart's rhythm, and include the Holter monitor, loop recorder, and trans-telephonic transmitter.

**AMBULATORY SURGERY.** Surgery done on an outpatient basis; the patient goes home the same day.

**AMBULATORY.** Referring to a condition that is treatable without admission to a hospital, or to a surgical procedure performed on an outpatient basis.

**AMINE.** A chemical compound that contains  $\text{NH}_3$  (a nitrogen-hydrogen combination) as part of its structure.

**AMNIOCENTESIS.** A procedure for removing amniotic fluid from the womb using a fine needle.

**AMNIOTIC MEMBRANE.** A thin membrane that contains the fetus and the protective amniotic fluid surrounding the fetus.

**ANAEROBIC.** Pertaining to a microorganism (an anaerobe) that either does not use oxygen or actually cannot live in the presence of oxygen.

**ANALGESIA.** Refers to pain relief without loss of consciousness. An analgesic is a drug that is given to relieve pain. The term also refers to the absence of the ability to feel pain.

**ANALYTE.** A material or chemical substance subjected to analysis.

**ANAPHYLACTIC SHOCK.** A potentially fatal allergic reaction to a substance that causes a severe drop in blood pressure, swelling of the respiratory tract with associated breathing problems, rash, and possible convulsions.

**ANASTOMOSIS (PLURAL, ANASTOMOSES).** The surgical connection of two structures, such as blood vessels or sections of the intestine.

**ANDROGENS.** A class of chemical compounds (hormones) that stimulates the development of male secondary sexual characteristics.

**ANEMIA.** A lack of hemoglobin. Hemoglobin is the compound in blood that carries oxygen from the lungs throughout the body and brings waste carbon dioxide from the cells to the lungs, where it is released.

**ANENCEPHALY.** A hereditary defect resulting in the partial to complete absence of a brain and spinal cord. It is fatal.

**ANEROID MONITOR.** A monitor that works without fluids, i.e. without mercury.

**ANESTHESIA.** A combination of drugs administered by a variety of techniques by trained professionals that provide sedation, amnesia, analgesia, and immobility adequate for the accomplishment of a surgical procedure with minimal discomfort, and without injury to the patient.

**ANESTHESIOLOGIST.** A doctor of medicine (MD) or osteopathy (DO) who has completed advanced training in administering anesthesia and monitoring patients' well-being during surgery. Many anesthesiologists have completed additional training in critical care medicine or pain management.

**ANESTHESIOLOGIST.** A physician with advanced training in anesthesia (and sometimes other medical specialties) who administers or oversees the administration of anesthesia to the patient and monitors care after surgery.

**ANESTHESIOLOGY.** The branch of medicine that specializes in the study of anesthetic agents, their effects on patients, and their proper use and administration.

**ANESTHETIC.** Medicine that causes a loss of feeling, especially pain. Some anesthetics also cause a loss of consciousness.

**ANESTHETIST.** A nurse trained in anesthesiology who, working as an assistant to an anesthesiologist, administers the anesthesia in surgery and monitors the patient after surgery.

**ANEURYSM.** A bulge in the wall of a blood vessel caused by the weakening of the vessel wall. Aneurysms can be fatal if the affected blood vessel bursts.

**ANGINA.** Also called angina pectoris; chest pain or discomfort that occurs when diseased blood vessels restrict blood flow to the heart.

**ANGIOEDEMA.** An allergic skin disease characterized by patches of circumscribed swelling involving the skin and its subcutaneous layers, the mucous membranes, and sometimes the viscera—also called angio-neurotic edema, giant urticaria, Quincke's disease, or Quincke's edema.

**ANGIOGRAM.** An examination of a part of the body by injecting dye into an artery so that the blood vessels show up on an x ray.

**ANGIOGRAPHY.** Any of the different methods for investigating the condition of blood vessels, usually via a combination of radiological imaging and injections of chemical tracing and contrasting agents.

**ANGIOMATOUS MALFORMATIONS.** Tumors in blood vessels.

**ANGIOPLASTY.** A procedure in which a balloon catheter is used to mechanically dilate the affected area of a diseased artery and enlarge the constricted or narrowed segment; it is an alternative to vascular surgery.

**ANGIOTENSIN-CONVERTING ENZYME (ACE) INHIBITOR.** A drug that lowers blood pressure by interfering with the breakdown of a protein-like substance involved in blood pressure regulation.

**ANGLE (OR ANGLE CLOSURE).** The open point in the anterior chamber of the eye at which the iris meets the cornea. Blockage of the angle prevents fluid from leaving the anterior chamber, resulting in closed-angle glaucoma.

**ANISMUS.** Dysfunctional contraction or spasm of the muscle comprising the anal sphincter.

**ANKLE-BRACHIAL INDEX (ABI) TEST.** A means of checking the blood pressure in the arms and ankles using a regular blood pressure cuff and a special ultrasound stethoscope (Doppler). The pressure in the ankle is compared to the pressure in the arm.

**ANKYLOSING SPONDYLITIS.** A form of inflammatory arthritis in which the bones in the spine and pelvis gradually fuse when inflamed connective tissue is replaced by bone.

**ANNULUS.** A ring-shaped structure.

**ANOMALY.** A marked deviation from normal structure or function, particularly as the result of congenital defects.

**ANOREXIA NERVOSA.** An eating disorder marked by refusal to eat, intense fear of obesity, and distortions of body image.

**ANTACID.** A substance that counteracts or neutralizes acidity, usually of the stomach. Antacids have a rapid onset of action compared to histamine H-2 receptor blockers and proton pump inhibitors, but they have a short duration of action and require frequent dosing.

**ANTALGIC.** Medication that alleviates pain.

**ANTEROLATERAL.** Situated in front and to the side.

**ANTERIOR CHAMBER.** The front chamber of the eye bound by the cornea in front and the iris in the back. The anterior chamber is filled with aqueous humor. The drainage site for the aqueous fluid is in the anterior chamber.

**ANTERIOR CRUCIATE LIGAMENT (ACL).** A crossing ligament that attaches the femur to the tibia and stabilizes the knee against forward motion of the tibia.

**ANTERIOR MEDIASTINOTOMY.** A surgical procedure to look at the organs and tissues between the lungs and between the breastbone and spine for abnormal areas. An incision (cut) is made next to the breastbone and a thin, lighted tube is inserted into the chest. Tissue and lymph node samples may be taken for biopsy.

**ANTHRAX.** A dangerous pathogen that should be contained in a negative pressure room.

**ANTIARRHYTHMIC.** Medication used to treat abnormal heart rhythms.

**ANTIBIOTIC.** A chemical substance produced by a microorganism that is able to kill other microorganisms without being toxic to the host. Antibiotics are used to treat diseases in humans, other animals, and plants.

**ANTIBODIES.** Proteins that are produced normally by specialized white blood cells after stimulation by a foreign substance (antigen) and that act specifically against the antigen in an immune response.

**ANTICHOLINERGICS.** Drugs that interfere with impulses from the parasympathetic nervous system. They may be given before general anesthesia to reduce airway secretions or the risk of bronchospasm.

**ANTICOAGULANT.** A medication, also called a “blood thinner,” that prevents blood from clotting. This type of medication is used for people at risk of stroke or blood clots.

**ANTIDIURETIC HORMONE (ADH).** Also called vasopressin. A hormone produced by the hypothalamus and stored in and excreted by the pituitary gland. ADH acts on the kidneys to reduce the flow of urine, increasing total body fluid.

**ANTIDIURETIC.** A medication or other compound that suppresses the production of urine.

**ANTIEMETIC.** A drug that prevents emesis, or vomiting.

**ANTIGEN.** A substance that stimulates the immune system to manufacture antibodies (immunoglobulins). The function of antibodies is to fight off such intruder cells as bacteria or viruses. Antigens stimulate the blood to fight other blood cells that have the wrong antigens. If a person with blood type A is given a



transfusion with blood type B, the A antigens will fight the foreign blood cells as though they were an infectious agent.

**ANTIHISTAMINE.** Medicine that prevents or relieves allergy symptoms.

**ANTIMICROBIAL.** A compound that prevents the growth of microbes which may include bacteria, fungi, and viruses.

**ANTIMYCOTIC.** A medicine that can be used to kill yeast and fungus.

**ANTIPLATELET DRUG.** Drug that inhibits platelets from aggregating to form a plug.

**ANTIPYRETIC.** A medication that lowers fever.

**ANTISEPTIC.** Substance preventing or stopping the growth of microorganisms.

**ANTITHROMBIC.** Preventing clot formation.

**ANTITRYPSIN.** A substance that inhibits the action of trypsin.

**ANTRECTOMY.** A surgical procedure for ulcer disease in which the antrum, a portion of the stomach, is removed.

**ANTROSTOMY.** The operation of opening an antrum for drainage.

**ANTRUM.** The cavity of a sinus. Also the lower part of the stomach that lies between the pylorus and the body of the stomach. It is also called the gastric antrum or antrum pyloricum.

**ANUS.** The terminal orifice of the bowel.

**ANXIETY.** Worry or tension in response to real or imagined stress, danger, or dreaded situations. Physical reactions such as fast pulse, sweating, trembling, fatigue, and weakness may accompany anxiety.

**ANXIETY ATTACK.** A disorder in which sudden feelings of dread, fear, and apprehension of danger enter a person's mind in an overwhelming manner. Attacks may lead to a state of hyperventilation.

**ANXIOLYTICS.** Medications given to reduce anxiety; tranquilizers. Benzodiazepines are the anxiolytics most commonly used to premedicate patients before general anesthesia.

**AORTA.** The main artery that carries blood from the heart to the rest of the body. The aorta is the largest artery in the body.

**AORTIC ANEURYSM.** Occurs when an area in the aorta (the main artery of the heart) is weakened and bulges like a balloon.

**AORTIC DISSECTION.** A situation in which a tear in the interior lining of the wall of the aorta causes bleeding between the layers of that major artery.

**AORTIC VALVE.** The valve between the heart's left ventricle and ascending aorta that prevents regurgitation of blood back into the left ventricle.

**APHAKIC.** Without a lens. An older form of cataract surgery known as intracapsular extraction left patients' eyes aphakic.

**APHERESIS.** A procedure in which whole blood is withdrawn from a donor, a specific blood component is separated and collected, and the remainder is reinfused into the patient.

**APICOECTOMY.** Also called root resectioning. The root tip of a tooth is accessed in the bone and a small amount is shaved away. The diseased tissue is removed and a filling is placed to reseal the canal.

**APLASTIC ANEMIA.** A disorder in which the body produces inadequate amounts of red blood cells and hemoglobin due to underdeveloped or missing bone marrow.

**APNEA.** A period of no breathing, sometimes sudden, sometimes prolonged.

**APPENDECTOMY.** Removal of the appendix.

**APPENDIX.** A pouch-shaped organ that is attached to the upper part of the large intestine.

**APPETITE SUPPRESSANT.** A medication given to reduce the desire to eat.

**APROTININ.** A protein derived from cows' lungs included in some fibrin sealants to prevent the fibrin clot from dissolving.

**AQUEOUS HUMOR.** The watery fluid produced in the eye that ordinarily leaves the eye through the angle of the anterior chamber.

**AREFLEXIA.** A condition in which the body's normal reflexes are absent. It is one of the objectives of general anesthesia.

**ARGON.** A colorless, odorless gas.

**ARREST.** A sudden stopping of the function of a body organ, such as no breathing (respiratory arrest) or no beating of the heart (cardiac arrest).

**ARRHYTHMIA.** An abnormal heart rhythm. Examples are a slow, fast, or irregular heart rate.

**ARTERIAL BLOOD.** Blood from the arteries, the blood vessels that carry oxygen from the lungs to supply the body tissues.

**ARTERIAL BLOOD GAS (ABG).** A type of blood laboratory test done to check for imbalances in pH or gases that affect pH.

**ARTERIAL EMBOLISM.** A blood clot arising from another location that blocks an artery.

**ARTERIAL LINE.** A catheter inserted into an artery and connected to a physiologic monitoring system to allow direct measurement of oxygen, carbon dioxide, and invasive blood pressure.

**ARTERIES.** Blood vessels that carry blood away from the heart to the cells, tissues, and organs of the body.

**ARTERIOGRAM.** A diagnostic test that involves viewing the arteries and/or attached organs by injecting a contrast medium, or dye, into the artery and taking an x ray.

**ARTERIOLAR BED.** An area in which arterioles cluster between arteries and capillaries.

**ARTERIOLES.** The smallest branches of arteries.

**ARTERIOSCLEROSIS.** A chronic condition characterized by thickening and hardening of the arteries and the build-up of plaque on the arterial walls. Arteriosclerosis can slow or impair blood circulation.

**ARTERIOVENOUS MALFORMATION.** An anomaly present since birth in which the arteries and veins in a particular part of the body are caught up in a complex tangle, and in which there is an abnormal pattern of blood flowing from the arteries directly into the veins.

**ARTERY.** A blood vessel that carries blood from the heart to other parts of the body.

**ARTHRITIS.** A disease of the joints that arises from wear and tear, age, and, less often, from inflammation.

**ARTHRODESIS.** Surgery that joins (or fuses) two bones so that the joint can no longer move; it may be done on joints such as the fingers, knees, ankles, or spine.

**ARTHROGRAPHY.** Visualization of a joint by radiographic means following injection of a contrast dye into the joint space.

**ARTHROPLASTY.** The surgical reconstruction or replacement of a joint.

**ARTHROSCOPE.** A pencil-sized fiber-optic instrument fitted with a lens, light source, and camera, used for detailed examination of joints.

**ARTHROSCOPY.** The introduction of a thin fiber-optic scope (arthroscope) into a joint space to allow direct visualization of internal structures. In some cases, surgical repair can also be performed using the arthroscope.

**ARTHROSIS.** A disease of a joint.

**ARTIFACT.** Extra electrical activity typically caused by interference.

**ARTIFICIAL SPHINCTER.** An implanted device that functions to control the opening and closing of the urethral or anal canal for the expelling of urine or feces, respectively.

**ASCITES.** An abnormal collection of fluid within the abdomen, often suggests liver disease such as cirrhosis.

**ASCITIC FLUID.** The fluid that accumulates in the peritoneal cavity in ascites.

**ASEPSIS.** Freedom from infection or infectious material; also, the absence of viable pathogenic organisms. Asepsis can be accomplished using aseptic techniques, which are the use of surgical practices that restrict microorganisms in the environment and prevent contamination of the surgical wound; they include sterilization of instruments and the wearing of sterile caps, gloves, and masks.

**ASPIRATION.** The process of removing fluids or gases from the body by suction.

**ASSISTED LIVING.** A type of facility for people who are not able to live independently but do not require the level of skilled nursing provided by a nursing home.

**ASTHMA.** An inflammatory respiratory disorder in which the airway becomes obstructed and breathing is difficult.

**ASTIGMATISM.** A condition in which one or both eyes cannot filter light properly and images appear blurred and indistinct.

**ATELECTASIS.** Partial or complete collapse of the lung, usually due to a blockage of the air passages with fluid, mucus or infection.

**ATHERECTOMY.** A non-surgical technique for treating diseased arteries with a rotating device that cuts or shaves away obstructing material inside the artery.

**ATHEROMA.** A collection of plaque (lesion) blocking a portion of an artery.

**ATHEROSCLEROSIS.** A condition in which the major arteries throughout the body become obstructed by fatty plaques, causing narrowing, obstruction of blood flow, and ultimately hardening and stiffening of the arterial walls.

**ATKINS DIET.** A diet that involves eating a high amount of protein and fat with a low amounts of carbohydrates.

**ATRESIA.** Lack of development. In tricuspid atresia, the tricuspid valve has not developed. In pulmonary atresia, the pulmonary valve has not developed.

**ATRIA (SINGULAR, ATRIUM).** The right and left upper chambers of the heart.

**ATRIAL FIBRILLATION.** A condition in which the upper chamber of the heart quivers instead of pumping in an organized way.

**ATRIAL FLUTTER.** A rapid pulsation of the upper chambers of the heart that interferes with normal heart function. Atrial flutter is usually more organized and regular than atrial fibrillation, although it often converts to atrial fibrillation. Atrial flutter occurs most often in people with heart disease and in the first week after heart surgery.

**ATRIOVENTRICULAR.** Referring to the valves regulating blood flow from the upper chambers of the heart (atria) to the lower chambers (ventricles). There are two such valves, one connecting the right atrium and ventricle and one connecting the left atrium and ventricle.

**ATROPHY.** Wasting away or degeneration of body tissue. Atrophy of the optic nerve, for example, is one of the defining characteristics of glaucoma.

**ATTENTION DEFICIT HYPERACTIVITY DISORDER (ADHD).** A disorder involving a developmentally inappropriate degree of inattention and impulsivity. Hyperactivity may or may not be a component. This disorder usually appears in childhood and manifests itself as difficulty at home or school. It sometimes persists into adulthood where it may affect work, relationships, and other social situations.

**AUDIOGRAM.** A test of hearing at a range of sound frequencies.

**AUDIOLOGIST.** A health care professional who performs diagnostic testing of impaired hearing.

**AUDITORY NERVE.** The nerve that carries electrical signals from the cochlea to the brain.

**AURICLE.** The portion of the external ear that is not contained inside the head. It is also called the pinna.

**AUSCULTATION.** The act of listening to sounds arising within organs as an aid to diagnosis and treatment.

**AUTISM.** A childhood disorder that manifests as an inability to communicate with or relate to others, or interact in social situations in a healthy, normal manner. Autism may range from mild to severe and includes repetitive behaviors, the inability to cope with changes from routine activities, and obsessions with specific objects. Autism is sometimes associated with below-normal intelligence or anxiety.

**AUTOCLAVE.** A heavy vessel that uses pressurized steam for disinfecting and sterilizing surgical instruments.

**AUTOGENOUS TISSUE.** Tissue or skin taken from any part of a person's body to graft onto another part of the body that needs repairing; laid on as a patch.

**AUTOGRAFT.** Tissue that is taken from one part of a patient's body and transplanted to another part of the patient's body.

**AUTOIMMUNE DISEASE.** A disease in which the immune system is overactive and produces antibodies that attack the body's own tissues.

**AUTOLOGOUS.** From the same person; an autologous breast reconstruction uses the woman's own tissues.

**AUTOLOGOUS BLOOD.** A patient's own blood, drawn and set aside for use during surgery in case a transfusion is needed.

**AUTONOMIC NERVOUS SYSTEM.** The part of the nervous system that regulates the activity of heart muscle, smooth muscle, and glands.

**AUTOTRANSFUSION.** A technique for recovering blood during surgery, separating and concentrating the red blood cells, and reinfusing them in the patient. Also known as blood salvage.

**AUXILIARY HOSPITAL SERVICES.** A term used broadly to designate such nonmedical services as financial services, birthing classes, support groups, etc. that are instituted in response to consumer demand.

**AVASCULAR NECROSIS.** A disorder in which bone tissue dies and collapses following the temporary or

permanent loss of its blood supply; it is also known as osteonecrosis.

**AVULSION.** The tearing away of a body part or tissue.

**AXILLARY.** Pertaining to the armpit.

**AXILLARY LYMPH NODE.** Lymph nodes under the arm.

**AXILLARY VEIN.** A blood vessel that takes blood from tissues back to the heart to receive oxygenated blood.

## B

**B-LYMPHOCYTE.** A type of blood cell that is active in immune response.

**BACTERIA.** Microscopically small one-celled forms of life that cause many diseases and infections.

**BACTERICIDAL.** An agent that kills bacteria.

**BACTERIOSTATIC.** An agent that stops the multiplication of bacteria.

**BACTERIURIA.** The presence of bacteria in the urine.

**BACTEROIDES.** A family of anaerobic, rod-shaped bacteria. Its organisms are normal inhabitants of the oral, respiratory, intestinal, and urogenital cavities of humans, animals, and insects. Some species are infectious agents.

**BALANCED ANESTHESIA.** The use of a combination of inhalation and intravenous anesthetics, often with opioids for pain relief and neuromuscular blockers for muscle paralysis.

**BALLOON ANGIOPLASTY.** A procedure used to open an obstructed blood vessel. A small, balloon-tipped catheter is inserted into the vessel and the balloon is inflated to widen the vessel and push the obstructing material against the vessel's walls. The result is improved blood flow through the vessel.

**BAND CELL.** An immature neutrophil at the stage just preceding a mature cell. The nucleus of a band cell is unsegmented.

**BARIATRIC SURGERY.** Weight loss surgery, such as gastric bypass.

**BARIATRICS.** The branch of medicine that deals with the prevention and treatment of obesity and related disorders.

**BARIUM ENEMA.** An X-ray test of the bowel performed after giving the patient an enema of a white chalky substance (barium) that outlines the colon and the rectum.

**BARIUM SULFATE.** A barium compound used during a barium enema to block the passage of x rays during the exam.

**BARIUM SWALLOW.** Barium is used to coat the throat and the upper digestive tract, a contrast medium that allows the areas to be visualized in x-ray studies.

**BAROTRAUMA.** Ear pain caused by unequal air pressure on the inside and outside of the ear drum. Barotrauma, which is also called pressure-related ear pain or barotitis media, is the most common reason for myringotomies in adults.

**BARRETT'S ESOPHAGUS.** A potentially precancerous change in the type of cells that line the esophagus, caused by acid reflux disease.

**BARTTER'S SYNDROME.** An inherited disorder which affects a number of body processes, including the functioning of the part of the kidney that regulates potassium excretion and absorption. People with Bartter's syndrome have abnormally low blood potassium levels (hypokalemia).

**BASAL CELL CARCINOMA.** Basal cell carcinoma is the most common malignant tumor, affecting more than 800,000 people annually in the United States.

**BASOPHIL.** Segmented white blood cell with large dark blue-black granules that releases histamine in allergic reactions.

**BELL.** The cup-shaped portion of the head of a stethoscope, useful for detecting low-pitched sounds.

**BELL'S PALSY.** One-sided paralysis of the face that may be due to damage to the facial nerve.

**BENIGN PROSTATIC HYPERPLASIA (BPH).** Also called benign prostatic enlargement (BPE). Non-cancerous enlargement of the prostate gland as a result of an increase in the number of its constituent cells.

**BENIGN TUMOR.** An abnormal growth that is not cancerous (malignant), and does not spread to other areas of the body.

**BETA BLOCKER.** An antihypertensive drug that limits the activity of epinephrine, a hormone that increases blood pressure.



**BEVEL.** The slanted opening on one side of the tip of a needle.

**BEZOAR.** A collection of foreign material, usually hair or vegetable fibers or a mixture of both, that may occasionally occur in the stomach or intestines and block the passage of food.

**BILATERAL.** Occurring on both the right and left sides of the body.

**BILATERAL CLEFT LIP.** Cleft that occurs on both sides of the lip.

**BILE.** A fluid produced by the liver and stored in the gallbladder. Bile is important for the appropriate digestion of fats in the intestine.

**BILE DUCTS.** Tubes carrying bile from the liver to the intestines.

**BILIARY ATRESIA.** A disease in which the ducts that carry bile out of the liver are missing or damaged is the most frequent reason for transplantation in children. Biliary atresia of the major bile ducts causes cholestasis and jaundice, which does not become apparent until several days after birth; periportal fibrosis develops and leads to cirrhosis, with proliferation of small bile ducts unless these are also atretic; giant cell transformation of hepatic cells also occurs.

**BILIARY SYSTEM.** The term used to describe the system of ducts that carries the bile flow through the liver and the gallbladder, and ultimately empties into the duodenum. Also called the biliary tract.

**BILIRUBIN.** A yellow bile pigment found as sodium (soluble) bilirubinate, or as an insoluble calcium salt found in gallstones.

**BILIVERDIN.** A green bile pigment formed from the oxidation of heme, which is a bilin with a structure almost identical to that of bilirubin.

**BINGE EATING DISORDER.** An eating disorder in which the person binges but does not try to get rid of the food afterward by vomiting, using laxatives, or exercising.

**BIOLOGICAL TISSUE VALVE.** A replacement heart valve that is harvested from the patient (autograft), a human cadaver (homograft or allograft), or other animal, such as a pig (heterograft).

**BIOMECHANICS.** The application of mechanical laws to the structures in the human body, such as measuring the force and direction of stresses on a joint.

**BIOPSY.** The surgical removal and analysis of a tissue sample for diagnostic purposes. Usually the term refers to the collection and analysis of tissue from a suspected tumor to establish malignancy.

**BLADDER.** A membranous sac that serves as a reservoir for urine. Contraction of the bladder results in urination.

**BLADDER EXSTROPHY.** One of many bladder and urinary congenital abnormalities. Occurs when the wall of the bladder fails to close in embryonic development and remains exposed to the abdominal wall.

**BLADDER IRRIGATION.** To flush or rinse the bladder with a stream of liquid (as in removing a foreign body or medicating).

**BLADDER MUCOSA.** Mucous coat of the bladder.

**BLADDER TUMOR MARKER STUDIES.** A test to detect specific substances released by bladder cancer cells into the urine using chemical or immunologic (using antibodies).

**BLADDER WASHINGS.** A procedure in which bladder washing samples are taken by placing a salt solution into the bladder through a catheter (tube) and then removing the solution for microscopic testing.

**BLANK.** If an individual has inherited the same HLA antigen from both parents, the HLA typing is designated by the shared HLA antigen followed by a “blank”(-).

**BLAST CELLS.** Blood cells in early stage of cellular development.

**BLAST CRISIS.** Stage of chronic myelogenous leukemia where large quantities of immature cells are produced by the marrow, and it is not responsive to treatment.

**BLEB.** A thin-walled auxiliary drain created on the outside of the eyeball during filtering surgery for glaucoma. It is sometimes called a filtering bleb.

**BLEEDING DISORDER.** A problem related to the clotting mechanism of the blood.

**BLEPHAROPLASTY.** Plastic surgery performed on the eyelids.

**BLOOD BANK.** A laboratory that specializes in blood typing, antibody identification, and transfusion services.

**BLOOD PRESSURE.** The pressure exerted by arterial blood on the walls of arteries. This depends on the strength of the heart beat, elasticity of the arterial walls, and volume and viscosity (resistance to flow) of blood. The pressure of blood in the arteries is measured in millimeters of mercury by a sphygmomanometer or by an electronic device.

**BLOOD SERUM.** The fluid portion of the blood.

**BLOOD TYPE.** Any of various classes into which human blood can be divided according to immunological compatibility based on the presence or absence of certain antigens on the red blood cells. Blood types are sometimes called blood groups.

**BLOOD UREA NITROGEN (BUN).** Blood urea nitrogen is a chemical waste product of protein metabolism that circulates in the bloodstream. Healthy kidneys remove urea from the bloodstream and it leaves the body in the urine. When the kidneys are not functioning properly, they are unable to filter the urea out of the blood, and blood urea nitrogen levels become elevated.

**BODY DYSMORPHIC DISORDER (BDD).** A psychiatric condition marked by excessive preoccupation with an imaginary or minor defect in a facial feature or localized part of the body. Many people with BDD seek cosmetic surgery as a treatment for their perceived flaw.

**BODY MASS INDEX (BMI).** A measurement that has replaced weight as the preferred determinant of obesity. The BMI can be calculated (in American units) as a person's weight in pounds divided by the square of the person's height in inches, multiplied by the conversion factor of 703.

**BOLUS.** A mass of food ready to be swallowed, or a preparation of medicine to be given by mouth or IV all at once rather than gradually.

**BONE DENSITOMETRY TEST.** A test that quickly and accurately measures the density of bone.

**BONE MARROW.** A spongy tissue located within flat bones, including the hip and breast bones and the skull. This tissue contains stem cells, the precursors of platelets, red blood cells, and white blood cells.

**BONE MARROW BIOPSY.** A test involving the insertion of a thin needle into the breastbone or, more commonly, the hip, in order to aspirate (remove) a sample of the marrow. A small piece of cortical bone may also be obtained for biopsy.

**BONE MARROW TRANSPLANT.** Healthy marrow is infused into people who have had high-dose

chemotherapy for one of the many forms of leukemias, immunodeficiencies, lymphomas, anemias, metabolic disorders, and sometimes solid tumors.

**BONE MORPHOGENETIC PROTEINS.** A family of substances in human bones and blood that encourage the process of osteoinduction.

**BONE SPURS.** A sharp or pointed calcified projection.

**BONY LABYRINTH.** A series of cavities contained in a capsule inside the temporal bone of the skull. The endolymph-filled membranous labyrinth is suspended in a fluid inside the bony labyrinth.

**BORBORYGMI.** Sounds created by the passage of food, gas or fecal material in the stomach or intestines.

**BOTULINUM TOXIN.** A toxin produced by the spores and growing cells of *Clostridium botulinum*. It causes muscle paralysis, therefore this toxin can be used to reduce frown lines by temporarily paralyzing the muscles in the face that contract when a person frowns or squints.

**BOUGIE.** A slender, flexible tube or rod inserted into the urethra in order to dilate it.

**BOWEL LUMEN.** The space within the intestine.

**BRACHIAL.** Referring to the arm; the brachial artery is an artery that runs from the shoulder to the elbow.

**BRACHYTHERAPY.** The use of radiation during angioplasty to prevent the artery from narrowing again (a process called restenosis).

**BRADYCARDIA.** Relatively slow heart action, usually considered as a rate under 60 beats per minute.

**BRAIN DEATH.** Irreversible cessation of brain function. Patients with brain death have no potential capacity for survival or for recovery of any brain function.

**BRAIN LESION.** Physical damage done to a specific part or location of the brain, that may result in specific symptoms or behaviors associated with that brain lesion.

**BRCA1 OR BRCA2 GENETIC MUTATION.** A genetic mutation that predisposes otherwise healthy women to breast cancer.

**BREAST AUGMENTATION.** A surgery to increase the size of the breasts.

**BREAST BIOPSY.** A procedure where suspicious tissue is removed and examined by a pathologist for

cancer or other disease. The breast tissue may be obtained by open surgery, or through a needle.

**BREATHING RATE.** The number of breaths per minute.

**BREECH PRESENTATION.** The condition in which the baby enters the birth canal with its buttocks or feet first.

**BRONCHI.** The large air tubes leading from the trachea to the lungs that convey air to and from the lungs.

**BRONCHIECTASIS.** Persistent and progressive dilation of bronchi or bronchioles as a consequence of inflammatory disease such as lung infections, obstructions, tumors, or congenital abnormality.

**BRONCHIOLES.** Small airways extending from the bronchi into the lobes of the lungs.

**BRONCHITIS.** Inflammation of the air passages in the lungs.

**BRONCHOALVEOLAR LAVAGE.** Washing cells from the air sacs at the end of the bronchioles.

**BRONCHODILATOR.** A drug that relaxes the bronchial muscles, resulting in expansion of the bronchial air passages.

**BRONCHOPLEURAL FISTULA.** An abnormal connection between an air passage and the membrane that covers the lungs.

**BRONCHOSCOPE.** A tubular illuminated instrument used for inspecting or passing instruments into the bronchi.

**BRONCHOSCOPY.** A medical test that enables the physician to see the breathing passages and the lungs through a hollow, lighted tube.

**BRONCHOSPASM.** A spasmodic contraction of the muscles that line the two branches of the trachea that lead into the lungs, causing difficulty in breathing. Bronchospasm is a common complication in heavy smokers under anesthesia.

**BROTH.** A growth mixture for bacteria. Different compounds, such as sugars or amino acids, may be added to increase the growth of certain organisms. Also known as media.

**BRUCELLOSIS.** An infectious disease transmitted to humans from farm animals, most commonly goats, sheep, cattle, and dogs. It is marked by high fever, pains in the muscles and joints, heavy sweating, headaches, and depression.

**BRUIT.** A roaring sound created by a partially blocked artery.

**BRUNESCENT.** Developing a brownish or amber color over time; nuclear cataracts are sometimes called brunescent.

**BUCCAL SULCUS.** Groove in the upper part of the upper jaw (where there are teeth).

**BUCCAL.** The interior surface of the cheek.

**BUERGER'S DISEASE.** An episodic disease that causes inflammation and blockage of the veins and arteries of the limbs. It tends to be present almost exclusively in men under age 40 who smoke, and may require amputation of the hand or foot.

**BULIMIA NERVOSA.** An eating disorder marked by episodes of binge eating followed by purging, over-exercising, or other behaviors intended to prevent weight gain.

**BUNION.** A swelling or deformity of the big toe, characterized by the formation of a bursa and a sideways displacement of the toe.

**BURCH PROCEDURE.** A surgical procedure, also called retropubic colposuspension, in which the neck of the bladder is suspended from nearby ligaments with sutures. It is performed to treat urinary incontinence.

**BURSA.** A sac found in connective tissue that acts to reduce friction between tendon and bone.

**BURSITIS.** Inflammation of a bursa.

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## C

**CADAVER.** A dead body.

**CADAVER KIDNEY.** A kidney from a brain-dead organ donor used for purposes of kidney transplantation.

**CADAVER ORGAN.** A pancreas, kidney, or other organ from a brain-dead organ donor.

**CADAVER SKIN.** Skin donated from another person to treat burns.

**CADAVERIC DONOR.** An organ donor who has recently died of causes not affecting the organ intended for transplant.

**CAESARIAN SECTION.** An incision made through the wall of a pregnant woman's abdomen and uterus in order to deliver the fetus. It is commonly abbreviated as C-section.

**CALCITONIN.** A hormone made by the thyroid gland. Calcitonin is involved in regulating levels of calcium and phosphorus in the blood.

**CALCIUM CHANNEL BLOCKER.** A drug that lowers blood pressure by regulating calcium-related electrical activity in the heart.

**CALCULUS.** Any type of hard concretion (stone) in the body, but usually found in the gallbladder, pancreas, and kidneys. Calculi (the plural form) are formed by the accumulation of excess mineral salts and other organic material, such as blood or mucus. They can cause problems by lodging in and obstructing the proper flow of fluids, such as bile to the intestines or urine to the bladder.

**CALDWELL-LUC PROCEDURE.** A surgical procedure in which the surgeon enters the maxillary sinus by making an opening under the upper lip above the teeth.

**CALLUS.** A localized thickening of the outer layer of skin cells, caused by friction or pressure from shoes or other articles of clothing.

**CANCER STAGING.** A surgical procedure to remove a lymph node and examine the cells for cancer. It determines the extent of the cancer and how far it has spread.

**CANCER SURGERY.** Surgery in which the goal is to excise a tumor and its surrounding tissue found to be malignant.

**CANCER.** The uncontrolled growth of abnormal cells which have mutated from normal tissues.

**CANINE TOOTH.** In humans, the tooth located in the mouth next to the second incisor. The canine tooth has a pointed crown and the longest root of all the teeth.

**CANKER SORE.** A blister-like sore on the inside of the mouth that can be painful but is not serious.

**CANNULA.** A tube inserted into a body cavity.

**CAPILLARY.** Smallest extremity of the arterial vessel, where oxygen and nutrients are released from the blood into the cells, and cellular waste is collected.

**CAPSULAR CONTRACTURE.** Thick scar tissue around a breast implant, which may tighten and cause discomfort and/or firmness.

**CAPSULE.** A general medical term for a structure that encloses another structure or body part. The capsule of the testicle is the membrane that surrounds the glandular tissue.

**CAPSULORRHESIS.** The creation of a continuous circular tear in the front portion of the lens capsule during cataract surgery to allow for removal of the lens nucleus.

**CAPSULOTOMY.** A procedure that is sometimes needed after ECCE to open a lens capsule that has become cloudy.

**CARBOHYDRATES.** Compounds such as cellulose, sugar, and starch that contain only carbon, hydrogen, and oxygen, and are a major part of the diets of people and other animals.

**CARBON DIOXIDE.** A heavy, colorless gas that dissolves in water. Abbreviated CO<sub>2</sub>, it also produces light that is well absorbed by the skin, so is commonly used for skin resurfacing treatments.

**CARCINOMA.** A malignant growth that arises from epithelium, found in skin or, more commonly, the lining of body organs.

**CARDIAC.** Of or relating to the heart.

**CARDIAC ANGIOGRAPHY.** A procedure used to visualize blood vessels of the heart.

**CARDIAC ARREST.** A condition in which the heart has no discernable electrical activity to stimulate contraction, therefore no blood is pumped.

**CARDIAC ARRHYTHMIA.** An irregular heart rate (frequency of heartbeats) or rhythm (the pattern of heartbeats).

**CARDIAC CATHETER.** Long, thin, flexible tube, which is threaded into the heart through a blood vessel.

**CARDIAC CATHETERIZATION.** A procedure to pass a catheter to the heart and its vessels for the purpose of diagnosing coronary artery disease, assessing injury or disease of the aorta, or evaluating cardiac function.

**CARDIAC DISEASE.** Any disease involving the heart.

**CARDIAC MARKER.** A substance in the blood that rises following a myocardial infarction.

**CARDIAC OUTPUT.** The liter per minute blood flow generated by contraction of the heart.

**CARDIAC PULMONARY BYPASS.** A procedure where heart blood is diverted into an inserted pump in order to maintain appropriate blood flow.

**CARDIAC REHABILITATION.** A structured program of education and activity offered by hospitals and other organizations.



**CARDIAC SURGERY.** Surgery performed on the heart.

**CARDIAC TAMPONADE.** A condition in which the sac around the heart is filled with blood and keeps the heart from functioning properly.

**CARDIOLOGIST.** A physician who specializes in problems of the heart.

**CARDIOMYOPATHIES.** Diseases of the heart muscle; usually refers to a disease of obscure etiology.

**CARDIOPLEGIC ARREST.** Halting the electrical activity of the heart by delivery of a high potassium solution to the coronary arteries. The arrested heart provides a superior surgical field for operation.

**CARDIOPULMONARY BYPASS.** Use of the heart-lung machine to provide systemic circulation, cardiac output, and ventilation of the blood.

**CARDIOPULMONARY DISEASE.** Illness of the heart and lungs.

**CARDIOPULMONARY RESUSCITATION (CPR).** An emergency procedure used to restore circulation and prevent brain death to a person who has collapsed, is unconscious, is not breathing, and has no pulse.

**CARDIOPULMONARY.** Involving both heart and lungs.

**CARDIOTHORACIC SURGERY.** Surgery involving the chest body cavity known as the thoracic cavity.

**CARDIOVASCULAR SYSTEM.** The physiological system including the heart and the blood vessels.

**CARDIOVERSION.** A procedure used to restore the heart's normal rhythm by applying a controlled electric shock to the exterior of the chest.

**CARDIOVERTER.** A device to apply electric shock to the chest to convert an abnormal heartbeat into a normal heartbeat.

**CAROTID ARTERY DISEASE.** A condition in which the arteries in the neck that supply blood to the brain become clogged, causing the danger of a stroke.

**CAROTID ARTERY.** Major artery leading to the brain, blockages of which can cause temporary or permanent strokes.

**CAROTID ENDARTERECTOMY.** A surgical technique for removing intra-arterial obstructions of the internal carotid artery.

**CARPAL BONES.** Eight wrist bones arranged in two rows that articulate proximally with the radius and

indirectly with the ulna, and distally with the five metacarpal bones.

**CARTILAGE.** A tough, elastic connective tissue found in the joints, outer ear, nose, larynx, and other parts of the body.

**CASE MANAGER.** A health-care professional who can provide assistance with a patient's needs beyond the hospital.

**CAST.** An insoluble gelled protein matrix that takes the form of the renal tubule in which it was deposited. Casts are washed out by normal urine flow.

**CASTRATION.** Removal or destruction by radiation of both testicles (in a male) or both ovaries (in a female), making the individual incapable of reproducing.

**CATARACT.** A cloudy or opaque area on or in the lens of the eye.

**CATEGORICALLY NEEDY.** A term that describes certain groups of Medicaid recipients who qualify for the basic mandatory package of Medicaid benefits. There are categorically needy groups that states participating in Medicaid are required to cover, and other groups that the states have the option to cover.

**CATGUT.** The oldest type of absorbable suture. In spite of its name, catgut is made from collagen derived from sheep or cattle intestines. Synthetic absorbable sutures have been available since the 1980s.

**CATHARTIC.** An agent which stimulates defecation.

**CATHARTIC COLON.** A poorly functioning colon, resulting from the chronic abuse of stimulant cathartics.

**CATHETER.** A thin, hollow tube inserted into the body at specific points in order to infuse medications, blood components, or nutritional fluids into the body, or to withdraw fluids from the body such as gastric fluid or urine.

**CAUDA EQUINA.** A bundle of nerve roots in the lower back (lumbar region) of the spinal canal that controls the leg muscles and functioning of the bladder, intestines, and genitals.

**CAUDA EQUINA SYNDROME (CES).** A group of symptoms characterized by numbness or pain in the legs and/or loss of bladder and bowel control, caused by compression and paralysis of the nerve roots in the cauda equina. CES is a medical emergency.

**CAUSALGIA.** A severe burning sensation sometimes accompanied by redness and inflammation of the skin.

**Causalgia** is caused by injury to a nerve outside the spinal cord.

**CAUTERIZE.** To use heat or chemicals to stop bleeding, prevent the spread of infection, or destroy tissue.

**CECUM.** The beginning of the large intestine and the place where the appendix attaches to the intestinal tract.

**CELLULITE.** Dimpled skin that is caused by uneven fat deposits beneath the surface.

**CENTRAL LINE.** A catheter passed through a vein into large blood vessels of the chest or the heart; used in various medical procedures.

**CENTRAL NERVOUS SYSTEM.** The brain, spinal cord and the nerves throughout the body.

**CENTRAL VENOUS LINE.** A catheter inserted into a vein and connected to a physiologic monitoring system to directly measure venous blood pressure.

**CEPHALOPELVIC DISPROPORTION (CPD).** The condition in which the baby's head is too large to fit through the mother's pelvis.

**CEREBRAL ANEURYSM.** The dilation, bulging, or ballooning out of part of the wall of a vein or artery in the brain.

**CEREBRAL CORTEX.** The outer portion of the brain, consisting of layers of nerve cells and their connections. The cerebral cortex is the part of the brain in which thought processes take place.

**CEREBRAL PALSY.** Group of disorders characterized by loss of movement or loss of other nerve functions. These disorders are caused by injuries to the brain that occur during fetal development or near the time of birth.

**CEREBROSPINAL FLUID.** A clear fluid that fills the hollow cavity inside the brain and spinal cord. The cerebrospinal fluid has several functions, including providing a cushion for the brain against shock or impact, and removing waste products from the brain.

**CEREBROVASCULAR ACCIDENT.** Brain hemorrhage, also known as a stroke.

**CERVICAL CRYOTHERAPY.** Surgery performed after a biopsy has confirmed abnormal cervical cells (dysplasia).

**CERVIX.** The lower part of the uterus extending into the vagina.

**CESAREAN SECTION.** A surgical procedure in which incisions are made through a woman's abdomen and uterus to deliver her baby.

**CHARCOT'S ARTHROPATHY.** Also called neuropathic arthropathy, a condition in which the shoulder joint is destroyed following loss of its nerve supply.

**CHEMICAL PEEL.** A skin treatment that uses the application of chemicals, such as phenol or trichloroacetic acid (TCA), to remove the uppermost layer of skin.

**CHEMICAL TOXICITY.** State of physical illness induced by poisoning with toxic chemicals. Chemical toxicities may affect a person's behavior or mental function.

**CHEMOPREVENTION.** The use of drugs, vitamins, or other substances to reduce the risk of developing cancer or of the cancer returning.

**CHEMOTHERAPY.** Medical treatment of a disease, particularly cancer, with drugs or other chemicals.

**CHEST TUBE.** A tube inserted into the chest to drain fluid and air from around the lungs.

**CHEST X RAY.** A diagnostic procedure in which a small amount of radiation is used to produce an image of the structures of the chest (heart, lungs, and bones) on film.

**CHILD LIFE SPECIALIST.** A person who has had specific training in the care of children, including understanding growth and development specific to each age range and how to talk to children of different ages.

**CHIROPRACTIC.** A system of therapy based on the notion that health and disease are related to the interactions between the brain and the nervous system. Treatment involves manipulation and adjustment of the segments of the spinal column. Chiropractic is considered a form of alternative medicine.

**CHOLANGITIS.** A bacterial infection of the biliary system.

**CHOLECYSTECTOMY.** Surgical removal of the gallbladder.

**CHOLECYSTITIS.** Infection and inflammation of the gallbladder, causing severe pain and rigidity in the upper right abdomen.

**CHOLELITHIASIS.** Also known as gallstones, these hard masses are formed in the gallbladder or passages, and can cause severe upper right abdominal pain radiating to the right shoulder, as a result of blocked bile flow.

**CHOLELITHOTOMY.** Surgical incision into the gallbladder to remove stones.

**CHOLESTASIS.** A blockage in the flow of bile.

**CHOLESTEATOMA.** A destructive and expanding sac that develops in the middle ear or mastoid process.

**CHOLESTEROL.** An abundant fatty substance in animal tissues. High levels in the diet are a factor in the cause of atherosclerosis.

**CHORDAE TENDINEAE.** The strands of connective tissue that connect the mitral valve to the papillary muscle of the heart's left ventricle.

**CHORDEE.** A condition associated with hypospadias in which the penis bends downward during erections.

**CHORIOAMNIONITIS.** Infection of the amniotic sac.

**CHORIONIC VILLUS SAMPLING (CVS).** A procedure similar to amniocentesis, except that cells are taken from the chorionic membrane (rather than the amniotic fluid) for testing. These cells, called chorionic villus cells, eventually become the placenta. The samples are collected either through the abdomen, as in amnio, or through the vagina. CVS can be done earlier in the pregnancy than amnio, but carries a somewhat higher risk.

**CHORIORETINAL.** Relating to the choroid coat of the eye and retina.

**CHOROID.** The middle of the three tunicae or coats that surround the eyeball; the choroid lies between the retina and the sclera.

**CHROMOSOMES.** Chromosomes are the strands of genetic material in a cell that occur in nearly identical pairs. Normal human cells contain 23 chromosome pairs—one in each pair inherited from the mother, and one from the father. Every human cell contains the exact same set of chromosomes.

**CHRONIC.** A condition that is persistent or recurs frequently.

**CHRONIC MYELOGENOUS LEUKEMIA (CML).** Also called chronic myelocytic leukemia, a malignant disorder that involves abnormal accumulation of white cells in the marrow and bloodstream.

**CHRONIC OTITIS MEDIA.** Inflammation of the middle ear with signs of infection lasting three months or longer.

**CHRONIC PAIN.** Pain that lasts more than three months and threatens to disrupt daily life.

**CHRONIC RENAL (KIDNEY) FAILURE.** Progressive loss of kidney function over several years that can result in permanent kidney failure requiring dialysis.

**CILIA.** Short hairlike processes that are capable of a lashing movement.

**CILIARY BODY.** The part of the eye, located behind the iris, that makes the intraocular aqueous fluid.

**CIRCULATION.** The passage of blood and delivery of oxygen through the veins and arteries of the body.

**CIRCUMCISION.** The removal of the foreskin of the penis.

**CIRRHOSSIS.** A chronic degenerative disease causing irreversible scarring of the liver.

**CLASSIC INCISION.** In a cesarean section, an incision made vertically along the uterus.

**CLATHRATES.** Substances in which a molecule from one compound fills a space within the crystal lattice of another compound. One theory of general anesthesia proposes that water molecules interact with anesthetic molecules to form clathrates that decrease receptor function.

**CLAUDICATION.** Cramping or pain in a leg caused by poor blood circulation, frequently caused by hardening of the arteries (atherosclerosis). Intermittent claudication occurs only at certain times, usually after exercise, and is relieved by rest.

**CLAVICLE.** Also called the collar bone, it is a doubly curved long bone that connects the upper limb to the trunk.

**CLEAN-CATCH SPECIMEN.** A urine specimen that is collected from the middle of the urine stream after the first part of the flow has been discarded.

**CLEARANCE.** The process of removing a substance or obstruction from the body. Also the rate at which a drug or other substance is removed from the blood by the liver or kidneys.

**CLEFT.** Split or opening, which can occur in the lip or palate or both.

**CLEFT PALATE.** A birth defect in which the roof of the mouth is open because the two sides of the palate failed to join together during fetal development.

**CLINICAL BREAST EXAM.** An examination of the breast and surrounding tissue by a physician, who is feeling for lumps and looking for other signs of abnormality.

**CLINICAL NURSE SPECIALISTS.** Nurses with advanced training as well as a master's degree.

**CLOT.** A soft, semi-solid mass that forms when blood gels.

**CLOTTING FACTORS.** Substances in the blood that act in sequence to stop bleeding by forming a clot.

**CO-INSURANCE.** The percentage of health care charges that an insurance company pays after the beneficiary pays the deductible. Most co-insurance percentages are 70–90%.

**COAGULATION.** Blood clotting.

**COAGULATION CASCADE.** The process of blood clotting. The cascade itself is a series of chemical reactions involving blood proteins and enzymes that occurs wherever there is a break in a blood vessel. The end product of the cascade is a protein called fibrin.

**COAGULOPATHY.** A defect in the blood clotting mechanism.

**COARCTATION OF THE AORTA.** A congenital defect in which severe narrowing or constriction of the aorta obstructs the flow of blood.

**COATS' DISEASE.** Also called exudative retinitis, a chronic abnormality characterized by the deposition of cholesterol on the outer retinal layers.

**COCHLEA.** The hearing part of the inner ear. This snail-shaped structure contains fluid and thousands of microscopic hair cells tuned to various frequencies.

**COGNITION.** The mental activity of thinking, learning, and memory.

**COLD SORE.** A small blister on the lips or face, caused by a virus. Also called a fever blister.

**COLECTOMY.** The surgical removal of the colon or part of the colon.

**COLITIS.** Inflammation of the colon, or large bowel.

**COLLAGEN.** A protein that provides structural support for the skin. Collagen is the main component of connective tissue.

**COLLATERAL VESSEL.** A side branch or network of side branches of a large blood vessel.

**COLLATERALS.** Alternate pathways for arterial blood.

**COLON.** Also called the large intestine, the colon has six major segments: caecum, ascending colon,

transverse colon, descending colon, sigmoid colon, and rectum. Its length is approximately 5 ft (1.5 m) in the adult and it is responsible for forming, storing, and expelling waste matter.

**COLONOSCOPE.** The fiberoptic device used to view the inside of the large intestine, and through which a variety of procedures can be performed, including biopsies and colonic stent placement.

**COLONOSCOPY.** An examination of the colon performed with a colonoscope.

**COLORECTAL.** Pertaining to the large intestine and the rectum.

**COLORECTAL CANCER.** Cancer of the large intestine, or colon, including the rectum.

**COLOSTOMY.** A temporary or permanent diversion in which the colon opens to the outside of the body through a hole (stoma). Stool is collected outside of the body in a bag attached to the colostomy.

**COLPORRHAPHY.** A surgical procedure in which the vagina is sutured.

**COLPOSCOPY.** Examination of the cervix through a magnifying device to detect abnormal cells.

**COLUMELLA.** The strip of skin running from the tip of the nose to the upper lip, separating the nostrils.

**COMA.** A state of unconsciousness from which a person cannot be aroused, even by strong or painful stimuli.

**COMMISSURES.** The normal separations between the valve leaflets.

**COMMON BILE DUCT.** The branching passage through which bile—a necessary digestive enzyme—travels from the liver and gallbladder into the small intestine. Digestive enzymes from the pancreas also enter the intestines through the common bile duct.

**COMMON PATHWAY.** The pathway that results from the merging of the extrinsic and intrinsic pathways. The common pathway includes the final steps before a clot is formed.

**COMORBID.** A term applied to a disease or disorder that occurs at the same time as another disease condition. For example, there are a number of health problems that are comorbid with obesity.

**COMPATIBLE DONOR.** A person whose tissue and blood type are the same as the recipient's.



**COMPLETE BLOOD COUNT (CBC).** A blood test to check the numbers of red blood cells, white blood cells, and platelets in the blood.

**COMPOUND FRACTURE.** A fracture in which the broken end or ends of the bone have penetrated through the skin; also known as an open fracture.

**COMPULSION.** The uncontrollable impulse to perform specific acts. In mental health disorders, compulsions are often repetitive and carried out by the person in order to avoid feelings of anxiety.

**COMPUTED TOMOGRAPHY (CT) SCAN.** An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

**CONCEPTION.** The union of egg and sperm to form a fetus.

**CONCHA.** The hollow shell-shaped portion of the external ear.

**CONDITIONING.** Process of preparing a patient to receive marrow donation, often through the use of chemotherapy and radiation therapy.

**CONDUCTIVE HEARING LOSS.** A type of medically treatable hearing loss in which the inner ear is usually normal, but there are specific problems in the middle or outer ears that prevent sound from getting to the inner ear in a normal way.

**CONDUIT DIVERSION.** A surgical procedure that restores urinary and fecal continence by diverting these functions through a constructed conduit leading to an external waste reservoir (ostomy).

**CONFIRMATORY TYPING.** Repeat tissue typing to confirm the compatibility of the donor and patient before transplant.

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**CONGENITAL DEFECT.** A defect present at birth that occurs during the growth and development of the fetus in the womb.

**CONGESTIVE HEART FAILURE.** A serious condition caused by disease or damage to the heart that weakens the heart's ability to pump a sufficient amount of blood to the body tissues.

**CONGREGATE HOUSING.** A type of housing arrangement for seniors that offers independent living in separate apartments as well as opportunities to share activities of daily living with other residents.

Congregate housing does not usually involve assisted living or skilled nursing care, however.

**CONJUNCTIVA.** The mucous membrane that covers the eyes and lines the eyelids.

**CONJUNCTIVITIS.** Inflammation of the conjunctiva, the membrane on the inner part of the eyelids and the covering of the white of the eye.

**CONNECTIVE TISSUE.** Cells such as fibroblasts, and material such as collagen and reticulin, that unite one part of the body with another.

**CONSENT.** Permission or agreement.

**CONSERVATION SURGERY.** Surgery that preserves the aesthetics of the area undergoing an operation.

**CONSTIPATION.** Difficulty passing a bowel movement. May refer to infrequent passage of stool, or to a hard, dry stool requiring straining and physical effort in order to pass.

**CONSTRUCT.** To squeeze tightly, compress, draw together.

**CONSULTATION.** Evaluation by an outside expert or specialist, someone other than the primary care provider.

**CONTAMINATE.** To make an item unsterile or unclean by direct contact.

**CONTAMINATION.** A breach in the preservation of a clean or sterile object or environment.

**CONTINENT.** Able to hold the contents of the bladder or bowel until one can use a bathroom. A continent surgical procedure is one that allows the patient to keep waste products inside the body rather than collecting them in an external bag attached to a stoma.

**CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP).** A ventilation device that blows a gentle stream of air into the nose during sleep to keep the airway open.

**CONTRACEPTION.** The prevention of the union of the male's sperm with the female's egg.

**CONTRACTURE.** An abnormal persistent shortening of a muscle or the overlying skin at a joint, usually caused by the formation of scar tissue following an injury.

**CONTRAST AGENT.** Also called a contrast medium, this is usually a barium or iodine dye that is injected into the area under investigation. The dye makes the interior body parts more visible on an x-ray film. For myelograms, an iodine based contrast agent is used.

**CONVULSION.** To shake or effect with spasms; to agitate or disturb violently.

**COR PULMONALE.** Enlargement of the right ventricle of the heart caused by pulmonary hypertension that may result from emphysema or bronchiectasis; eventually, the condition leads to congestive heart failure.

**CORACOID PROCESS.** A long curved projection from the scapula overhanging the glenoid cavity; it provides attachment to muscles and ligaments of the shoulder and back region.

**CORE NEEDLE BIOPSY (CNB).** A procedure using a larger diameter needle to remove a core of tissue from the breast.

**CORECTOMY.** Another term for iridectomy.

**CORN.** A horny thickening of the skin on a toe, caused by friction and pressure from poorly fitted shoes or stockings.

**CORNEA.** Clear, bowl-shaped structure at the front of the eye. It is located in front of the colored part of the eye (iris). The cornea lets light into the eye and partially focuses it.

**CORNEAL TOPOGRAPHY.** Mapping the cornea's surface with a specialized computer that illustrates corneal elevations.

**CORONARY.** Of or relating to the heart.

**CORONARY ARTERY BYPASS GRAFT SURGERY (CABG).** A surgical procedure in which arteries or veins from elsewhere in the patient's body are grafted onto the arteries of the heart as a way to bypass damaged or narrowed heart blood vessels.

**CORONARY ARTERY DISEASE.** Also called atherosclerosis, it is a buildup of fatty matter and debris in the coronary artery wall that causes narrowing of the artery.

**CORONARY BLOOD VESSELS.** The arteries and veins that supply blood to the heart muscle.

**CORONARY OCCLUSION.** Obstruction of an artery that supplies the heart. When the artery is completely blocked, a myocardial infarction (heart attack) results; an incomplete blockage may result in angina.

**CORONARY STENT.** An artificial support device used to keep a coronary vessel open.

**CORONARY VASCULAR DISEASE.** Or cardiovascular disease; disease of the heart or blood vessels, such as atherosclerosis (hardening of the arteries).

**CORTICOSTEROIDS.** A class of drugs that are synthetic versions of the cortisone produced by the body. They rank among the most powerful anti-inflammatory agents.

**CORTISOL.** A corticosteroid hormone produced by the adrenal gland.

**CORTISONE.** A steroid compound used to treat autoimmune diseases and inflammatory conditions. It is sometimes injected into a joint to relieve the pain of arthritis.

**COSMETIC SURGERY.** Surgery that is intended to improve a patient's appearance or correct disfigurement. It is also called aesthetic surgery.

**COUCHING.** The oldest form of cataract surgery, in which the lens is dislocated and pushed backward into the vitreous body with a lance.

**CRANIOCAUDAL.** Head to tail, x-ray beam directly overhead the part being examined.

**CRANIOFACIAL SURGERY.** Surgery of the facial tissue and skull.

**CRANIOPHARYNGEAL ACHALASIA.** A swallowing disorder of the throat.

**CRANIOSYNOSTOSIS.** Premature closing of the sutures joining the skull bones.

**CRANIOTOMY.** A surgical incision into the skull.

**CRANIUM.** The large, rounded upper part of the skull that encloses the brain.

**CREATINE.** Creatine is a substance produced by proteins and stored in the muscles. Creatine is a source of energy, allowing muscle contraction to take place. Some creatine is converted to creatinine, and enters the bloodstream, where it is filtered out by healthy kidneys and leaves the body in the urine. When the kidneys are not functioning properly, creatinine levels in the blood become abnormally elevated.

**CREATININE.** Creatinine is a chemical waste product that is produced by the muscles. Creatinine enters the bloodstream and goes to the kidneys. Healthy kidneys filter out this waste material from the blood. It passes into the urine and out of the body. Unhealthy kidneys, however, are unable to filter out the creatinine from the blood. The creatinine remains circulating in the bloodstream, and levels rise as the muscles continue to produce more and more.

**CREATININE CLEARANCE RATE.** The clearance of creatinine from the plasma compared to its appearance in the urine. Since there is no reabsorption of

creatinine, this measurement can estimate glomerular filtration rate.

**CREMASTERIC REFLEX.** A reflex in which the cremaster muscle, which covers the testes and the spermatic cord, pulls the testicles back into the scrotum. It is important for a doctor to distinguish between an undescended testicle and a hyperactive cremasteric reflex in small children.

**CRICOID CARTILAGE.** A ring-shaped piece of cartilage that forms the lower and rear parts of the voice box or larynx; it is sometimes called the annular cartilage because of its shape.

**CRICOTHYROID MEMBRANE.** The piece of connective tissue that lies between the thyroid and cricoid cartilages.

**CRICOTHYROIDOTOMY.** An emergency tracheotomy that consists of a cut through the cricothyroid membrane to open the patient's airway as fast as possible.

**CRITICAL CARE.** The multidisciplinary health-care specialty that provides care to patients with acute, life-threatening illness or injury.

**CROHN'S DISEASE.** A chronic, inflammatory bowel disease usually affecting the ileum, colon, or both.

**CROSS-MATCH.** A laboratory test done to confirm that blood from a donor and blood from the recipient are compatible. Serum from each is mixed with red blood cells from the other and observed for hemagglutination.

**CROWN.** The top part of the tooth. Also, an artificial replacement tooth.

**CRYOANESTHESIA.** The use of the numbing effects of cold as a surgical anesthetic. For dermabrasion, this involves the spraying of a cold-inducing chemical on the area being treated.

**CRYOGEN.** A substance with a very low boiling point, such as liquid nitrogen, used in cryotherapy treatment.

**CRYOPEXY.** Reattachment of a detached retina by freezing the tissue behind the tear with nitrous oxide.

**CRYOPROSTATECTOMY.** Freezing of the prostate through the use of liquid nitrogen probes guided by transrectal ultrasound of the prostate.

**CRYOSURGERY.** Freezing and destroying abnormal cells.

**CRYOTHERAPY.** The therapeutic use of cold to reduce discomfort, or remove abnormal tissue.

**CRYPTORCHIDISM.** A developmental disorder in which one or both testes fail to descend from the abdomen into the scrotum before birth. It is the most common structural abnormality in the male genital tract.

**CRYPTORCHIDISM.** A developmental disorder in which one or both testes fail to descend from the abdomen into the scrotum before birth.

**CUL-DE-SAC.** The closed end of a pouch or tubular cavity; also called a caecum.

**CULDOCENTESIS.** Removal of material from the pouch of Douglas, a deep peritoneal recess between the uterus and the upper vaginal wall, by means of puncture of the vaginal wall.

**CULDOSCOPY.** Procedure by which a surgeon performs a colpotomy and inserts a culdoscope, an instrument with a light on the end, through the incision.

**CULTURE.** A swab of blood, sputum, pus, urine, or other body fluid planted in a special medium, incubated, and allowed to grow for identification of infection-causing organisms.

**CULTURE CHANGE.** A term that refers to a movement in the United States to make nursing homes more resident-centered and less like hospitals.

**CUPID'S BOW.** Double curve of the upper lip.

**CURETTAGE.** Procedure performed with a curette, a spoon-shaped instrument used to scrape tissue.

**CURETTE.** A scoop-shaped surgical instrument used for removing tissue from body cavities.

**CUSHING'S DISEASE.** A disease in which too many hormones called glucocorticoids are released into the blood. This causes fat to build up in the face, back, and chest, and the arms and legs to become very thin. Other symptoms include excessive blood sugar levels, weak muscles and bones, a flushed face, and high blood pressure.

**CUTANEOUS SQUAMOUS CELL CARCINOMA.** Malignant skin tumor of the epidermis or its appendages.

**CYANOACRYLATE.** The chemical name of liquid surgical adhesive.

**CYANOSIS.** Blue, gray, or dark purple discoloration of the skin caused by a deficiency of oxygen.

**CYCLOCRYOTHERAPY.** The use of subfreezing temperatures to treat glaucoma.

**CYST.** An abnormal sac-like growth in the body that contains liquid or a semisolid material.

**CYSTECTOMY.** The surgical resection of part or all of the bladder.

**CYSTIC ARTERY.** An artery that brings oxygenated blood to the gallbladder.

**CYSTIC FIBROSIS.** A hereditary disease that appears in early childhood, involves functional disorder of digestive glands, and is marked especially by faulty digestion due to a deficiency of pancreatic enzymes, by difficulty in breathing due to mucus accumulation in airways, and by excessive loss of salt in the sweat.

**CYSTINE.** An amino acid normally reabsorbed by the kidney tubules. Cystinuria is an inherited disease in which cystine and some other amino acids are not reabsorbed by the body in normal amounts. Cystine crystals then form in the kidney, which leads to kidney stones and obstructive renal failure.

**CYSTOCELE.** Sagging or bulging of the bladder through the front wall of the vagina.

**CYSTOPLASTY.** Reconstructive surgery of the urinary bladder.

**CYSTOSCOPE.** Endoscope specially designed for urological use to examine the bladder, lower urinary tract, and prostate gland. The examination is called cystoscopy.

**CYSTOTOMY.** An incision in the bladder.

**CYTOKINE.** A protein that regulates the duration and intensity of the body's immune response.

**CYTOLOGIST (CYTOLOGY).** A medical technologist who specializes in preparing and examining biopsy specimens and cell specimens for changes that may indicate precancerous conditions or a specific stage of cancer.

**CYTOMEGALOVIRUS (CMV).** Virus that can cause pneumonia in post bone marrow transplant patients.

**CYTOPLASM.** The part of a cell outside of the nucleus.

**CYTOSTATIC.** A type of drug that inhibits the process of cell division. Azathioprine is an example of a cytostatic drug.

## D

**DACRON GRAFT.** A synthetic material used in the repair or replacement of blood vessels.

**DEBRIDEMENT.** The act of removing any foreign material and damaged or contaminated tissue from a wound to expose surrounding healthy tissue.

**DEBULKING.** The removal of part of a malignant tumor in order to make the remainder more sensitive to radiation or chemotherapy.

**DECOMPRESSION.** Any surgical procedure done to relieve pressure on a nerve or other part of the body. A laminectomy is sometimes called an open decompression.

**DEDICATED.** Reserved for a specific purpose. An ambulatory surgical center must have at least one dedicated operating room in order to qualify for accreditation.

**DEDUCTIBLE.** An amount of money that an insured person is required to pay on each claim made on an insurance policy.

**DEEP VEIN THROMBOSIS.** The development or presence of a blood clot in a vein deep within the leg. Deep vein thrombosis can lead to pulmonary embolism.

**DEFECATION.** The act of passing a bowel movement.

**DEFIBRILLATION.** An electronic process that helps reestablish a normal heart rhythm.

**DEFIBRILLATOR.** A device that delivers an electric shock to the heart muscle through the chest wall in order to restore a normal heart rate.

**DEGENERATIVE ARTHRITIS, OR OSTEOARTHRITIS.** A non-inflammatory type of arthritis, usually occurring in older people, characterized by degeneration of cartilage, enlargement of the margins of the bones, and changes in the membranes in the joints.

**DEGLOVING.** Separating the skin of the penis from the shaft temporarily in order to correct chordee.

**DEHISCENCE.** Separation or splitting open of the different layers of tissue in a surgical incision. Dehiscence may be partial, involving only a few layers of surface tissue; or complete, reopening all the layers of the incision.

**DEHYDRATION.** Low overall levels of body fluid. May occur due to increased loss of fluids through sweating, vomiting, or diarrhea.

**DELIRIUM.** An altered state of consciousness that includes confusion, disorientation, incoherence, agitation, and defective perception (such as hallucinations).

**DELTOID MUSCLE.** Muscle that covers the prominence of the shoulder.



**DELUSION.** Conviction of a false belief or wrong judgment despite obvious evidence to the contrary.

**DEMENTIA.** The progressive loss of cognitive and intellectual function of the brain including impaired memory, judgment, and disorientation, without the impairment of perception or consciousness. It is usually associated with a structural brain disease such as Alzheimer's disease.

**DEMYELINATION.** The loss of myelin with preservation of the axons or fiber tracts. Central demyelination occurs within the central nervous system, and peripheral demyelination affects the peripheral nervous system as with Guillain-Barré syndrome.

**DEOXYHEMOGLOBIN.** Hemoglobin with oxygen removed.

**DEPARTMENT OF HEALTH AND HUMAN SERVICE (DHHS).** It is a federal agency that houses the Centers for Medicare and Medicaid Services, and distributes funds for Medicaid.

**DEPRESSANT.** A drug or other substance that soothes or lessens tension of the muscles or nerves.

**DERMABRASION.** A technique for removing the upper layers of skin with planing wheels powered by compressed air.

**DERMATOME.** A surgical instrument used to cut thin slices of skin for grafts.

**DERMIS.** The underlayer of skin, containing blood vessels, nerves, hair follicles, and oil and sweat glands.

**DESICCATION.** Tissue death.

**DETOXIFICATION.** To remove a poison or toxin, or the effect of such a harmful substance; to free from an intoxicating or addictive substance or from dependence on or addiction to a harmful substance.

**DETRUSOR MUSCLE.** The medical name for the layer of muscle tissue covering the urinary bladder. When the detrusor muscle contracts, the bladder expels urine.

**DEVELOPMENTAL DISORDER.** A disorder or disability that occurs because of prenatal or early childhood events that affect cognition, language, motor, or social skills.

**DEVIATED SEPTUM.** An abnormal configuration of the cartilage that divides the two sides of the nose. It can cause breathing problems if left uncorrected.

**DHHS.** The Department of Health and Human Service. This federal agency houses the Centers for Medicare and Medicaid Services and distributes funds for Medicaid.

**DIABETES MELLITUS.** A disease in which a person can't effectively use glucose to meet the needs of the body. It is caused by a lack of the hormone insulin.

**DIABETES MELLITUS.** A disease in which insufficient insulin is made by the body to metabolize sugars.

**DIABETIC NEPHROPATHY.** Kidney damage or disease brought on by the long-term effects of diabetes.

**DIABETIC RETINOPATHY.** Degeneration of the retina related to diabetes; both type 1 and type 2 diabetes can lead to diabetic retinopathy.

**DIAGNOSTIC WINDOW.** A cardiac marker's timeline for rising, peaking, and returning to normal after a heart attack.

**DIALYSATE.** A chemical bath used in dialysis to draw fluids and toxins out of the bloodstream and supply electrolytes and other chemicals to the bloodstream.

**DIALYSIS.** A blood filtration therapy that replaces the function of the kidneys, filtering fluids and waste products out of the bloodstream. There are two types of dialysis treatment: hemodialysis, which uses an artificial kidney, or dialyzer, as a blood filter; and peritoneal dialysis, which uses the patient's abdominal cavity (peritoneum) as a blood filter.

**DIALYSIS PRESCRIPTION.** The general parameters of dialysis treatment that vary according to each patient's individual needs. Treatment length, type of dialyzer and dialysate used, and rate of ultrafiltration are all part of the dialysis prescription.

**DIALYZER.** An artificial kidney usually composed of hollow fiber which is used in hemodialysis to eliminate waste products from the blood and remove excess fluids from the bloodstream.

**DIAPHRAGM.** The large muscle that is located between the abdomen and the chest area. The diaphragm aids in breathing. Also the flat-shaped portion of the head of a stethoscope, useful for detecting high-pitched sounds.

**DIAPHYSIS.** The shaft of a long bone.

**DIASTOLE.** Period between contractions of the heart.

**DIASTOLIC.** Minimum arterial blood pressure during ventricular relaxation or rest.

**DIATHERMY.** Also called electrocautery, this is a procedure that heats and destroys abnormal cells.

**DIETHYLSTILBESTROL (DES).** A synthetic form of estrogen that was widely prescribed to women from

1940 to 1970 to prevent complications during pregnancy, and linked to several serious birth defects and disorders of the reproductive system in daughters of women who took DES.

**DIETHYLSTILBESTROL (DES).** A synthetic hormone that was used in the mid-twentieth century to treat recurrent miscarriages; exposure to DES as a fetus is a risk factor for premature labor.

**DIFFERENTIAL.** Blood test that determines the percentage of each type of white blood cell in a person's blood.

**DIFFUSE ESOPHAGEAL SPASM (DES).** An uncommon condition characterized by abnormal simultaneous contractions of the esophagus.

**DIFFUSION TENSOR IMAGING (DTI).** A refinement of magnetic resonance imaging that allows the doctor to measure the flow of water and track the pathways of white matter in the brain. DTI is able to detect abnormalities in the brain that do not show up on standard MRI scans.

**DIGESTIVE TRACT.** The stomach, intestines, and other parts of the body through which food passes.

**DIGITAL RECTAL EXAM (DRE).** Procedure in which the physician inserts a gloved finger into the rectum to examine the rectum and the prostate gland for signs of cancer.

**DIGITS.** Fingers or toes.

**DILATE.** To expand or open a valve or blood vessel.

**DILATION.** The process of enlarging, usually applied to relatively circular openings.

**DILATION AND CURETTAGE (D&C).** A surgical procedure that expands the cervical canal (dilation) so that the lining of the uterus can be scraped (curettage).

**DIMINISHED BREATH SOUNDS.** A lack of breath sound due to fluid or air accumulation.

**DIMINISHED CHEST EXPANSION.** A decrease in the chest expansion due to an inability of the lungs to fully pull air in and push it out.

**DIRECTED DONATION.** Blood donated by a patient's family member or friend, to be used by the patient.

**DISCHARGE PLANNER.** A health-care professional who helps patients arrange for health and home care needs after they go home from the hospital.

**DISCIPLINE.** In health care, a specific area of preparation or training such as social work, nursing, or nutrition.

**DISEASE-MODIFYING ANTIRHEUMATIC DRUGS (DMARDs).** A group of medications that can be given to slow or stop the progression of rheumatoid arthritis. DMARDs include such drugs as oral or injectable gold, methotrexate, leflunomide, and penicillamine.

**DISINFECT.** To remove most microorganisms but not highly resistant ones.

**DISSECTOMY (OR DISCECTOMY).** The surgical removal of a portion of an intervertebral disk.

**DISSEMINATED INTRAVASCULAR COAGULATION (DIC).** A condition in which spontaneous bleeding and clot formation occur throughout the circulatory system. DIC can be caused by transfusion reactions and a number of serious illnesses.

**DISSEMINATED INTRAVASCULAR DISSEMINATION.** A condition in which the clotting factors in the blood are rapidly used up, resulting in a severe deficit in clotting factors and a very high risk of severe, uncontrollable bleeding.

**DIURETIC.** A type of medication that increases the amount of urine produced and relieves excess fluid buildup in body tissues. Diuretics may be used in treating high blood pressure, lung disease, premenstrual syndrome, and other conditions.

**DIVERTICULA (SINGULAR, DIVERTICULUM).** Pouch-like herniations through the muscular wall of an organ such as the stomach, small intestine, or colon.

**DIVERTICULITIS.** Inflammation or infection of the diverticula of the intestines.

**DIVERTICULOSIS.** A condition that involves the development of sacs that bulge through the large intestine's muscular walls, but are not inflamed. It may cause bleeding, stomach distress, and excess gas.

**DNA.** Deoxyribonucleic acid; the substance within the nucleus of all human cells in which the genetic information is stored.

**DOCUMENTATION.** The process of recording information in the medical chart, or the materials contained in a medical chart.

**DOMINANT HAND.** The hand that the individual prefers to use for most activities, especially writing.

**DONOR.** A person who supplies organ(s), tissue or blood to another person for transplantation.

**DOPPLER.** The Doppler effect refers to the apparent change in frequency of sound-wave echoes returning to a stationary source from a moving target. If the object is moving toward the source, the frequency increases; if the object is moving away, the frequency decreases. The size of this frequency shift can be used to compute the object's speed—be it a car on the road or blood in an artery.

**DOPPLER ECHOCARDIOGRAPHY.** A testing technique that uses Doppler ultrasound technology to evaluate the pattern and direction of blood flow in the heart.

**DORSAL.** Referring to a position closer to the back than to the stomach. The laminae in the spinal column are located on the dorsal side of each vertebra.

**DOSE LIMITING.** Case in which the side effects of a drug prevent an increase in dose.

**DOWN SYNDROME.** The most prevalent of a class of genetic defects known as trisomies, in which cells contain three copies of certain chromosomes rather than the usual two. Down syndrome, or trisomy 21, usually results from three copies of chromosome 21.

**DRAINAGE.** The withdrawal or removal of blood and other fluid matter from an incision or wound. An incision that is oozing blood or tissue fluids is said to be draining.

**DRESSING.** A bandage, gauze pad, or other material placed over a wound or incision to cover and protect it.

**DRY EYE.** Corneal dryness due to insufficient tear production.

**DRY SOCKET.** A painful condition following tooth extraction in which a blood clot does not properly fill the empty socket. Dry socket leaves the underlying bone exposed to air and food particles.

**DUANE SYNDROME.** A hereditary congenital syndrome in which the affected eye shows a limited capacity to move, and is deficient in convergence with the other eye.

**DUCTOGRAM.** A test used for imaging the breast ducts and diagnosing the cause of abnormal nipple discharges.

**DUCTUS ARTERIOSIS.** A fetal blood vessel that connects the aorta and pulmonary artery.

**DUMPING SYNDROME.** A complex physical reaction to food passing too quickly from the stomach into the small intestine, characterized by sweating, nausea, abdominal cramps, dizziness, and other symptoms.

**DUODENECTOMY.** Excision of the duodenum.

**DUODENUM.** The first part of the small intestine that connects the stomach above and the jejunum below.

**DURA.** The strongest and outermost of three membranes that protect the brain, spinal cord, and nerves of the cauda equina.

**DURABLE MEDICAL POWER OF ATTORNEY.** A legal document that empowers a person to make medical decisions for the patient should the patient be unable to make the decisions.

**DYSMENORRHEA.** Painful menstruation.

**DYSMOTILITY.** A lack of normal muscle movement (motility), especially in the esophagus, stomach, or intestines.

**DYSPHAGIA.** Difficulty and pain in swallowing.

**DYSPLASIA.** The abnormal form or abnormal development of a body organ or organ system.

**DYSPNEA.** Difficulty breathing.

**DYSTOCIA.** Failure to progress in labor, either because the cervix will not dilate (expand) further or (after full dilation) the head does not descend through the mother's pelvis.

## E

**EALLES DISEASE.** A disorder marked by recurrent hemorrhages into the retina and vitreous body. It occurs most often in males between the ages of 10 and 25.

**EAR MOLDING.** A non-surgical method for treating ear deformities shortly after birth with the application of a mold held in place by tape and surgical glue.

**EBOLA VIRUS.** A dangerous pathogen that should be contained in a negative pressure room.

**ECG OR EKG.** A record of the waves that relate to the electrical impulses produced at each beat of the heart.

**ECHOCARDIOGRAPHY.** An imaging procedure used to create a picture of the heart's movement, valves,

and chambers. The test uses high-frequency sound waves that come from a hand wand placed on the chest. Echocardiogram may be used in combination with Doppler ultrasound to evaluate the blood flow across the heart's valves.

**ECLAMPSIA.** A serious, life-threatening complication of pregnancy, in which high blood pressure results in a variety of problems, including seizures.

**ECTOPIC.** Located in an abnormal site or tissue. An ectopic testicle is one that is located in an unusual position outside its normal line of descent into the scrotum.

**ECTOPIC BEAT.** Abnormal heart beat arising elsewhere than from the sinoatrial node.

**ECTOPIC PREGNANCY.** A pregnancy that occurs outside of the uterus, most often in the fallopian tubes.

**ECTROPION.** A complication of blepharoplasty, in which the lower lid is pulled downward, exposing the inner surface.

**EDEMA.** An abnormal accumulation of fluids in intercellular spaces in the body; causes swelling.

**EFFUSION.** The escape of fluid from blood vessels or the lymphatic system and its collection in a cavity, in this case, the middle ear.

**EGOBRONCHOPHONY.** Increased intensity of the spoken voice.

**EJACULATION.** The act of expelling the sperm through the penis during orgasm. The fluid that is released is called the ejaculate.

**EJECTION FRACTION.** The fraction of blood in the ventricle that is ejected during each beat. One of the main advantages of the MUGA scan is its ability to measure ejection fraction, one of the most important measures of the heart's performance.

**ELECTIVE PROCEDURE.** A surgical procedure that is a matter of choice rather than emergency treatment.

**ELECTIVE SURGERY.** Surgery that would be beneficial to the patient but is not urgent, and is therefore a matter of choice.

**ELECTROCARDIOGRAM (ECG OR EKG).** A recording of the electrical activity of the heart. An ECG uses externally attached electrodes to detect the electrical signals of the heart.

**ELECTROCAUTERY.** A technique for sealing a blood vessel with a low-voltage electrified probe.

**ELECTROCOAGULATION.** The coagulation or destruction of tissue through the application of a high-frequency electrical current.

**ELECTRODE.** A medium, such as platinum wires, for conducting an electrical current. Used for recording the electrical activity of the body, for example in the heart or the brain.

**ELECTRODESICCATION.** A method of treating spider veins or drying up tissue by passing a small electric current through a fine needle into the affected area.

**ELECTROENCEPHALOGRAM (EEG).** A recording of the electrical activity of the nerve cells in the brain. The first such recording was made in 1929 by Hans Berger, an Austrian psychiatrist.

**ELECTROLYTE.** Ions in the body that participate in metabolic reactions. The major human electrolytes are sodium ( $\text{Na}^+$ ), potassium ( $\text{K}^+$ ), calcium ( $\text{Ca}^{2+}$ ), magnesium ( $\text{Mg}^{2+}$ ), chloride ( $\text{Cl}^-$ ), phosphate ( $\text{HPO}_4^{2-}$ ), bicarbonate ( $\text{HCO}_3^-$ ), and sulfate ( $\text{SO}_4^{2-}$ ).

**ELECTROMYOGRAPHY.** A test that measures muscle response to nerve stimulation. It is used to evaluate muscle weakness and to determine if the weakness is related to the muscles themselves or to a problem with the nerves that supply the muscles.

**ELECTRON.** One of the small particles that make up an atom. An electron has the same mass and amount of charge as a positron, but the electron has a negative charge.

**ELECTRONYSTAGMOGRAM.** A test that involves the graphic recording of eye movements.

**ELECTROPHYSIOLOGICAL STUDY.** A test that monitors the electrical activity of the heart in order to diagnose arrhythmia. An electrophysiological study measures electrical signals through a cardiac catheter that is inserted into an artery in the leg and guided up into the atrium and ventricle of the heart.

**ELECTROSURGICAL DEVICE.** A medical device that uses electrical current to cauterize or coagulate tissue during surgical procedures; often used in conjunction with laparoscopy.

**ELECTROTHERAPY.** The treatment of body tissues by passing electrical currents through them, stimulating the nerves and muscles.



**EMASCULATION.** Another term for castration of a male.

**EMBALMING.** Process of treating a dead body with chemicals to preserve it from decay.

**EMBOLISM.** A blood clot, air bubble, or clot of foreign material that blocks the flow of blood in an artery. When an embolism blocks the blood supply to a tissue or organ, the tissue the artery feeds dies (infarction). Without immediate and appropriate treatment, an embolism can be fatal.

**EMBOLIZATION.** The purposeful introduction of a substance into a blood vessel to stop blood flow.

**EMBOLUS (PLURAL EMBOLI).** A gas or air bubble, bit of tissue, blood clot, or foreign object that circulates in the bloodstream until it lodges in a vessel. A large embolus can narrow or block the vessel, which leads to decreased blood flow in the organ supplied by that vessel.

**EMESIS BASIN.** A basin used to collect sputum or vomit.

**EMPHYSEMA.** A chronic disease characterized by loss of elasticity and abnormal accumulation of air in lung tissue.

**EMPYEMA.** An accumulation of pus in the lung cavity, usually as a result of infection.

**ENCEPHALITIS.** An inflammation or infection of the brain and spinal cord caused by a virus or as a complication of another infection.

**ENCEPHALOCELES.** Protrusion of the brain through a defect in the skull.

**END-STAGE HEART OR LUNG FAILURE.** Severe heart or lung disease that does not respond adequately to medical or surgical treatment.

**ENDEMIC.** Present in a specific population or geographical area at all times. Some diseases that may affect the spleen are endemic to certain parts of Africa or Asia.

**ENDOCARDITIS.** An infection of the inner membrane lining of the heart.

**ENDOCRINE SYSTEM.** Group of glands and parts of glands that control metabolic activity. The pituitary, thyroid, adrenals, ovaries, and testes are all part of the endocrine system.

**ENDOCRINOLOGIST.** A physician who specializes in treating persons with diseases of the thyroid, parathyroid, adrenal glands, and the pancreas.

**ENDODONTIC.** Pertaining to the inside structures of the tooth, including the dental pulp and tooth root, and the periapical tissue surrounding the root.

**ENDODONTIST.** A dentist who specializes in the diagnosis and treatment of disorders affecting the inside structures of teeth.

**ENDOLYMPH.** The watery fluid contained in the membranous labyrinth of the inner ear.

**ENDOLYMPHATIC SAC.** The pouch at the end of the endolymphatic duct that connects to the membranous labyrinth of the inner ear.

**ENDOMETRIAL POLYPS.** Growths in the lining of the uterus (endometrium) that may cause bleeding and can develop into cancer.

**ENDOMETRIOSIS.** A painful disease in which cells from the lining of the uterus (endometrium) become attached to other organs in the pelvic cavity. The condition is hard to diagnose and often causes severe pain as well as infertility.

**ENDOMYOCARDIAL BIOPSY.** Removal of a small sample of heart tissue to check it for signs of damage caused by organ rejection.

**ENDOPHTHALMITIS.** An infection on the inside of the eye that may result in vision loss.

**ENDORPHINS.** Any of a group of proteins with analgesic properties that occur naturally in the brain.

**ENDOSCOPE.** A narrow, flexible tube with a fiber optic light on it, used to pass into the body for a variety of medical examinations.

**ENDOSCOPIC RETROGRADE CHOLANGIOPANCREATOGRAPHY (ERCP).** A procedure to x ray the ducts (tubes) that carry bile from the liver to the gallbladder and from the gallbladder to the small intestine.

**ENDOSCOPIC ULTRASOUND.** An imaging procedure that uses high-frequency sound waves to visualize the esophagus via a lighted telescopic instrument (endoscope) and a monitor.

**ENDOSCOPIST.** A physician or other medical professional highly trained in the use of the endoscope and related diagnostic and therapeutic procedures.

**ENDOSCOPY.** The visual inspection of any cavity of the body by means of an endoscope.

**ENDOSTEAL IMPLANTS.** Dental implants that are placed within the bone.

**ENDOTRACHEAL.** Located inside the trachea.

**ENDOTRACHEAL INTUBATION.** A procedure in which a tube is inserted into the trachea in order to administer anesthesia or ventilate the patient.

**ENDOTRACHEAL TUBE.** A tube inserted through the patient's nose or mouth that functions as an airway and is connected to a ventilator.

**EPIGLOTTIS.** A cartilaginous lidlike appendage that closes the glottis while food or drink is passing through the pharynx.

**ENDOVASCULAR.** Within the walls of a blood vessel.

**ENDOVASCULAR GRAFTING.** A procedure that involves the insertion of a delivery catheter through a groin artery into the abdominal aorta under fluoroscopic guidance.

**ENEMA.** Insertion of a tube into the rectum to infuse fluid into the bowel and encourage a bowel movement. Ordinary enemas contain tap water, mixtures of soap and water, glycerine and water, or other materials.

**ENOPHTHALMOS.** A condition in which the eye falls back into the socket and inhibits proper eyelid function.

**ENTERAL NUTRITIONAL SUPPORT.** Nutrition utilizing an intact gastrointestinal tract, but bypassing another organ such as the stomach or esophagus.

**ENTERIC COAT.** A coating put on some tablets or capsules to prevent their disintegration in the stomach. The contents of coated tablets or capsules will be released only when the dose reaches the intestine. This may be done to protect the drug from stomach acid, to protect the stomach from drug irritation, or to delay the onset of action of the drug.

**ENTERITIS.** Inflammation of the mucosal lining of the small intestine.

**ENTEROCELE.** Sagging or bulging of an area of the intestine into the vagina.

**ENTEROSTOMAL THERAPIST.** A health care provider who specializes in the care of patients with enterostomies (e.g., ileostomies or colostomies).

**ENTITLEMENT.** A program that creates a legal obligation by the federal government to any person, business, or government entity that meets the legally defined criteria. Medicaid is an entitlement both for eligible individuals and for the states that decide to participate in it.

**ENUCLEATION.** Surgical removal of the eyeball.

**ENZYME.** A protein, produced by cells, that causes chemical changes in other substances.

**EOSINOPHIL.** Segmented white blood cell with large orange-red granules that increases in response to parasitic infections and allergic reactions.

**EPHEDRA.** A herb used in traditional Chinese medicine to treat asthma and hay fever. It should never be used for weight management.

**EPIDERMIS.** The outer layer of skin, consisting of a layer of dead cells that perform a protective function and a second layer of dividing cells.

**EPIDIDYMIS.** A coiled cordlike structure at the upper border of the testis, in which sperm mature and are stored.

**EPIDIDYMITIS.** Inflammation of the epididymis.

**EPIDURAL.** A type of regional anesthetic delivered by injection into the area around the patient's lower spine. An epidural numbs the body below the waist but allows the patient to remain conscious throughout the procedure.

**EPIDURAL CATHETER.** A thin plastic tube, through which pain medication is delivered, inserted into the patient's back before surgery.

**EPIGLOTTIS.** A leaf-shaped piece of cartilage lying at the root of the tongue that protects the respiratory tract from aspiration during the swallowing reflex.

**EPIKERATOPHAKIA.** A procedure in which the donor cornea is attached directly onto the host cornea.

**EPILEPSY.** The name for a group of syndromes characterized by periodic temporary disturbances of brain function. The symptoms of an epileptic seizure may include loss of consciousness, abnormal movements, falling, emotional reactions, and disturbances of sight or hearing.

**EPINEPHRINE.** Epinephrine, also called adrenalin, occurs naturally in the body and causes blood vessels to constrict or narrow. As a drug, it is used to reduce bleeding.

**EPIPHYSIODESIS.** An surgical procedure that partially or totally destroys an epiphysis and may incorporate a bone graft to produce fusion of the epiphysis or premature cessation of its growth; usually performed to equalize leg length.

**EPIPHYSIS.** A part of a long bone where bone growth occurs from.

**EPITHELIAL CELLS.** Cells that form a thin surface coating on the outside of a body structure.

**EPITHELIUM.** The covering of internal and external surfaces of the body, including the lining of vessels and other small cavities. It consists of cells joined by small amounts of cementing substances.

**ERBIUM:YAG.** A crystal made of erbium, yttrium, aluminum, and garnet that produces light that is well absorbed by the skin, so it is used for skin resurfacing treatments.

**ERGOT ALKALOIDS.** Compounds derived from a fungus, *Claviceps purpurea*, which grows on rye plants and forms a hard blackish body. Ergot itself is toxic.

**EROSION.** A gradual breakdown or ulceration of the uppermost layer of tissue lining the esophagus or stomach.

**ERUPTION.** The emergence of a tooth through the gum tissue.

**ERYTHEMA.** Redness.

**ERYTHROBLASTOSIS FETALIS.** A condition in which the incompatibility between a mother's Rh-negative blood type and a baby's Rh-positive blood type results in destruction of the baby's red blood cells by maternal antibodies.

**ERYTHROPOIETIN.** A hormone produced by the kidneys that stimulates the production of red blood cells by bone marrow.

**ERYTHROPOIETIN.** A hormone secreted chiefly by the kidney (in adults) that stimulates the production of red blood cells.

**ESCHAR.** A hardened dry crust that forms on skin exposed to burns or corrosive agents.

**ESOPHAGEAL SPHINCTER.** Muscle at the opening to the stomach that keeps the stomach contents from traveling into the esophagus.

**ESOPHAGEAL VARICES.** Varicose veins at the lowermost portion of the esophagus. Esophageal varices are easily injured, and bleeding from them is often difficult to stop.

**ESOPHAGECTOMY.** Surgical removal of the esophagus.

**ESOPHAGITIS.** Inflammation of the esophagus.

**ESOPHAGUS.** The muscular tube that connects the mouth to the stomach.

**ESRD.** End-stage renal disease; chronic or permanent kidney failure.

**ESTATE PLANNING.** Preparation of a plan of administration and disposition of one's property before or

after death, including will, trusts, gifts, and power of attorney.

**ESTROGENS.** A class of chemical compounds (hormones) that stimulates the development of female secondary sexual characteristics.

**ETHMOID SINUSES.** Paired labyrinth of air cells between the nose and eyes.

**ETHYLENE OXIDE.** A colorless gas used to sterilize surgical sutures, bandages, and most other surgical materials or implements.

**EUSTACHIAN TUBE.** A canal that extends from the middle ear to the pharynx.

**EUTHANASIA.** To bring about the death of another person who has an incurable disease or condition.

**EVENT RECORDER.** A small machine, worn by a patient usually for several days or weeks, that is activated by the patient to record his or her EKG when a symptom is detected.

**EXCIMER LASER.** An instrument that is used to vaporize tissue with a cold, coherent beam of light with a single wavelength in the ultraviolet range.

**EXCISION.** The surgical removal of a damaged or diseased part of the body.

**EXCISIONAL BIOPSY.** Procedure in which a surgeon removes all of a lump or suspicious area and an area of healthy tissue around the edges. The tissue is then examined under a microscope to check for cancer cells.

**EXOPHTHALMOS.** A condition in which the eyes bulge out of their sockets and inhibit proper eyelid function.

**EXTRACAPSULAR SURGERY.** A cataract surgical procedure in which an incision is made in the cornea to remove the hard center of the lens. The natural lens is then replaced with an intraocular lens (IOL).

**EXTRACORPOREAL.** Occurring outside the patient's body.

**EXTRACORPOREAL CIRCUIT (ECC).** The path the hemodialysis patient's blood takes outside of the body. It typically consists of plastic tubing, a hemodialysis machine, and a dialyzer.

**EXTRACORPOREAL SHOCK WAVE LITHOTRIPSY (ESWL).** The use of focused shock waves, generated outside the body, to fragment kidney stones.

**EXTRACTION.** The surgical removal of a tooth from its socket in a bone.

**EXTRACTION SITE.** The empty tooth socket following removal of a tooth.

**EXTRAOCULAR MUSCLES.** The muscles (lateral rectus, medial rectus, inferior rectus, superior rectus, superior oblique, and inferior oblique) that move the eyeball.

**EXTRINSIC PATHWAY.** One of three pathways in the coagulation cascade.

**EXTRUSION.** Pushing out or expulsion. Extrusion of a chin implant is one possible complication of mentoplasty.

**EXUDATE.** Fluid, cells, or other substances that are slowly discharged by tissue, especially due to injury or inflammation.

**EXUDATIVE RD.** A type of retinal detachment caused by the accumulation of tissue fluid underneath the retina.

## F

**FACE LIFT.** Plastic surgery performed to remove sagging skin and wrinkles from an individual's face.

**FACTOR XIII.** A substance found in blood that forms cross-links between strands of fibrin during the process of blood coagulation. Factor XIII is an ingredient in some types of fibrin sealants. It is also known as fibrin stabilizing factor.

**FALLOPIAN TUBES.** The pair of anatomical tubes that carry the egg from the ovary to the uterus.

**FALSE NEGATIVE.** Test results showing no problem when one exists.

**FALSE POSITIVE.** Test results showing a problem when one does not exist.

**FASCIA.** Fibrous tissue that separates and supports organs and other structures in the body.

**FAST TRACK.** A protocol for postoperative patients with projected shorter recovery times. Fast-tracking a patient means that they will either bypass PACU completely, or spend a shorter time there with less intensive staff intervention and monitoring.

**FATIGUE.** Physical or mental weariness.

**FECAL INCONTINENCE.** The inability to control bowel movement.

**FEDERAL POVERTY LEVEL (FPL).** The definition of poverty provided by the federal government, used as the reference point to determine Medicaid eligibility

for certain groups of beneficiaries. The FPL is adjusted every year to allow for inflation.

**FELLOWSHIP TRAINING.** Additional specialty training that follows completion of residency training; fellowships are one to two years in length.

**FELON.** A very painful abscess on the lower surface of the fingertip, resulting from infection in the closed space surrounding the bone in the fingertip. It is also known as whitlow.

**FEMALE STERILIZATION.** The process of permanently ending a woman's ability to conceive by tying off or cutting apart the fallopian tubes.

**FEMORAL.** Pertaining to the thigh region.

**FEMORAL ARTERY.** An artery located in the groin area that is the most frequently accessed site for arterial puncture in angiography.

**FEMORAL HEAD.** The upper end of the femur.

**FEMUR.** The medical name for the thighbone. The femur is the largest bone in the human body.

**FEVER.** An abnormally elevated body temperature, usually defined as being 101 degrees Fahrenheit or more

**FIBER.** Carbohydrate material in food that cannot be digested.

**FIBEROPTICS.** In medicine, fiberoptics uses glass or plastic fibers to transmit light through a specially designed tube inserted into organs or body cavities where it transmits a magnified image of the internal body structures.

**FIBRILLATION.** Independent rapid contraction of cardiac muscle fibers producing no productive contraction, therefore no blood is pumped.

**FIBRIN.** The protein formed as the end product of the blood clotting process when fibrinogen interacts with thrombin.

**FIBRINOGEN.** A blood protein made in the liver that is broken up into shorter molecules by the action of thrombin to form fibrin.

**FIBROBLAST.** A type of cell found in connective tissue involved in collagen production as well as tendon formation and healing.

**FIBROID TUMORS.** Non-cancerous (benign) growths in the uterus; they occur in 30–40% of women over age 40 and do not need to be removed unless they are causing symptoms that interfere with a woman's normal activities.



**FIBROSIS.** A condition characterized by the presence of scar tissue, or reticulin and collagen proliferation in tissues to the extent that it replaces normal tissues.

**FIBROUS CONNECTIVE TISSUE.** Dense tissue found in various parts of the body containing very few living cells.

**FIBULA.** The bone in the lower leg that is next to and smaller than the tibia. It supports approximately one-sixth of the body weight and produces the outer prominence of the ankle.

**FINE NEEDLE BIOPSY.** Use of a very thin type of needle to withdraw cells from an organ, a tumor, or other body tissue, in order to examine those cells for abnormalities (such as malignancy).

**FINGER STICK.** A technique for collecting a very small amount of blood from the fingertip area.

**FIRST RESPONDER.** A term used to describe the first medically trained responder to arrive on scene of an emergency, accident, natural or human-made disaster, or similar event. First responders may be police officers, fire fighters, emergency medical services personnel, or bystanders with some training in first aid.

**FISTULA.** An abnormal connection between two organs, or between an organ and the outside of the body.

**FIXATIVE.** A chemical that preserves tissue without destroying or altering the structure of the cells.

**FIXATOR.** A device providing rigid immobilization through external skeletal fixation by means of rods (attached to pins which are placed in or through the bone).

**FIXED.** A term used to describe chemically preserved tissue. Fixed tissue is dead so it does not bleed or sense pain.

**FLAP.** A piece of tissue used for grafting that has kept its own blood supply.

**FLIGHT OF IDEAS.** A psychiatric term describing a thought disorder where streams of unrelated words or ideas enter a patient's mind too quickly to be properly vocalized despite the rushed and rapid rate of the patient's speech.

**FLOATERS.** Spots seen in front of the eyes, caused by clumping of the collagen fibers in the vitreous body.

**FLOW METER.** Device for measuring the rate of a gas (especially oxygen) or liquid.

**FLUORESCCEIN DYE.** An orange dye used to illuminate the blood vessels of the retina in fluorescein angiography.

**FLUOROSCOPE.** An imaging device that displays "moving x rays" of the body. Fluoroscopy allows the radiologist to visualize the guide wire and catheter he or she is moving through the patient's artery.

**FLUOROSCOPIC ANGIOGRAM.** A method of precisely visualizing the brain cardiovascular system and its defects, including aneurysms.

**FLUOROSCOPY.** A diagnostic imaging procedure that uses x rays and contrast agents to visualize anatomy and motion in real time.

**FOLEY CATHETER.** A thin tube that is inserted into the urethra (the tube that runs from the bladder to the outside of the body) to allow the drainage of urine.

**FOLIC ACID.** A water-soluble vitamin belonging to the B-complex group of vitamins.

**FOOTPLATE.** A flat oval plate of bone that fits into the oval window on the wall of the inner ear; the base of the stapes.

**FORAMEN (PLURAL, FORAMINA).** The medical term for a natural opening or passage. The foramina of the spinal column are openings between the vertebrae for the spinal nerves to branch off from the spinal cord.

**FORCED EXPIRATORY VOLUME (FEV).** The volume of air exhaled from the beginning of expiration to a set time (usually 0.5, 1, 2, and 3 seconds).

**FORCED VITAL CAPACITY (FVC).** The volume of air that can be exhaled forcefully after a maximal inspiration.

**FORCEPS.** An instrument designed to grasp or hold. Forceps usually have a locking mechanism so that they continue to hold tissue when put down by an operator.

**FORENSIC.** Referring to legal or courtroom proceedings.

**FORESKIN.** A covering fold of skin over the tip of the penis.

**FORMALIN.** A clear solution of diluted formaldehyde that is used to preserve liver biopsy specimens until they can be examined in the laboratory.

**FRACTIONATED RADIOSURGERY.** Radiosurgery in which the radiation is delivered in several smaller doses over a period of time rather than the full amount in a single treatment.

**FRACTIONATION.** The process of separating the various components of whole blood.

**FREE FLAP.** A section of tissue is detached from its blood supply, moved to another part of the body, and reattached by microsurgery to a new blood supply.

**FREQUENCY.** Sound, whether traveling through air or the human body, produces vibrations—molecules bouncing into each other—as the shock wave travels along. The frequency of a sound is the number of vibrations per second. Within the audible range, frequency means pitch: the higher the frequency, the higher a sound's pitch.

**FRONTAL BONE.** The part of the skull that lies behind the forehead.

**FUCHS' DYSTROPHY.** A hereditary disease of the inner layer of the cornea.

**FUNGAL.** Caused by a fungus.

**FUNGUS.** A member of a group of simple organisms that are related to yeast and molds.

**FUSION.** A union, joining together; e.g., bone fusion.

## G

**GADOLINIUM.** A very rare metallic element useful for its sensitivity to electromagnetic resonance, among other things. Traces of it can be injected into the body to enhance the MRI pictures.

**GAIT.** A person's habitual manner or style of walking.

**GALLBLADDER.** A hollow pear-shaped sac on the under surface of the right lobe of the liver. Bile comes to it from the liver, and passes from it to the intestine to aid in digestion.

**GAMETE INTRAFALLOPIAN TUBE TRANSFER (GIFT).** A process where eggs are taken from a woman's ovaries, mixed with sperm, and then deposited into the woman's fallopian tube.

**GAMMA RAY.** A high-energy photon emitted by radioactive substances.

**GANGLION.** A knot or knot-like mass; it can refer either to groups of nerve cells outside the central nervous system or to cysts that form on the sheath of a tendon.

**GANGLIONECTOMY.** Surgery to excise a ganglion cyst.

**GANGRENE.** The death of a considerable mass of tissue, usually associated with loss of blood supply and followed by bacterial infection.

**GANTRY.** A name for the portion of a CT scanner which houses the X-ray tube and detector array used to capture image information and send it to the computer.

**GAS GANGRENE.** A severe form of gangrene caused by *Clostridium* infection.

**GASTRECTOMY.** A surgical procedure in which all or a portion of the stomach is removed.

**GASTRIC (OR PEPTIC) ULCER.** An ulcer (sore or hole) in the stomach lining, duodenum, or other part of the gastrointestinal system.

**GASTRIC GLANDS.** Branched tubular glands located in the stomach.

**GASTRIC PACING.** An experimental form of obesity surgery in which electrodes are implanted in the muscle of the stomach wall. Electrical stimulation paces the timing of stomach contractions so that the patient feels full on less food.

**GASTRIC ULCER.** An ulcer of the stomach, duodenum, or other part of the gastrointestinal system. Also called a peptic ulcer.

**GASTRIN.** A hormone produced by cells in the antrum that stimulates the production of gastric acid.

**GASTRODUODENOSTOMY.** A surgical procedure in which the doctor creates a new connection between the stomach and the duodenum.

**GASTROENTEROLOGIST.** A physician who specializes in digestive disorders and diseases of the organs of the digestive tract, including the esophagus, stomach, and intestines.

**GASTROENTEROLOGY.** The branch of medicine that specializes in the diagnosis and treatment of disorders affecting the stomach and intestines.

**GASTROESOPHAGEAL REFLUX DISEASE (GERD).** A condition in which the contents of the stomach flow backward into the esophagus. There is no known single cause.

**GASTROINTESTINAL.** Pertaining to the digestive organs and structures, including the stomach and intestines.

**GASTROINTESTINAL DISEASES.** Diseases that affect the digestive system.

**GASTROINTESTINAL TRACT.** The path in the body from the mouth, through the stomach, intestines, rectum, and the anus.

**GASTROINTESTINAL TUBE.** A tube surgically inserted into the stomach for feeding a patient who is unable to eat by mouth.

**GASTROJEJUNOSTOMY.** A surgical procedure in which the stomach is surgically connected to the jejunum (middle portion of the small intestine).

**GASTROSCHISIS.** A defect of the abdominal wall caused by rupture of the amniotic membrane or by the delayed closure of the umbilical ring. It is usually accompanied by protrusion of internal organs in the abdomen.

**GENDER IDENTITY DISORDER (GID).** A mental disorder in which a person strongly identifies with the other sex and feels uncomfortable with his or her biological sex. It occurs more often in males than in females.

**GENDER REASSIGNMENT SURGERY.** The surgical alteration and reconstruction of a person's sex organs to resemble those of the other sex as closely as possible; it is sometimes called sex reassignment surgery.

**GENE.** A piece of DNA, located on a chromosome, that determines how such traits as blood type are inherited and expressed.

**GENERAL ANESTHESIA.** Deep sleep induced by a combination of medicines that allows surgery to be performed.

**GENERAL SURGEON.** A physician who has special training and expertise in performing a variety of operations.

**GENERALIZED INFECTION.** An infection that has entered the bloodstream and has general systemic symptoms such as fever, chills, and low blood pressure.

**GENETIC.** The term refers to genes, the basic units of biological heredity, which are contained on the chromosomes, and contain chemical instructions that direct the development and functioning of an individual.

**GENIOPLASTY.** Another word for mentoplasty. It comes from the Greek word for "chin."

**GENITAL.** Sexual organ.

**GENITOURINARY RECONSTRUCTION.** Surgery that corrects birth defects or the results of disease that involve the genitals and urinary tract, including the

kidneys, ureters, bladder, urethra, and the male and female genitals.

**GENTIAN VIOLET.** An antibacterial, antifungal dye that is commonly applied to the skin during dermabrasion.

**GENUINE STRESS INCONTINENCE (GSI).** A specific term for a type of incontinence that has to do with the instability of the urethra due to weakened support muscles.

**GENUINE URINARY STRESS INCONTINENCE (USI).** Stress incontinence due to hypermobility of the urethra.

**GERD (GASTROESOPHAGEAL REFLUX DISEASE).** A chronic condition in which the lower esophageal sphincter allows gastric acids to reflux into the esophagus, causing heartburn, acid indigestion, and possible injury to the esophageal lining.

**GERIATRICIAN.** Physician specializing in the care and treatment of older adults.

**GERMINOMA.** A tumor of germ cells (ovum and sperm cells that participate in production of the developing embryo).

**GESTATIONAL AGE.** The length of time of growth and development of the young in the mother's womb.

**GESTATIONAL DIABETES.** A type of diabetes that occurs during pregnancy. Untreated, it can cause severe complications for the mother and the baby. However, it usually does not lead to long-term diabetes in either the mother or the child.

**GIGANTISM.** A condition in which the individual grows to an abnormally large size. Mental development may or may not be normal.

**GINGIVITIS.** Inflammation of the gingiva or gums caused by bacterial buildup in plaque on the teeth.

**GLANS.** The cone-shaped tip of the penis.

**GLAUCOMA.** A group of eye diseases characterized by an increase in intraocular pressure that causes changes in the optic disk and defects in the field of vision.

**GLENOHUMERAL JOINT.** A ball-and-socket synovial joint between the head of the humerus and the glenoid cavity of the scapula. Also called the glenohumeral articulation or shoulder joint.

**GLENOID CAVITY.** The hollow cavity in the head of the shoulder blade that receives the head of the humerus to make the glenohumeral or shoulder joint.

**GLOMERULONEPHRITIS.** A condition in which the filtering structures within the kidneys become damaged, limiting the kidneys' ability to filter waste products from the blood.

**GLOTTIS.** The vocal part of the larynx, consisting of the vocal cords and the opening between them.

**GLUCAGON.** A hormone produced in the pancreas that is responsible for elevating blood glucose when it falls below a safe level for the body's organs and tissues.

**GLUCOSE-6-PHOSPHATE DEHYDROGENASE (G6PD) DEFICIENCY.** An inherited disorder in which the body lacks an enzyme that normally protects red blood cells from toxic chemicals. Certain drugs can cause patients' red blood cells to break down, resulting in anemia. This may also happen when they have a fever or an infection. The condition usually occurs in males. About 10% of black males have it, as do a small percentage of people from the Mediterranean region.

**GLUCOSE.** The main form of sugar (chemical formula  $C_6H_{12}O_6$ ) used by the body for energy.

**GLYCATED HEMOGLOBIN.** A test that measures the amount of hemoglobin bound to glucose. It is a measure of how much glucose has been in the blood during a two to three month period beginning approximately one month prior to sample collection.

**GLYCOGEN.** The form in which glucose is stored in the body.

**GLYCOPROTEIN.** Any of a group of complex proteins that consist of a carbohydrate combined with a simple protein. Some tumor markers are glycoproteins.

**GLYCYLCYCLES.** The name of a new subgroup of tetracyclines derived from minocycline, a semi-synthetic tetracycline. As of 2007, the only drug in this class approved for use is tigecycline.

**GOITER.** An enlargement of the thyroid gland due to insufficient iodine in the diet.

**GONADOTROPINS.** Hormones that stimulate the activity of the ovaries in females and testes in males.

**GONIOSCOPY.** A technique for examining the angle between the iris and the cornea with the use of a special mirrored lens applied to the cornea.

**GONORRHEA.** A sexually transmitted disease (STD) that causes infection in the genital organs and may cause disease in other parts of the body.

**GRAFT.** Replacement of a diseased or damaged part of the body with a compatible substitute that

can be artificial (metal or other substance) or taken from the body itself, such as a piece of skin, healthy tissue, or bone.

**GRAFT VERSUS HOST DISEASE.** A life-threatening complication of bone marrow transplants in which the donated marrow causes an immune reaction against the recipient's body.

**GRAM STAINING.** Use of a purple dye to identify pathogens, usually bacteria.

**GRANULE.** A small grain or pellet. Medicines that come in granule form are usually mixed with liquids or sprinkled on food before they are taken.

**GRANULOCYTES.** White blood cells.

**GRAVEL.** The debris that is formed from a fragmented kidney stone.

**GUGLIELMI DETACHABLE COILS.** A new method of treating aneurysms that is minimally invasive.

**GUIDE WIRE.** A wire that is inserted into an artery to guide a catheter to a certain location in the body.

**GUIDED IMAGERY.** A form of focused relaxation that coaches the patient to visualize calm, peaceful images.

**GUILLAIN-BARRÉ SYNDROME.** A demyelinating disease involving nerves that affect the extremities and causing weakness and motor and sensory dysfunction.

**GUILLOTINE AMPUTATION.** An amputation in which the severed part is cut off cleanly by a blade or other sharp-edged object.

**GUTTA PERCHA.** An inert, latex-like substance used for filling root canals.

**GYNECOMASTIA.** Overly developed or enlarged breasts in a male.

## H

**HAIR CELLS.** Sensory receptors in the inner ear that transform sound vibrations into messages that travel to the brain.

**HAIR FOLLICLE.** A tube-like indentation in the skin from which a single hair grows.

**HALF-LIFE.** The time required for half of the atoms in a radioactive substance to disintegrate.

**HALLUCINATION.** A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.



**HARMONIC SCALPEL.** A scalpel that uses ultrasound technology to seal tissues while it is cutting.

**HARVESTING.** The process of removing tissues or organs from a donor and preserving them for transplantation.

**HCFA.** Health Care Financing Administration. A federal agency that provides guidelines for the Medicaid program.

**HEAD-UPRIGHT TILT TABLE TEST.** A test used to determine the cause of fainting spells. During the test, the patient is tilted at different angles on special table for a period time. During the test, the patient's heart rhythm, blood pressure and other measurements are evaluated with changes in position.

**HEALTH CARE AGENT.** Also known as the surrogate or patient representative, this is the person who has power of attorney to have the patient's wishes carried out if the patient is incapacitated.

**HEALTH CARE FINANCING ADMINISTRATION (HCFA).** A federal agency that provides guidelines for the Medicaid program.

**HEALTH MAINTENANCE ORGANIZATION (HMO).** A broad term that covers a variety of prepaid systems providing health care within a certain geographic area to all persons covered by the HMO's contract.

**HEART LUNG MACHINE.** A machine that temporarily takes over the function of the heart and lungs during surgical procedures in order to maintaining blood circulation and delivery of oxygen to body tissues while the heart is being operated on.

**HEART MONITOR LEADS.** Sticky pads placed on the chest to monitor the electrical activity of the heart. The pads are connected to an electrocardiogram machine.

**HEART VALVE REPLACEMENT SURGERY.** Surgery performed to repair or replace the valves in the heart that control blood flow through the heart and are responsible for the audible heartbeat.

**HEARTBURN.** A pain in the center of the chest behind the breastbone caused by the contents of the stomach flowing backwards (refluxing) into the lower end of the esophagus and causing irritation.

**HELICAL.** Having a spiral shape.

**HELICOBACTER PYLORI.** A spiral-shaped bacterium that was discovered in 1982 to be the underlying cause of most ulcers in the stomach and duodenum.

**HEMAGGLUTINATION.** The clumping of red blood cells due to blood type incompatibility.

**HEMATEMESIS.** Vomit that contains blood, usually seen as black specks in the vomitus.

**HEMATOCRIT.** The proportion of the volume of a blood sample that consists of red blood cells. It is expressed as a percentage.

**HEMATOLOGIST.** A specialist who treats diseases and disorders of the blood and blood-forming organs.

**HEMATOMA.** An accumulation of blood, often clotted, in a body tissue or organ, usually caused by a break or tear in a blood vessel.

**HEMIFACIAL MICROSOMIA (HFM).** A term used to describe a group of complex birth defects characterized by underdevelopment of one side of the face.

**HEMOCHROMATOSIS.** A genetic disorder known as iron overload disease. Untreated hemochromatosis may cause osteoporosis, arthritis, cirrhosis, heart disease, or diabetes.

**HEMODILUTION.** A technique in which the fluid content of the blood is increased without increasing the number of red blood cells.

**HEMODYNAMIC.** Relating to the flow of blood through the circulatory system.

**HEMODYNAMICS.** Measurement of the movements involved in the circulation of the blood; it usually includes blood pressure and heart rate.

**HEMOGLOBIN.** The iron-containing protein in the blood that transports oxygen from the lungs to all parts of the body.

**HEMOLYSIS.** Separation of hemoglobin from the red blood cells.

**HEMOPTYSIS.** Spitting up of blood derived from the lungs or bronchial tubes as a result of pulmonary or bronchial hemorrhage.

**HEMORRHAGE.** Major, abnormal blood loss either from a surface wound or from internal trauma.

**HEMORRHAGIC STROKE.** A disruption of the blood supply to the brain caused by bleeding into the brain.

**HEMOSIDERIN.** A form of iron that is stored inside tissue cells. The brownish discoloration of skin that sometimes occurs after sclerotherapy is caused by hemosiderin.

**HEMOSTASIS.** Slowing down or stopping bleeding.

**HEMOSTAT.** A small surgical clamp used to hold a blood vessel closed.

**HEMOSTATIC.** Relating to blood clotting and coagulation.

**HEMOTHORAX.** Blood in the pleural cavity.

**HEPARIN.** A complex sugar compound used in medicine to prevent the formation of blood clots during hemodialysis, hemoperfusion, and open-heart surgery.

**HEPATIC ARTERY.** The blood vessel supplying arterial blood to the liver.

**HEPATIC DUCT.** A duct that carries bile from the liver.

**HEPATITIS.** Disease of the liver causing inflammation. Symptoms include an enlarged liver, fever, nausea, vomiting, abdominal pain, and dark urine.

**HEPATOCELLULAR CARCINOMA.** The most common type of liver tumor.

**HEPATOCYTE.** Liver cell.

**HEPATOMA.** A liver tumor.

**HEREDITARY.** Something that is inherited or passed down from parents to offspring. In biology and medicine, the word pertains to inherited genetic characteristics.

**HEREDITARY SPHEROCYTOSIS.** A hereditary disorder that leads to a chronic form of anemia (too few red blood cells) due to an abnormality in the red blood cell membrane.

**HERNIA.** The protrusion of an organ or other structure through an opening in the wall that normally contains it.

**HERNIATED DISK.** A blister-like bulging or protrusion of the contents of the disk out through the fibers that normally hold them in place. Also called ruptured disk, slipped disk, or displaced disk.

**HERNIORRHAPHY.** The surgical repair of any type of hernia.

**HETEROTOPIC BONE.** Bone that develops as an excess growth around a joint following joint replacement surgery.

**HETEROTOPIC TRANSPLANTATION.** The addition of a donor liver at another site, while the diseased liver is left intact.

**HIATAL HERNIA.** Protrusion of the stomach upward into the mediastinal cavity through the esophageal hiatus of the diaphragm.

**HIGH TIBIAL OSTEOTOMY (HTO).** The tibial bone is cut to redistribute weight on the knee for varus alignment deformities or injuries.

**HIGH-DENSITY LIPOPROTEIN (HDL).** A type of lipoprotein that protects against CAD by removing cholesterol deposits from arteries or preventing their formation.

**HIP DYSPLASIA.** Abnormal development of the hip joint.

**HIPAA.** Health Insurance Portability and Accountability Act of 1996.

**HIRSUTISM.** Excessive or increased growth of facial or body hair in women resembling the male pattern of hair distribution.

**HISTOCOMPATIBILITY ANTIGENS.** Proteins scattered throughout body tissues that are unique for almost every individual.

**HISTOCOMPATIBILITY TESTING.** Testing of genotypes of a recipient and potential donor to see if rejection would occur when tissues are transplanted.

**HIV INFECTION.** An infectious disease that impairs the immune system. It is also known as acquired immune deficiency syndrome or AIDS.

**HODGKIN'S DISEASE.** A type of cancer involving the lymph nodes and potentially affecting non-lymphatic organs in the later stage.

**HOLISTIC.** Pertaining to all aspects of the patient, including biological, psychosocial, and cultural factors.

**HOLTER MONITOR.** A small machine worn by a patient usually for 24 hours, that continuously records the patient's EKG during usual daily activity.

**HOME HEALTH AIDE.** An employee of a home care agency who provides the same services to a patient in the home as nurses aides perform in hospitals and nursing homes.

**HOMEOSTASIS.** The process of maintaining balance in the normal vital life functions of a living organism.

**HOMOCYSTEINE.** An amino acid normally found in small amounts in the blood.

**HOODIA.** A succulent African plant resembling a cactus said to contain a natural appetite suppressant.

**HORMONE.** A substance that is produced in one part of the body, then travels through the bloodstream to another part of the body where it has its effect.

**HOSPICE.** An approach for providing compassionate, palliative care to terminally ill patients and counseling or assistance for their families. The term may also refer to a hospital unit or freestanding facility devoted to the care of terminally ill patients.

**HOST.** A living organism that harbors or potentially harbors infection.

**HUMAN CHORIONIC GONADOTROPIN (HCG).** A hormone that is measured to detect early pregnancy.

**HUMAN LEUCKOCYTE ANTIGEN (HLA).** A group of protein molecules located on bone marrow cells that can provoke an immune response. A donor's and a recipient's HLA types should match as closely as possible to prevent the recipient's immune system from attacking the donor's marrow as a foreign material that does not belong in the body.

**HUMAN PAPILLOMAVIRUS (HPV).** A family of viruses that cause common warts of the hands and feet, as well as lesions in the genital and vaginal area. More than 50 types of HPV have been identified, some of which are linked to cancerous and precancerous conditions, including cancer of the cervix. A vaccine is now available against some of these viruses.

**HUMERUS.** The bone of the upper part of the arm.

**HYDRAMNIOS.** The excessive production of amniotic fluid due to either fetal or maternal conditions.

**HYDROCELE.** Collection of fluid in the scrotum.

**HYDROCEPHALUS.** Abnormal dilatation of fluid-containing ventricles in the brain.

**HYDROCEPHALUS.** The buildup of cerebrospinal fluid in the brain.

**HYDROGEL.** A gel that contains water, used as a dressing after laser skin resurfacing.

**HYDROGEN.** The simplest, most common element known in the universe. It is composed of a single electron (negatively charged particle) circling a nucleus consisting of a single proton (positively charged particle). It is the nuclear proton of hydrogen that makes MRI possible by reacting resonantly to radio waves while aligned in a magnetic field.

**HYDROGEN IONS.** Ions that contain one hydrogen atom with a positive charge. Hydrogen ions cause blood to be acidic.

**HYDROSALPINX.** A condition in which a fallopian tube becomes blocked and filled with fluid.

**HYDROXIDE IONS.** Ions that contain one oxygen and one hydrogen atom, with a negative charge. Hydroxide ions cause blood to be alkaline.

**HYDROXYAPATITE.** A calcium phosphate complex that is the primary mineral component of bone.

**HYPERALDOSTERONISM.** A disorder of excessive aldosterone secretion.

**HYPERCALCEMIA.** Excess concentration of calcium in the blood.

**HYPERCARBIA.** An excess of carbon dioxide in the blood.

**HYPERCHLOREMIA.** Elevated serum chloride levels.

**HYPERCHOLESTEROLEMIA.** The presence of excessively high levels of cholesterol in the blood.

**HYPERESONANCE ON PERCUSSION.** A highly resonating sound when the physician taps gently on a patient's back; this is not a normal finding and should be investigated with an x ray.

**HYPERGLYCEMIA.** Elevated blood glucose levels.

**HYPERHIDROSIS.** Excessive sweating. Hyperhidrosis can be caused by heat, overactive thyroid glands, strong emotion, menopause, or infection.

**HYPERKALEMIA.** An abnormally high concentration of potassium in the blood.

**HYPERMOBILE URETHRA.** A term that denotes the movement of the urethra that allows for leakage or spillage of urine.

**HYPERNATREMIA.** Elevated blood sodium levels.

**HYPEROPIA.** The inability to see near objects as clearly as distant objects, and the need for accommodation to see objects clearly.

**HYPEROSMETIC.** Hypertonic, containing a higher concentration of salts or other dissolved materials than normal tissues.

**HYPEROSMOTIC AGENTS.** Causing abnormally rapid osmosis.

**HYPERPARATHYROIDISM.** A condition in which the parathyroid gland is overactive; usually caused by the presence of an adenoma on one or more of the glands.

**HYPERPHOSPHATEMIA.** Elevated blood phosphate levels.

**HYPERREFLEXIA.** A condition in which the detrusor muscle of the bladder contracts too frequently, leading to inability to hold one's urine.

**HYPERTENSION.** High blood pressure.

**HYPERTHYROIDISM.** Abnormal overactivity of the thyroid gland. People with hyperthyroidism are hyper-metabolic, lose weight, exhibit nervousness, have muscular weakness and fatigue, sweat heavily, and have increased urination and bowel movements. This condition is also called thyrotoxicosis.

**HYPERTRIGLYCERIDEMIA.** The presence of excessively high levels of TAG in the blood.

**HYPERTROPHIC.** A type of thick scar that is raised above the surface of the skin, usually caused by increasing or prolonging the inflammation stage of wound healing.

**HYPERTROPHY.** The overgrowth of muscle.

**HYPHEMA.** Blood inside the anterior chamber of the eye. Hyphema is one of the risks associated with sclerostomies.

**HYPNOSIS.** The term is used to refer to a specific verbal technique for refocusing a person's attention in order to change their perceptions, judgment, control of movements, and memory. A hypnotic medication is one that induces sleep.

**HYPNOTIC.** A medicine that causes sleep.

**HYPOALBUMINEMIA.** An abnormally low concentration of albumin in the blood.

**HYPOCALCEMIA.** Low levels of blood calcium.

**HYPOCHLOREMIA.** Low serum chloride levels.

**HYPOCHROMIC.** A descriptive term applied to a red blood cell with a decreased concentration of hemoglobin.

**HYPODERMIC.** Applied or administered beneath the skin. The modern hypodermic needle was invented to deliver medications below the skin surface.

**HYPODERMOCLYSIS.** A technique for restoring the body's fluid balance by injecting a solution of salt and water into the tissues beneath the skin rather than directly into a vein.

**HYPOGLYCEMIA.** Low blood glucose levels.

**HYPOKALEMIA.** Low blood potassium levels.

**HYPONATREMIA.** Low blood sodium levels.

**HYPOPARATHYROIDISM.** An endocrine disorder involving a deficiency of secretion of PTH from the parathyroid gland.

**HYPOPHARYNX.** The last part of the throat or the pharynx.

**HYPOPHOSPHATEMIA.** Low blood phosphate levels.

**HYPOPITUITARISM.** A medical condition where the pituitary gland produces lower than normal levels of its hormones.

**HYOSPADIAS.** A congenital deformity of the penis where the urinary tract opening is not at the tip of the glans.

**HYPOTENSION.** Low blood pressure.

**HYPOTHERMIA.** An abnormally low body temperature, usually defined as being 90 degrees Fahrenheit or less.

**HYPOTHYROIDISM.** Abnormal underfunctioning of the thyroid gland. People with hypothyroidism have a lowered body metabolism, gain weight, and are sluggish.

**HYPOTONY.** Intraocular fluid pressure that is too low.

**HYPOVOLEMIA.** An abnormally low amount of blood in the body.

**HYPOXEMIA.** Oxygen deficiency, defined as an oxygen level less than 60 mm Hg or arterial oxygen saturation of less than 90%. Different values are used for infants and patients with certain lung diseases.

**HYPOXIA.** Reduction of oxygen supply to tissues below physiological requirements despite adequate perfusion of the tissue by blood.

**HYSTERECTOMY.** Surgical removal of part or all of the uterus.

**IATROGENIC.** Resulting from the activity of the physician.

**ICTAL EEG.** An EEG done to determine the type of seizure characteristic of a person's disorder. During this EEG, seizure medicine may be discontinued in an attempt to induce a seizure during the testing period.

**IDIOPATHIC.** Having an unknown cause or arising spontaneously. Most cases of intussusception in children are idiopathic.



**IDIOPATHIC THROMBOCYTOPENIA PURPURA (ITP).** A rare autoimmune disorder characterised by an acute shortage of platelets with resultant bruising and spontaneous bleeding.

**ILEECTOMY.** Excision of the ileum.

**ILEOANAL ANASTOMOSIS.** A reservoir for fecal waste surgically created out of the small intestine. It retains the sphincter function of the anus and allows the patient to defecate in the normal fashion.

**ILEUM.** The third and lowest portion of the small intestine, extending from the jejunum to the beginning of the large intestine.

**ILEUS.** Obstruction in or immobility of the intestines. Symptoms include nausea and vomiting, absent bowel sounds, abdominal pain, and abdominal distension.

**ILIAC ARTERY.** Large blood vessel in the pelvis that leads into the leg.

**ILIZAROV METHOD.** A bone fixation technique using an external fixator for lengthening limbs, correcting deformities, and assisting the healing of fractures and infections. The method was designed by the Russian orthopedic surgeon Gavriil Abramovich Ilizarov (1921-1992).

**IMMUNE RESPONSE.** The body's natural protective reaction against disease and infection.

**IMMUNE SYSTEM.** Mechanism that protects the body from foreign substances, foreign cells, and pathogens. The thymus, spleen, lymph nodes, white blood cells, including the B cells and T cells, and antibodies are involved in the immune response, which aims to destroy these foreign bodies.

**IMMUNOASSAY.** A laboratory method for detecting the presence of a substance by using an antibody that reacts with it.

**IMMUNOCOMPROMISED.** Lacking or deficient in defenses provided by the immune system, usually due to disease state or a side effect of treatment.

**IMMUNODEFICIENCY.** A disorder in which the immune system is ineffective or disabled due either to acquired or inherited disease.

**IMMUNOGLOBULIN.** An antibody.

**IMMUNOSUPPRESSIVE CYTOTOXIC DRUGS.** A class of drugs that function by destroying cells and suppressing the immune response.

**IMMUNOSUPPRESSION.** A disorder or condition where the immune response is reduced or absent.

**IMMUNOSUPPRESSIVE MEDICATION.** Drugs given to a transplant recipient to prevent his or her immune system from attacking the transplanted organ.

**IMMUNOTHERAPY.** A method of treating allergies in which small doses of substances that a person is allergic to are injected under the skin.

**IMPACTED TOOTH.** A tooth that is growing against another tooth, bone, or soft tissue.

**IMPACTION GRAFTING.** The use of crushed bone from a donor to fill in the central canal of the femur during hip revision surgery, or to fill in the central canal of the tibia during knee revision surgery.

**IMPLANTABLE CARDIOVERTER-DEFIBRILLATOR.** A device placed in the body to deliver an electrical shock to the heart in response to a serious abnormal rhythm.

**IN VITRO FERTILIZATION (IVF).** A process in which sperm are incubated with a female egg under carefully controlled conditions, then transferred to the female uterus once fertilization has occurred.

**INCARCERATED HERNIA.** An inguinal hernia that is trapped in place and cannot slip back into the abdominal cavity, often causing intestinal obstruction.

**INCARCERATED INTESTINE.** Intestines trapped in the weakened area of the hernia that cannot slip back into the abdominal cavity.

**INCARCERATION.** The abnormal confinement of a section of the intestine or other body tissues. A femoral hernia may lead to incarceration of part of the intestine.

**INCENTIVE SPIROMETER.** Device that is used post-operatively to prevent lung collapse and promote maximum inspiration. The patient inhales until a preset volume is reached, then sustains the volume by holding his or her breath for three to five seconds.

**INCISION.** A cut, usually made by a surgeon during a surgical procedure.

**INCISIONAL BIOPSY.** A procedure in which a surgeon cuts out a sample of a lump or suspicious area.

**INCISIONAL HERNIA.** Hernia occurring at the site of a prior surgery.

**INCOMPETENT.** In a medical context, insufficient. An incompetent sphincter is one that is not closing properly.

**INCONTINENCE.** The inability to control excretory functions, as defecation (fecal incontinence) or urination (urinary incontinence).

**INCUS.** The middle of the three bones of the middle ear. It is also known as the “anvil.”

**INDEMNITY.** Protection, as by insurance, against damage or loss.

**INDICATED TEST.** A test that is given for a specific clinical reason.

**INDIRECT COOMBS' TEST.** A test used to screen for unexpected antibodies against red blood cells. The patient's serum is mixed with reagent red blood cells, incubated, washed, tested with antihuman globulin, and observed for clumping.

**INDUCE.** To begin or start.

**INFARCTION.** An area of dead tissue caused by obstruction of the blood supply to that tissue.

**INFECTIOUS DISEASE TEAM.** A team of physicians and hospital staff who help control the hospital environment to protect patients against harmful sources of infection.

**INFERIOR TURBINATE.** Bony projections on each side of the nose.

**INFERIOR VENA CAVA.** The biggest vein in the body, returning blood to the heart from the lower half of the body.

**INFERTILITY.** The inability to become pregnant or carry a pregnancy to term.

**INFLAMMATION.** A process occurring in body tissues, characterized by increased circulation and the accumulation of white blood cells. Inflammation also occurs in such disorders as arthritis and causes harmful effects.

**INFLAMMATORY ARTHRITIS.** An inflammatory condition that affects joints.

**INFLAMMATORY BOWEL DISEASES.** Ulcerative colitis or Crohn's disease: chronic conditions characterized by periods of diarrhea, bloating, abdominal cramps, and pain, sometimes accompanied by weight loss and malnutrition because of the inability to absorb nutrients.

**INFORMED CONSENT.** An educational process between health-care providers and patients intended to instruct the patient about the nature and purpose of the procedure or treatment, the risks and benefits of the procedure, and alternatives, including the option of not proceeding with the test or treatment.

**INFRARED.** A type of energy wave given off as heat.

**INFUSION.** Introduction of a substance directly into a vein or tissue by gravity flow.

**INGUINAL HERNIA.** A weak spot in the lower abdominal muscles of the groin through which body organs, usually the large intestines, can push through as a result of abdominal pressure.

**INJECTION.** Forcing a fluid into the body by means of a needle and syringe.

**INJECTION SNOREPLASTY.** A technique for reducing snoring by injecting a chemical that forms scar tissue near the base of the uvula, helping to anchor it and reduce its fluttering or vibrating during sleep.

**INNER EAR.** The interior section of the ear, where sound vibrations and information about balance are translated into nerve impulses.

**INNERVATE.** To carry nerve impulses to a particular body part.

**INPATIENT SURGERY.** Surgery that requires an overnight stay of one or more days in the hospital.

**INSIDIOUS.** Developing in a stealthy and inconspicuous way. Open-angle glaucoma is an insidious disorder.

**INSPECTION.** The visual examination of the body using the eyes and a lighted instrument if needed. The sense of smell may also be used.

**INSTRUMENTAL ACTIVITIES OF DAILY LIVING (IADLS).** Daily tasks that enable a person to live independently.

**INSTRUMENTS.** Tools or devices that perform such functions as cutting, dissecting, grasping, holding, retracting, or suturing.

**INSUFFLATION.** Blowing air into the ear as a test for the presence of fluid in the middle ear. Also, inflation of the abdominal cavity using carbon dioxide; performed prior to laparoscopy to give the surgeon space to maneuver surgical equipment.

**INSULIN.** A hormone produced by the pancreas that is responsible for allowing the body's cells to utilize glucose. The deficiency or absence of insulin is one of the causes of the disease diabetes.

**INSULINOMA.** A tumor within the pancreas that produces insulin, potentially causing the serum glucose level to drop to dangerously low levels.

**INTEGUMENT.** A covering; in medicine, the skin as a covering for the body. The skin is also called the integumentary system.

**INTENSIVIST.** A physician who specializes in caring for patients in intensive care units.

**INTERCOSTAL ARTERY.** Runs from the aorta.

**INTERDISCIPLINARY.** Consisting of several interacting disciplines that work together to care for an individual.

**INTERLEUKIN-2 (IL-2).** A cytokine derived from T helper lymphocytes that causes proliferation of T-lymphocytes and activated B lymphocytes.

**INTERMITTENT CATHETERIZATION.** Periodic catheterization to facilitate urine flow. The catheter is removed when the bladder is sufficiently empty.

**INTERMITTENT CLAUDICATION.** Pain that occurs on walking and is relieved on rest.

**INTERNSHIP.** The first year of residency training

**INTERSTITIAL CYSTITIS.** A chronic inflammatory condition of the bladder involving symptoms of bladder pain, frequent urination, and burning during urination.

**INTERSTITIAL LUNG DISEASE.** About 180 diseases fall into this category of breathing disorders. Injury or foreign substances in the lungs (such as asbestos fibers) as well as infections, cancers, or inherited disorders may cause the diseases. They can lead to breathing or heart failure.

**INTERSTITIAL RADIATION THERAPY.** The process of placing radioactive sources directly into the tumor. These radioactive sources can be temporary (removed after the proper dose is reached) or permanent.

**INTERVERTEBRAL DISK.** Cylindrical elastic-like gel pads that separate and join each pair of vertebrae in the spine.

**INTESTINAL ILEUS.** Mechanical or dynamic obstruction of the bowel causing pain, abdominal distention, vomiting, and often fever.

**INTESTINAL PERFORATION.** A hole in the intestinal wall.

**INTESTINE.** Commonly called the bowels, divided into the small and large intestine. They extend from the stomach to the anus. The small intestine is about 20 ft (6 m) long. The large intestine is about 5 ft (1.5 m) long.

**INTRA-ABDOMINAL PRESSURE.** Pressure that occurs within the abdominal cavity. Pressure in this area builds up with coughing, crying, and the pressure exerted when bearing down with a bowel movement.

**INTRA-AORTIC BALLOON PUMP.** A temporary device inserted into the femoral artery and guided up to the aorta. The small balloon helps strengthen heart contractions by maintaining improved blood pressure.

**INTRACRANIAL.** Existing or occurring within the cranium; affecting or involving intracranial structures.

**INTRACYTOPLASMIC SPERM INJECTION (ICSI).** A process used to inject a single sperm into each egg before fertilized eggs are put back into a woman's body; the procedure may be used if the male has a low sperm count.

**INTRAOCULAR LENS (IOL) IMPLANT.** A small, plastic device (IOL) that is usually implanted in the lens capsule of the eye to correct vision after the lens of the eye is removed. This is the implant used in cataract surgery.

**INTRAOCULAR MELANOMA.** A rare form of cancer in which malignant cells are found in the part of the eye called the uvea.

**INTRAOCULAR PRESSURE (IOP).** A measurement of the degree of pressure exerted by the aqueous fluid in the eye. Elevated IOP is usually 21 mm/Hg or higher, but glaucoma can be present when the pressure is lower.

**INTRAOPERATIVE.** During surgery.

**INTRAORAL.** Inside the mouth.

**INTRATHECAL.** Introduced into or occurring in the space under the arachnoid membrane that covers the brain and spinal cord.

**INTRAUTERINE DEVICE (IUD).** A small flexible device that is inserted into the uterus to prevent pregnancy.

**INTRAVENOUS PYELOGRAM (IVP).** A type of x ray. After obtaining an x ray of the lower abdomen, a radio-opaque dye is injected into the veins. X rays are then obtained every 15 minutes for the next hour. The dye pinpoints the location of kidney stones. It is also used to determine the anatomy of the urinary system.

**INTRAVENOUS SEDATION.** A method of injecting a fluid sedative into the blood through the vein.

**INTRAVENTRICULAR HEMORRHAGE.** Hemorrhage in the ventricles of the brain.

**INTRINSIC PATHWAY.** One of three pathways in the coagulation cascade.

**INTRINSIC SPHINCTER DEFICIENCY.** A type of incontinence caused by the inability of the sphincter muscles to keep the bladder closed.

**INTUBATION.** Placing a tube in the patient's airway to maintain adequate oxygen intake.

**INTUSSUSCEPTION.** Telescoping of one part of the intestine or the rectum into the neighboring part.

**INVASIVE SURGERY.** A form of surgery that involves making an incision in the patient's body and inserting instruments or other medical devices into it.

**INVASIVENESS.** A term that refers to the extent of surgical intrusion into the body or a part of the body. An invasive procedure is one that requires the insertion of a needle, catheter, or surgical instrument.

**INVOLUTION.** The slow healing and resolution stage of a hemangioma.

**IONIZING RADIATION.** A type of radiation that can damage living tissue by disrupting and destroying individual cells at the molecular level. All types of nuclear radiation, including x rays, gamma rays, and beta rays, are potentially ionizing. Sound waves physically vibrate the material through which they pass, but do not ionize it.

**IRIDECTOMY.** Removal of a portion of the iris.

**IRIDOPLASTY.** Surgery to alter the iris.

**IRIDOTOMY.** A procedure in which a laser is used to make a small hole in the iris to relieve fluid pressure in the eye.

**IRIS (PLURAL, IRIDES).** The circular pigmented membrane behind the cornea of the eye that gives the eye its color. The iris surrounds a central opening called the pupil.

**ISCHEMIA.** A decreased supply of oxygenated blood to a body part or organ, often marked by pain and organ dysfunction, as in ischemic heart disease.

**ISLET CELL.** The cell type within the pancreas that produces insulin.

**ISOENZYME.** One of a group of enzymes that brings about the same reactions on the same chemicals, but are different in their physical properties.

## J

**JAUNDICE.** A condition that results in a yellow tint to the skin, eyes, and body fluids. Bile retention in the liver, gallbladder, and pancreas is the immediate cause, but the underlying cause could be as simple as obstruction of the common bile duct by a gallstone or as serious as pancreatic cancer. Ultrasound can distinguish between these conditions.

**JEJUNECTOMY.** Excision of all or a part of the jejunum.

**JOINT COMMISSION ON ACCREDITATION OF HEALTHCARE ORGANIZATIONS (JCAHO).** The accrediting organization that evaluates virtually all U.S. health care organizations and programs. Accreditation is maintained with onsite surveys every three years; laboratories are surveyed every two years.

**JUGULAR VEIN.** Major vein of the neck that returns blood from the head to the heart.

## K

**KEGEL EXERCISES.** A series of contractions and relaxations of the muscles in the perineal area. These exercises are thought to strengthen the pelvic floor and may help prevent urinary incontinence in women.

**KELOID.** A raised, irregularly shaped scar that gradually increases in size due to the overproduction of collagen during the healing process. The name comes from a Greek word that means "crablike."

**KERATINOCYTES.** Dead cells at the outer surface of the epidermis that form a tough protective layer for the skin. The cells underneath divide to replenish the supply.

**KERATOCONUS.** An eye condition in which the cornea bulges outward, interfering with normal vision; usually both eyes are affected.

**KERATOMETER.** A device that measures the curvature of the cornea. It is used to determine the correct power for an IOL prior to cataract surgery.

**KETOACIDOSIS.** A potentially life-threatening condition in which abnormally high blood glucose levels result in the blood becoming too acidic.

**KETONES.** Substances produced during the breakdown of fatty acids. They are produced in excessive amounts in diabetes and certain other abnormal conditions.

**KETOSIS.** Abnormally elevated concentration of ketones in body tissues. A complication of diabetes.

**KIDNEY STONE.** A hard mass that forms in the urinary tract that can cause pain, bleeding, obstruction, and/or infection. Stones are primarily composed of calcium.

**KNEE SURGERY.** Refers primarily to knee repair, replacement or revision of parts of the knee, both tissue and bone, and includes both arthroscopic and open surgeries.





**LABIAL.** Of or pertaining to the lips.

**LACERATION.** A type of wound with rough, torn, or ragged edges.

**LAMINAE (SINGULAR, LAMINA).** The broad plates of bone on the upper surface of the vertebrae that fuse together at the midline to form a bony covering over the spinal canal.

**LAMINECTOMY.** An operation in which the surgeon cuts through the covering of a vertebra to reach a herniated disk in order to remove it.

**LAMINOTOMY.** A less invasive alternative to a laminectomy in which a hole is drilled through the lamina.

**LANGERHANS' CELLS.** Cells in the epidermis that help protect the body against infection.

**LAPAROSCOPE.** A device consisting of a tube and optical system for observing the inside of the abdomen and its organs.

**LAPAROSCOPY.** Minimally invasive surgical procedure in which small incisions are made in the abdominal or pelvic cavity and surgical tools are used with a miniature camera for guidance.

**LAPAROTOMY.** A procedure in which the surgeon opens the abdominal cavity to inspect the patient's internal organs.

**LARGE INTESTINE.** Also called the colon, this structure has six major divisions: cecum, ascending colon, transverse colon, descending colon, sigmoid colon, and rectum.

**LARYNGECTOMY.** Surgical removal of the larynx.

**LARYNGOPHARYNGECTOMY.** Surgical removal of both the larynx and the pharynx.

**LARYNGOSCOPE.** An endoscope equipped for viewing a patient's larynx through the mouth.

**LARYNGOSCOPY.** The visualization of the larynx and vocal cords. This may be done directly with a fiberoptic scope (laryngoscope) or indirectly with mirrors.

**LARYNGOSPASM.** Spasmodic closure of the larynx.

**LARYNX.** Also known as the voice box, the larynx is composed of cartilage that contains the apparatus for voice production. This includes the vocal cords and the muscles and ligaments that move the cords.

**LASER.** A device that produces high-intensity, narrowly focused monochromatic light by exciting atoms and causing them to give off their energy in phase.

**LASER IN SITU KERATOMILEUSIS (LASIK).** A procedure in which the shape of the cornea is changed with an excimer laser in order to correct the patient's vision.

**LASER IRIDOTOMY.** A procedure, using either the Nd:Yag laser or the argon laser, to penetrate the iris, such that a hole, through which the fluid in the eye can drain, is formed.

**LASER SKIN RESURFACING.** The use of laser light to remove the uppermost layer of skin. Two types of lasers commonly used in this manner are CO<sub>2</sub> and erbium.

**LASER THERAPY.** A cancer treatment that uses a laser beam (a narrow beam of intense light) to kill cancer cells.

**LATARJET'S NERVE.** Terminal branch of the anterior vagal trunk, which runs along the lesser curvature of the stomach.

**LATERAL.** Of or pertaining to a side (opposite of medial).

**LATERAL RELEASE SURGERY.** Release of tissues in the knee that keep the kneecap from tracking properly in its groove (sulcus) in the femur; by realigning or tightening tendons, the kneecap can be forced to track properly.

**LATISSIMUS DORSI.** In Latin, this muscle literally means "widest of the back." This is a large fan-shaped muscle that covers a wide area of the back.

**LAVAGE.** Washing out.

**LAXATIVE.** An agent which stimulates defecation.

**LE FORT FRACTURE.** A term that refers to a system for classifying fractures of the facial bones into three groups according to the region affected.

**LEAD.** Color-coded wire that connects an electrode to a monitor cable.

**LECITHIN.** A phospholipid found in high concentrations in surfactant.

**LEGG-CALVE-PERTHES DISEASE (LCP).** A disorder in which the femoral head deteriorates within the hip joint as a result of insufficient blood supply.

**LEGIONNAIRES' DISEASE.** A lung disease caused by a bacterium.

**LEIOMYOSARCOMA.** Leiomyosarcomas are cancers that start growing in the smooth muscle lining of the small intestine.

**LENS (THE CRYSTALLINE LENS).** A transparent structure in the eye that focuses light onto the retina.

**LENS CAPSULE.** A clear elastic membrane-like structure that covers the lens of the eye.

**LENTICULAR.** Lens-shaped; describes a shape of a surgical excision sometimes used to remove hemangiomas.

**LEUKEMIA.** A type of cancer that affects leukocytes, a particular type of white blood cell. A characteristic symptom is excessive production of immature or otherwise abnormal leukocytes.

**LICENSED PRACTICAL NURSE (LPN).** A person who is licensed to provide basic nursing care under the supervision of a physician or a registered nurse.

**LIFE SUPPORT.** Methods of replacing or supporting a failing bodily function, such as using mechanical ventilation to support breathing. In treatable or curable conditions, life support is used temporarily to aid healing until the body can resume normal functioning.

**LIGAMENT.** A band of fibrous tissue that connects bones to other bones or holds internal organs in place.

**LIGAMENTA FLAVA (SINGULAR, LIGAMENTUM FLAVUM).** A series of bands of tissue that are attached to the vertebrae in the spinal column. They help to hold the spine straight and to close the spaces between the laminar arches. The Latin name means “yellow band(s).”

**LIGATION.** Tying off a blood vessel or other structure with cotton, silk, or some other material. Rubber band ligation is one approach to treating internal hemorrhoids.

**LIPID.** Any organic compound that is greasy, insoluble in water, but soluble in alcohol. Fats, waxes, and oils are examples of lipids.

**LIPOMA.** A type of benign tumor that develops within adipose or fatty tissue.

**LIPOPROTEIN.** A chemical combination of a protein and a lipid (fats).

**LIPOSHAVING.** Involves removing fat that lies closer to the surface of the skin by using a needle-like instrument that contains a sharp-edged shaving device.

**LIPOSUCTION.** A surgical technique for removing fat from under the skin by vacuum suctioning.

**LITHOTRIPSY.** A technique for breaking up kidney stones within the urinary tract, followed by flushing out the fragments.

**LITTRE'S HERNIA.** A Meckel's diverticulum trapped in an inguinal hernia.

**LIVING WILL.** A document that is usually included in advanced medical directives containing explicit medical procedures that patients' wishes to have or to refuse should they become incapacitated.

**LOBECTOMY.** Removal of a section of the lung.

**LOCAL ANESTHESIA.** Anesthesia that numbs a localized area of the body.

**LOCALIZED INFECTION.** An infection that is limited to a specific part of the body and has local symptoms.

**LOCKOUT TIME.** The minimum amount of time (usually expressed in minutes) after one dose of pain medication on demand is given before the patient is allowed to receive the next dose on demand.

**LONG-TERM CARE (LTC).** The type of care one may need if one can no longer perform activities of daily living (ADLs) alone, such as eating, bathing or getting dressed. It also includes the kind of care one would need with a severe cognitive impairment, such as Alzheimer's disease. Care can be received in a variety of settings, including the home, assisted living facilities, adult day care centers, or hospice facilities.

**LONG-TERM CARE (LTC) INSURANCE.** A type of private health insurance intended to cover the cost of long-term nursing home or home health care.

**LOOP ELECTROSURGICAL EXCISION (LEEP).** A procedure that can help diagnose and treat cervical abnormalities using a thin wire loop that emits a low-voltage high-frequency radio wave that can excise tissue.

**LOOSENESS OF ASSOCIATION.** A psychiatric term describing a thought disorder where a patient makes irrelevant connections between seemingly unrelated topics. In a mental health assessment the patient's responses may not seem to correspond to the question asked by the health care provider.

**LOUPE.** A convex lens used to magnify small objects at very close range. It may be held on the hand, mounted on eyeglasses, or attached to a headband.

**LOW TRANSVERSE INCISION.** Incision made horizontally across the lower end of the uterus.

**LOW-DENSITY LIPOPROTEIN (LDL).** A type of lipoprotein that consists of about 50% cholesterol and is associated with an increased risk of CAD.

**LOWER EXTREMITY AMPUTATION.** To cut a limb from the body.

**LUMBAR.** Pertaining to the part of the back between the chest and the pelvis.

**LUMBAR VERTEBRAE.** The vertebrae of the lower back below the level of the ribs.

**LUMEN.** The channel or cavity inside a tube or hollow organ of the body.

**LUMPECTOMY.** A less-invasive procedure that just removes the tumor and some surrounding tissue, without removing the entire breast.

**LUPUS ERYTHEMATOSUS.** A chronic inflammatory disease in which inappropriate immune system reactions cause abnormalities in the blood vessels and connective tissue.

**LUXATE.** To loosen or dislocate a tooth from its socket.

**LYMPH.** The almost colorless fluid that bathes body tissues. Lymph is found in the lymphatic vessels and carries lymphocytes that have entered the lymph glands from the blood.

**LYMPH NODE BIOPSY.** The removal of all or part of a lymph node to view under a microscope for cancer cells.

**LYMPH NODES.** Small, bean-shaped organs located throughout the lymphatic system. Lymph nodes store special cells that can trap cancer cells and bacteria traveling through the body.

**LYMPHANGIOGRAPHY.** Injection of dye into lymphatic vessels followed by x rays of the area. It is a difficult procedure, as it requires surgical isolation of the lymph vessels to be injected.

**LYMPHATIC SYSTEM.** The tissues and organs that produce and store cells that fight infection, together with the network of vessels that carry lymph. The organs and tissues in the lymphatic system include the bone marrow, spleen, thymus gland, and lymph nodes.

**LYMPHEDEMA.** Swelling caused by an accumulation of fluid from faulty lymph drainage.

**LYMPHOCYTES.** Type of white blood cells that are part of the immune system. The lymphocytes are composed of three main cell lines: B lymphocytes, T lymphocytes, and natural killer (NK) cells.

**LYMPHOMA.** A type of cancer that affects lymph cells and tissues, including certain white blood cells (T cells and B cells), lymph nodes, bone marrow, and the spleen. Abnormal cells (lymphocyte/leukocyte) multiply uncontrollably.

**LYMPHOPROLIFERATIVE.** An increase in the number of lymphocytes. Lymphocytes are a white blood cell (WBC) formed in lymphatic tissue throughout the body—in the lymph nodes, spleen, thymus, tonsils, Peyer patches, and sometimes in bone marrow), and in normal adults, comprising approximately 22–28% of the total number of leukocytes in the circulating blood.

**LYMPHOSCINTIGRAPHY.** A technique in which a radioactive substance that concentrates in the lymphatic vessels is injected into the affected tissue and mapped using a gamma camera, which images the location of the radioactive tracer.

**LYSIS.** The process of removing adhesions from an organ. The term comes from a Greek word that means “loosening.”

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## M

**MACROCYTIC.** A descriptive term applied to a larger than normal red blood cell.

**MACROMASTIA.** Excessive size of the breasts.

**MACROPHAGE.** A type of blood cell derived from monocytes that are stimulated by inflammation and stimulate antibody production.

**MACROSOMIA.** The term used to describe a newborn baby with an abnormally high birth weight.

**MACULA.** A small, yellowish depressed area on the retina that absorbs the shorter wave lengths of visible light and is responsible for fine detailed vision. This is the part of the retina in which the highest concentration of photoreceptors are found.

**MACULAR DEGENERATION.** A progressive disease in which the central portion of the retina (the macula) is gradually destroyed.

**MAGNETIC FIELD.** The three-dimensional area surrounding a magnet, in which its force is active. During MRI, the patient's body is permeated by the force field of a superconducting magnet.

**MAGNETIC RESONANCE IMAGING (MRI).** A non-invasive diagnostic tool that takes pictures of internal body structures and tissues. Using powerful magnets that force hydrogen atoms in the body to align, the

machine sends radio waves toward the lined-up hydrogen atoms, and a computer displays and records the signals that bounce back. Different kinds of tissues (e.g., healthy and diseased) and different kinds of structures (e.g., organs and tumors) send back unique signals.

**MALABSORPTION.** Defective or inadequate absorption of nutrients from the intestinal tract.

**MALABSORPTIVE.** A type of bariatric surgery in which a part of the stomach is partitioned off and connected to a lower portion of the small intestine in order to reduce the amount of nutrients that the body absorbs from the food.

**MALIGNANT.** Cancerous. Cells tend to reproduce without normal controls on growth and form tumors or invade other tissues.

**MALIGNANT HYPERTHERMIA.** A type of allergic reaction (probably with a genetic basis) that can occur during general anesthesia in which the patient experiences a high fever, the muscles become rigid, and the heart rate and blood pressure fluctuate.

**MALIGNANT MESOTHELIOMA.** A cancer of the pleura (the membrane lining the chest cavity and covering the lungs) that typically is related to asbestos exposure.

**MALIGNANT NEOPLASM.** Any malignant cancerous growth or tumor caused by uncontrolled cell division and capable of spreading to other parts of the body than where it formed.

**MALIGNANT TUMOR.** A cancerous growth that has the potential to spread to other parts of the body.

**MALLEUS.** One of the three bones of the middle ear. It is also known as the “hammer.”

**MALOCCLUSION.** Malpositioning and defective contact between opposing teeth in the upper and lower jaws.

**MALPRACTICE.** A doctor or lawyer’s failure in his or her professional duties through ignorance, negligence, or criminal intent.

**MAMMARY ARTERY.** A chest wall artery that descends from the aorta and is commonly used for bypass grafts.

**MAMMARY HYPERPLASIA.** Increased size of the breast.

**MAMMOGRAM.** A set of x rays taken of the front and side of the breast used to help diagnose various breast abnormalities.

**MAMMOPLASTY.** Surgery performed to change the size or shape of breasts.

**MANDIBLE.** The horseshoe-shaped bone that forms the lower jaw.

**MANNITOL.** A type of diuretic.

**MARFAN SYNDROME.** A condition occasionally associated with chest wall deformities, in which the patients have a characteristic tall, thin appearance, and cardiac and great vessel abnormalities.

**MASTECTOMY.** Removal of all or a portion of breast tissue.

**MASTECTOMY, MODIFIED RADICAL.** Total mastectomy with axillary lymph node dissection, but with preservation of the pectoral muscles.

**MASTECTOMY, RADICAL.** Removal of the breast, pectoral muscles, axillary lymph nodes, and associated skin and subcutaneous tissue.

**MASTECTOMY, SIMPLE.** Removal of only the breast tissue, nipple and a small portion of the overlying skin

**MASTOID AIR CELLS.** Numerous small intercommunicating cavities in the mastoid process of the temporal bone that empty into the mastoid antrum.

**MASTOID ANTRUM.** A cavity in the temporal bone of the skull, communicating with the mastoid cells and with the middle ear.

**MASTOID PROCESS.** A large bony process at the base of the skull behind the ear. It contains air spaces that connect with the cavity of the middle ear.

**MASTOIDECTOMY.** Hollowing out the mastoid process by curetting, gouging, drilling, or otherwise removing the bony partitions forming the mastoid cells.

**MASTOIDITIS.** An inflammation of the bone behind the ear (the mastoid bone) caused by an infection spreading from the middle ear to the cavity in the mastoid bone.

**MASTOPEXY.** Surgical procedure to lift up a breast; may be used on opposite breast to achieve symmetrical appearance with a reconstructed breast.

**MATCH.** How similar the HLA typing, out of a possible six antigens, is between the donor and the recipient.

**MATERNAL BLOOD SCREENING.** Maternal blood screening is normally done early in pregnancy to test for a variety of conditions. Abnormal amounts of certain proteins in a pregnant woman’s blood raise



the probability of fetal defects. Amniocentesis is recommended if such a probability occurs.

**MATERNITY.** Refers to the mother.

**MAXILLA.** The facial bone that forms the upper jaw and holds the upper teeth.

**MAXILLARY SINUSES.** Sinuses located in the cheek under the eye next to the ethmoid sinus.

**MAZE PROCEDURE.** A surgical procedure used to treat atrial fibrillation. During the procedure, precise incisions are made in the right and left atria to interrupt the conduction of abnormal impulses. When the heart heals, scar tissue forms and the abnormal electrical impulses are blocked from traveling through the heart.

**MDR.** Multiple drug-resistance

**MEAN CORPUSCULAR HEMOGLOBIN (MCH).** A calculation of the average weight of hemoglobin in a red blood cell.

**MEAN CORPUSCULAR HEMOGLOBIN CONCENTRATION (MCHC).** A calculation of the average concentration of hemoglobin in a red blood cell.

**MEAN CORPUSCULAR VOLUME (MCV).** A measure of the average volume of a red blood cell.

**MEATUS.** A general term for an opening or passageway in the body.

**MECHANICAL VALVE.** An artificial device used to replace a patient's heart valve. There are three types: ball valve, disk valve, and bileaflet valve.

**MEDIAL (OR LATERAL) NASAL PROMINENCE.** The medial (toward the middle) or lateral (toward the sides) are anatomical structures that form and merge the nose of the developing embryo during weeks six to nine in utero.

**MEDIASTINOSCOPY.** A surgical procedure to look at the organs, tissues, and lymph nodes between the lungs for abnormal areas. An incision (cut) is made at the top of the breastbone and a thin, lighted tube is inserted into the chest. Tissue and lymph node samples may be taken for biopsy.

**MEDIASTINUM.** The area between the lungs, bounded by the spine, breastbone, and diaphragm, that consists of the heart, thoracic parts of the great vessels, and thoracic parts of the trachea, esophagus, thymus, and lymph nodes.

**MEDICAID.** Public assistance funded through the state to individuals unable to pay for health care.

Medicaid can be accessed only when all prior assets and funds are depleted.

**MEDICAL AGENT.** A designated representative for the patient who, in advance, is legally empowered to carry out their wishes with respect to medical care.

**MEDICAL DIRECTIVES.** Legal documents that include a declaration of wishes pertaining to medical treatment (living will) and the stipulation of a proxy decision maker (power of attorney).

**MEDICAL ERROR.** A preventable adverse event.

**MEDICAL SURROGATE.** Another name for a medical agent or person legally designated to represent the patient with medical providers.

**MEDICALLY NEEDY.** A term that describes a group whose coverage is optional with the states because of high medical expenses. These persons meet category requirements of Medicaid (they are children or parents or elderly or disabled) but their income is too high to qualify them for coverage as categorically needy.

**MEDICARE.** A government program, administered by the Social Security Administration, which provides financial assistance to individuals over the age of 65 for hospital and medical expenses. Medicare does not cover long-term care expenses.

**MEDICARE PART A.** Hospital insurance provided by Medicare, provided free to persons aged 65 and older.

**MEDICARE PART B.** Medical insurance provided by Medicare that requires recipients to pay a monthly premium. Part B pays for some medical services Part A does not.

**MEDIGAP.** A group of 10 standardized private health insurance policies intended to cover the coinsurance and deductible costs not covered by Medicare.

**MEDIONECHROSIS.** Death of the middle layer of tissues in a vessel.

**MEDULLARY CAVITY.** The marrow cavity in the shaft of a long bone.

**MEGACOLON.** Abnormally large colon associated with some chronic intestine disorders.

**MELANOCYTES.** Cells within the epidermis that give skin its color

**MELANOMA.** A malignant tumor arising from the melanocytic system of the skin and other organs.

**MELENA.** The passing of blackish-colored stools containing blood pigments or partially digested blood.

**MEMBRANOUS LABYRINTH.** A complex arrangement of communicating membranous canals and sacs, filled with endolymph and suspended within the cavity of the bony labyrinth.

**MENGHINI NEEDLE/JAMSHEDI NEEDLE.** Special needles used to obtain a sample of liver tissue by aspiration.

**MÉNIÈRE'S DISEASE.** Also known as idiopathic endolymphatic hydrops, Ménière's disease is a disorder of the inner ear. It is named for Prosper Ménière (1799–1862), a French physician.

**MENINGES.** Membranes that cover the brain.

**MENINGITIS.** An infection of the membranes that cover the brain and spinal cord.

**MENISCAL.** Pertaining to cartilage.

**MENISCUS.** The fibrous cartilage within the knee joint that covers the surfaces of the femur and the tibia as they join the patella.

**MENTAL DISABILITY.** The inability to mentally function due to injury, illness, or toxicity.

**MERKEL'S DIVERTICULUM.** Tissue faults in the lining of the intestines that are the result of a congenital abnormality originating in the umbilical duct's failure to close. Largely asymptomatic, the diverticula in some cases can become infected or obstructed.

**MERPERIDINE.** A type of narcotic pain killer that may be used after surgical procedures.

**MESENCHYMAL CELLS.** Embryonic cells that develop into many structures, including the soft tissues in the lip.

**MESENTERY.** The membranes, or one of the membranes (consisting of a fold of the peritoneum and enclosed tissues), that connect the intestines and their appendages with the dorsal wall of the abdominal cavity.

**METABOLIC ACIDOSIS.** A condition in which either too much acid or too little bicarbonate in the body results in a drop in the blood pH (towards acidity).

**METABOLIC ALKALOSIS.** A condition in which either too little acid or too much bicarbonate in the body results in an elevation in the blood pH (towards alkalinity).

**METABOLIC DISTURBANCE.** A disturbance in the general function of the body's basic life processes such as energy production. The body's ability to

provide the brain with appropriate nourishment can affect the mental status of the individual.

**METABOLIC SYNDROME.** A combination of medical disorders including diabetes, high blood pressure, and heart disease.

**METABOLISM.** The sum of all the chemical processes that occur in living organisms; the rate at which the body consumes energy.

**METABOLITES.** The chemicals produced in the body after nutrients, drugs, enzymes or other materials have been changed (metabolized).

**METABOLIZE.** The chemical changes that occur in the body, including the changes that occur in the liver, converting molecules to forms that are more easily removed from the body.

**METACARPAL BONES.** Five cylindrical bones extending from the wrist to the fingers.

**METAPHYSIS.** The widened end of the shaft of a long tubular bone such as the femur.

**METASTASIS.** A process in which a malignant tumor transfers cells to a part of the body not directly connected to its primary site. A cancer that has spread from its original site to other parts of the body is said to be metastatic.

**METATARSAL JOINT.** Having to do with the bones of the foot.

**METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS (MRSA).** A strain of Staph. bacteria that is resistant to methicillin and hence poses a greater health threat because it is difficult to control or kill.

**METHOTREXATE.** A drug that targets rapidly dividing fetal cells, preventing a fetus from developing further.

**MICROCYTIC.** A descriptive term applied to a smaller than normal red blood cell.

**MICRODERMABRASION.** A technique for skin resurfacing that uses abrasive crystals passed through a hand piece to even out skin irregularities.

**MICROGENIA.** An extremely small chin. It is the most common deformity of the chin.

**MICROKERATOME.** A precision surgical instrument that can slice an extremely thin layer of tissue from the surface of the cornea.

**MICROORGANISM.** An independent unit of life that is too small to be seen with the naked eye.

**MICROSURGERY.** Surgery performed under a microscope on nerves and other very small structures with the help of special instruments.

**MICROTIA.** The partial or complete absence of the auricle of the ear.

**MIDDLE EAR.** The cavity or space between the eardrum and the inner ear. It includes the eardrum, the three little bones (hammer, anvil, and stirrup) that transmit sound to the inner ear, and the Eustachian tube, which connects the inner ear to the nasopharynx (the back of the nose).

**MIDDLE MEATUS.** A curved passage in each nasal cavity located below the middle nasal concha and extending along the entire superior border of the inferior nasal concha.

**MIDDLE TURBINATE.** The lower of two thin bony processes on the ethmoid bone on the lateral wall of each nasal fossa that separates the superior and middle meatus of the nose.

**MILIA.** Small bumps on the skin that occur when sweat glands are clogged.

**MINIGRAFT OR MICROGRAFT.** Transplantation of a small number of hair follicles, as few as one to three hairs, into a transplant site.

**MINIMALLY INVASIVE SURGERY.** Surgical techniques, especially the use of small instruments and tiny video cameras, that allow surgery to take place without a full operative wound.

**MIOTICS.** Medications that cause the pupil of the eye to contract.

**MISCARRIAGE.** The loss of a fetus before it is viable, usually between the third and seventh months of pregnancy. A miscarriage is sometimes called a spontaneous abortion.

**MITRAL VALVE.** The bicuspid valve that lies between the left atrium and left ventricle of the heart.

**MIXED DENTITION.** A mix of both “baby teeth” and permanent teeth.

**MIXED LYMPHOCYTE CULTURE (MLC).** Test that measures level of reactivity between donor and recipient lymphocytes.

**MOHS EXCISION.** Referring to the excision of one layer of tissue during Mohs surgery. Also called stage.

**MONOCHORIONIC PREGNANCY.** A pregnancy in which twin fetuses share a placenta.

**MONOCYTE.** Mononuclear phagocytic white blood cell that removes debris and microorganisms by phagocytosis and processes antigens for recognition by immune lymphocytes.

**MONOFILAMENT.** A single untwisted strand of suture material.

**MONSEL'S SOLUTION.** A solution used to stop bleeding.

**MORBID.** Unwholesome or bad for health. Morbid obesity is a condition in which the patient's weight is a very high risk to his or her health. The NIH (National Institutes of Health) prefers the term “severely obese” to “morbidly obese.”

**MORBIDITY.** A state of disease or illness. Also, a statistic that provides the rate at which an illness or abnormality occurs.

**MORBIDLY OBESE.** Definition of a person who is 100 lb (45 kg) or more than 50% overweight and has a body mass index above 40.

**MORPHINE.** A very strong painkiller often used post-surgically.

**MORPHOLOGY.** Literally, the study of form. In medicine, morphology refers to the size, shape, and structure rather than the function of a given organ. As a diagnostic imaging technique, ultrasound facilitates the recognition of abnormal morphologies as symptoms of underlying conditions.

**MORTALITY.** The death rate, which reflects the number of deaths per unit of population in any specific region, age group, disease, or other classification, usually expressed as deaths per 1,000, 10,000, or 1,000,000.

**MOTILITY.** Ability to move freely or spontaneously. Esophageal motility refers to the ability of the muscle fibers in the tissue of the esophagus to contract in order to push food or other material toward the stomach.

**MOUTH GUARD.** A plastic device that protects the upper teeth from injury during athletic events.

**MUCOCILIARY.** Involving cilia of the mucous membranes of the respiratory system.

**MUCUS.** A viscous, slippery secretion that is produced by mucous membranes which it moistens and protects.

**MUCOUS MEMBRANE.** A membrane rich in mucous glands that lines body passages and cavities communicating directly or indirectly with the exterior of the body (as for example, the alimentary, respiratory, and genitourinary tracts). Mucous membranes functions in protection, support, nutrient absorption, and secretion of mucus, enzymes, and salts.

**MULTIFILAMENT.** A braided strand of suture material. Multifilament sutures are generally thicker than monofilament and used in such specialties as orthopedic surgery.

**MULTIPLE MYELOMA.** An uncommon disease that occurs more often in men than in women and is associated with anemia, hemorrhage, recurrent infections and weakness. Ordinarily it is regarded as a malignant neoplasm that originates in bone marrow and involves mainly the skeleton.

**MULTIPLE SCLEROSIS.** A chronic degenerative neurological disease in which demyelination of the nerves causes progressive weakness and loss of motor function.

**MURMUR.** The sound made as blood moves through the heart when there is turbulence in the flow of blood through a blood vessel, or if a valve does not completely close.

**MUSCULAR DYSTROPHY.** A genetic muscle disease that causes progressive muscle weakness along with the breakdown and death of muscle tissue.

**MYCOBACTERIUM.** Any of a genus of nonmotile, aerobic, acid-fast bacteria that include numerous saprophytes and the pathogens causing tuberculosis and leprosy.

**MYELOYDYSPLASIA.** Also called myelodysplastic syndrome, it is a condition in which the bone marrow does not function normally and can affect the various types of blood cells produced in the bone marrow. Often referred to as a preleukemia and may progress and become acute leukemia.

**MYELOFIBROSIS.** An anemic condition in which bone marrow cells are abnormal or defective and become fibrotic.

**MYELOGRAM.** A special type of x ray study of the spinal cord, made after a contrast medium has been injected into the space surrounding the cord.

**MYELOMA (MULTIPLE MYELOMA).** A tumor of plasma cells that originates in bone marrow and usually spreads to more than one bone.

**MYELOMENINGOCELES (MMC).** A protrusion in the vertebral column containing spinal cord and meninges.

**MYOCARDIAL INFARCTION (MI).** Commonly known as a heart attack, a myocardial infarction is an episode in which some of the heart's blood supply is severely cut off or restricted, causing the heart muscle to suffer and die from lack of oxygen.

**MYOCARDITIS.** Inflammation of the muscles of the walls of the heart due to a viral infection.

**MYOGLOBIN.** A protein that holds oxygen in heart and skeletal muscle. It rises after damage to either of these muscle types.

**MYOMA.** A tumor consisting of muscle tissue.

**MYOPIA.** A vision problem in which distant objects appear blurry. Myopia results when the cornea is too steep or the eye is too long and the light doesn't focus properly on the retina. People who are myopic or nearsighted can usually see near objects clearly, but not far objects.

**MYOSITIS.** Inflammation of muscle tissue.

**MYRINGOPLASTY.** Surgical restoration of a perforated tympanic membrane by grafting.

**MYRINGOTOMY.** A procedure that involves making a small incision in the eardrum to release pressure caused by excess fluid accumulation.

## N

**NARCOTIC.** A drug derived from opium or compounds similar to opium. Such drugs are potent pain relievers and can affect mood and behavior. Long-term use of narcotics can lead to dependence and tolerance.

**NASAL CANNULA.** A piece of flexible plastic tubing with two small clamps that fit into the nostrils and provide supplemental oxygen flow.

**NASAL CONCHA.** Any of three thin bony plates on the lateral wall of the nasal fossa on each side with or without their covering of mucous membrane.

**NASOGASTRIC TUBE.** A tube inserted through the nose and throat and into the stomach for direct feeding of the patient.

**NATRIURETIC PEPTIDES.** Peptides that prompt the kidneys to excrete sodium into the urine and out of the body.



**NEARSIGHTEDNESS.** A condition in which one or both eyes cannot focus normally, causing objects at a distance to appear blurred and indistinct. Also called myopia.

**NECROSIS.** Cellular or tissue death; skin necrosis may be caused by multiple, consecutive doses of radiation from fluoroscopic or x-ray procedures.

**NECROTIC.** Affected with necrosis (cell death).

**NEEDLE BIOPSY.** The use of a needle to remove tissue from an area that looks suspicious. Tissue removed in a needle biopsy goes to a lab to be checked for cancer cells.

**NEO-BLADDER.** A term that refers to the creation of a reservoir for urine made from intestinal tissue that allows for evacuation.

**NEONATAL JAUNDICE.** A disorder in newborns where the liver is too premature to conjugate bilirubin, which builds up in the blood.

**NEONATE.** A newborn baby.

**NEOPLASM.** A new growth or tumor.

**NEOVASCULAR GLAUCOMA.** A form of glaucoma that results from uncontrolled diabetes or hypertension.

**NEPHELOMETRY.** A method for measuring the light scattering properties of a sample.

**NEPHRECTOMY.** Surgical removal of a kidney.

**NEPHROLITHOTOMY.** The removal of renal calculi by an incision through the kidney. The term by itself usually refers to the standard open procedure for the surgical removal of kidney stones.

**NEPHROLOGIST.** A doctor specializing in kidney disease.

**NEPHROSCOPE.** An instrument used to view the inside of the kidney during PCNL. A nephroscope has channels for a fiberoptic light, a telescope, and an irrigation system for washing out the affected part of the kidney.

**NEPHROTIC SYNDROME.** A kidney disorder which causes a cluster of symptoms, including low serum protein, loss of protein in the urine, and body swelling.

**NEPHROTOXIC.** Destructive to kidney cells. Hemoperfusion can be used to remove nephrotoxic chemicals from the blood.

**NEPHROTOXICITY.** A building up of poisons in the kidneys.

**NEUROBLASTOMA.** Solid tumor in children, may be treated by BMT.

**NEUROFIBROMATOSIS.** A rare hereditary disease that involves the growth of lesions that may affect the spinal cord.

**NEUROGENIC BLADDER.** A urinary problem of neurological origin in which there is abnormal emptying of the bladder with subsequent retention or incontinence of urine.

**NEUROLOGICAL.** Pertaining to the nervous system: peripheral nervous system, brain, and spinal cord.

**NEUROLOGIST.** A physician who specializes in diagnosing and treating disorders of the nervous system.

**NEUROMODULATION.** Electrical stimulation of a nerve for relief of pain.

**NEUROPATHY.** Nerve damage.

**NEUROSURGERY.** Surgery involving the nervous system: peripheral nervous system, brain, and spinal cord. A physician who performs such surgery is called a neurosurgeon.

**NEUROTRANSMITTER.** Chemicals within the nervous system that transmit information from or between nerve cells.

**NEUTRALIZE.** The way the body addresses acidity or alkalinity: adding acid to an alkaline environment to arrive at a neutral pH value, or adding bicarbonate to an acidic environment to arrive at a neutral pH value.

**NEUTROPHIL.** A type of white blood cell. Neutrophils remove and kill bacteria by phagocytosis.

**NICOTINE.** A poisonous, oily alkaloid in tobacco.

**NITROUS OXIDE.** A colorless, sweet-smelling gas used by dentists for mild anesthesia. It is sometimes called laughing gas because it makes some people feel giddy or silly.

**NOCICEPTOR.** A nerve cell that is capable of sensing pain and transmitting a pain signal.

**NOMOGRAM.** A surgeon's adjustment of the excimer laser to fine-tune results.

**NON-INVASIVE.** A procedure that does not penetrate the body.

**NON-MYELOABLATIVE ALLOGENEIC BONE MARROW TRANSPLANT.** Also called “mini” bone marrow transplants. This type of bone marrow transplant involves receiving low-doses of chemotherapy and radiation therapy, followed by the infusion of a donor’s bone marrow or peripheral stem cells. The goal is to suppress the patient’s own bone marrow with low-dose chemotherapy and radiation therapy to allow the donor’s cells to engraft.

**NON-PALPABLE.** Unable to be detected through the sense of touch. A non-palpable testicle is one that is located in the abdomen or other site where the doctor cannot feel it by pressing gently on the child’s body.

**NON-UNION.** Bone fracture or defect induced by disease, trauma, or surgery that fails to heal within a reasonable time span.

**NONABLATIVE.** Not requiring removal or destruction of the epidermis. Some techniques for minimizing scars are nonablative.

**NONINVASIVE TUMORS.** Tumors that have not penetrated the muscle wall and/or spread to other parts of the body.

**NONPHARMACOLOGICAL.** Referring to therapy that does not involve drugs.

**NONPROFIT HOSPITALS.** Hospitals that combine a teaching function with providing for uninsured within large, complex networks technically designated as nonprofit institutions. While the institution may be nonprofit, however, its services are allowed to make a profit.

**NONSTEROIDAL ANTI-INFLAMMATORY DRUGS (NSAIDS).** Drugs that relieve pain and reduce inflammation but are not related chemically to cortisone. Common drugs in this class are aspirin, ibuprofen (Advil, Motrin), naproxen (Aleve, Naprosyn), ketoprofen (Orudis), and several others.

**NOREPINEPHRINE.** A naturally occurring hormone that acts as a neurotransmitter and affects both alpha- and beta-adrenergic receptors. It is also known as noradrenaline.

**NORMAL FLORA.** The mixture of bacteria normally found at specific body sites.

**NORMOCHROMIC.** A descriptive term applied to a red blood cell with a normal concentration of hemoglobin.

**NORMOCYTIC.** A descriptive term applied to a red blood cell of normal size.

**NOSOCOMIAL.** Occurring in the hospital or clinical setting.

**NOSOCOMIAL INFECTION.** An infection acquired in the hospital.

**NOTHING BY MOUTH (NPO).** NPO refers to the time after which the patient is not allowed to eat or drink prior to a procedure or treatment.

**NUCLEAR IMAGING.** Method of producing images by detecting radiation from different parts of the body after a radioactive tracer material is administered.

**NUCLEUS.** The part of a cell that contains the DNA.

**NURSE ANESTHETIST.** A registered nurse who has obtained advanced training in anesthesia delivery and patient care.

**NURSE MANAGER.** The nurse responsible for managing the nursing care on the nursing unit and also supervises all of the other personnel who work on the nursing unit.

**NURSING UNIT.** The floor or section of the hospital where patient rooms are located.

**NYHA HEART FAILURE CLASSIFICATION.** A classification system for heart failure developed by the New York Heart Association. It includes the following four categories: I, symptoms with more than ordinary activity; II, symptoms with ordinary activity; III, symptoms with minimal activity; IV, symptoms at rest.

**NYSTAGMUS.** An involuntary, rapid, rhythmic movement of the eyeball, which may be horizontal, vertical, rotatory, or mixed.

## O

**OBESITY.** Excessive weight gain due to accumulation of fat in the body, sometimes defined as a BMI (body mass index) of 30 or higher, or body weight greater than 30% above one’s desirable weight on standard height-weight tables.

**OBJECTIVE.** Not biased by personal opinion; repeatable.

**OBSESSION.** A recurrent and persistent idea, thought, or impulse that the individual cannot repress.

**OBSTETRICS AND GYNECOLOGICAL SURGERY.** Surgery involving the reproductive organs or pregnancy.

**OBSTRUCTIVE SLEEP APNEA (OSA).** A potentially life-threatening condition characterized by episodes of breathing cessation during sleep alternating with snoring or disordered breathing. The low levels of oxygen in the blood of patients with OSA may eventually cause heart problems or stroke.

**OBTURATOR.** Any structure that occludes an opening. A trocar obturator has a tip used to penetrate the body wall while being held in the cannula of the trocar apparatus.

**OCCCLUSION.** An obstruction or blockage in a blood vessel.

**OCCULT.** Hidden; concealed from the doctor's direct observation. Some ganglion cysts are occult.

**OCULAR HYPERTENSION.** A condition in which fluid pressure inside the eye is higher than normal but the optic nerve and visual fields are normal.

**OCULAR MELANOMA.** A malignant tumor that arises within the structures of the eye. It is the most common eye tumor in adults.

**OCULAR ORBIT.** Bony cavity containing the eyeball.

**OINTMENT.** A thick spreadable substance that contains medicine and is meant to be used on the outside of the body.

**OLIGOHYDRAMNIOS.** Low levels of amniotic fluid during pregnancy.

**OLIGURIA.** Decreased urine production.

**OMBUDSMAN.** A patient representative who investigates patient complaints and problems related to hospital service or treatment. He or she may act as a mediator between the patient, the family, and the hospital.

**OMPHALOCELE.** A hernia that occurs at the navel.

**ONCOGENE.** A gene that is capable under certain conditions of triggering the conversion of normal cells into cancer cells.

**ONCOLOGIST.** A physician who specializes in the diagnosis and treatment of tumors.

**ONCOLOGY.** The branch of medicine that deals with the diagnosis and treatment of cancer.

**OOPHORECTOMY.** Removal of one or both ovaries in a woman.

**OOPHORECTOMY.** Surgical removal of the ovaries.

**OPEN SURGERY.** Surgery using a large incision to lay open area for examination or treatment; in joint surgery, the whole joint is exposed.

**OPEN-ANGLE GLAUCOMA.** A form of glaucoma in which fluid pressure builds up inside the eye even though the angle of the anterior chamber is open and looks normal when the eye is examined with a gonioscope. Most cases of glaucoma are open-angle.

**OPERATIVE NURSE.** A nurse specially trained to assist the surgeon and work in all areas of the surgical event to care for the patient.

**OPHTHALMOLOGIST.** A medical doctor with advanced training in the diagnosis and treatment of eye disease.

**OPHTHALMOLOGY.** The branch of medicine that deals with the diagnosis and treatment of eye disorders.

**OPHTHALMOSCOPE.** An instrument for viewing the interior of the eye, particularly the retina. Light is thrown into the eye by a mirror (usually concave) and the interior is then examined with or without the aid of a lens.

**OPIOID.** A synthetic drug resembling opium or alkaloids of opium.

**OPTIC DISC.** A visually inactive portion of the retina from which the optic nerve and blood vessels emerge.

**OPTIC NERVE.** A large nerve found in the posterior part of the eye, through which all the visual nerve fibers leave the eye on their way to the brain.

**OPTOMETRIST.** A primary health care provider who examines eyes and diagnoses disorders of the eye as well as prescribing eyeglasses, contact lenses, and other vision aids.

**ORAL SURGEON.** A dentist who specializes in surgical procedures of the mouth, including extractions.

**ORAL.** Pertaining to the mouth.

**ORBICULARIS ORIS.** Concentrically shaped muscle that surrounds the upper and lower lips.

**ORBIT.** The cavity in the skull containing the eyeball; formed from seven bones: frontal, maxillary, sphenoid, lacrimal, zygomatic, ethmoid, and palatine.

**ORCHIECTOMY.** Surgical removal of one or both testicles in a male; also called an orchidectomy.

**ORGAN PROCUREMENT.** The process of donor screening, and the evaluation, removal, preservation, and distribution of organs for transplantation.

**OROPHARYNX.** The part of the throat at the back of the mouth.

**ORTHODONTIC TREATMENT.** The process of realigning and straightening teeth to correct their appearance and function.

**ORTHOGNATHIC SURGERY.** Surgery that corrects deformities or malpositioning of the bones in the jaw. The term comes from two Greek words meaning straight and jaw.

**ORTHOPEDIC SURGERY.** Surgery involving the musculoskeletal system, which includes muscles, tendons, joints, and bones.

**ORTHOPEDICS (SOMETIMES SPELLED ORTHOPAEDICS).** The branch of surgery that treats deformities or disorders affecting the musculoskeletal system.

**ORTHOTIC.** A device designed to be inserted into a shoe to help keep the foot in proper alignment, stabilize the heel, support the arch, and distribute body weight more evenly over the foot.

**ORTHOTOPIC TRANSPLANTATION.** The replacement of a whole diseased liver with a healthy donor liver.

**OSMOLALITY.** A measurement of urine concentration that depends on the number of particles dissolved in it. Values are expressed as milliosmols per kilogram (mOsm/kg) of water.

**OSMOSIS.** Passage of a solvent through a membrane from an area of greater concentration to an area of lesser concentration.

**OSSICLES.** The three small bones of the middle ear: the malleus (hammer), the incus (anvil) and the stapes (stirrup). These bones help carry sound from the eardrum to the inner ear.

**OSSICULOPLASTY.** Surgical insertion of an implant to replace one or more of the ear ossicles. Also called ossicular replacement.

**OSTEOARTHRITIS.** Non-inflammatory degenerative joint disease occurring chiefly in older persons, characterized by degeneration of the articular cartilage.

**OSTEOBLASTS.** Bone cells that build new bone tissue.

**OSTEOCLASTS.** Bone cells that break down and remove bone tissue.

**OSTEOCONDUCTION.** Provision of a scaffold for the growth of new bone.

**OSTEOCYTES.** Bone cells that maintain bone tissue.

**OSTEOGENESIS.** Growth of new bone.

**OSTEOINDUCTION.** Acceleration of new bone formation by chemical means. Also refers to the process of building, healing, and remodeling bone in humans.

**OSTEOLYSIS.** Dissolution and loss of bone resulting from inflammation caused by particles of polyethylene debris from a prosthesis.

**OSTEOMALACIA.** A disease of adults, characterized by softening of the bone; similar to rickets, which is seen in children.

**OSTEONECROSIS.** Condition resulting from poor blood supply to an area of a bone and causing bone death.

**OSTEOPATHY.** A system of therapy that uses standard medical and surgical methods of diagnosis and treatment while emphasizing the importance of proper body alignment and manipulative treatment of musculoskeletal disorders. Osteopathy is considered mainstream primary care medicine rather than an alternative system.

**OSTEOPOROSIS.** A bone disorder, usually seen in the elderly, in which the bones become increasingly less dense and more brittle.

**OSTEOTOMY.** The cutting apart of a bone or removal of bone by cutting. An osteotomy is often necessary during hip revision surgery in order to remove the femoral part of the old prosthesis from the femur.

**OSTEOTOMY OF THE KNEE.** Realignment of the knee, using bone cutting to shift weight bearing from damaged cartilage to healthier cartilage.

**OSTIA.** A mouth-like opening in a bodily part.

**OSTOMY.** General term meaning a surgical procedure in which an artificial opening is formed to either allow waste (stool or urine) to pass from the body, or to allow food into the GI tract. An ostomy can be permanent or temporary, as well as single-barreled, double-barreled, or a loop.

**OTITIS.** Inflammation of the ear, which may be marked by pain, fever, abnormalities of hearing, hearing loss, tinnitus and vertigo.

**OTOLARYNGOLOGIST.** A surgeon who specializes in treating disorders of the ears, nose, and throat.

**OTOLOGY.** The branch of medicine that deals with the diagnosis and treatment of ear disorders.



**OTOSCLEROSIS.** Formation of spongy bone around the footplate of the stapes, resulting in conductive hearing loss.

**OTOSCOPY.** Examination of the ear with an otoscope, an instrument designed to evaluate the condition of the ear.

**OUTPATIENT PROCEDURES.** Surgeries that are performed on an outpatient basis, involving less recovery time and fewer expected complications.

**OUTPATIENT SURGERY.** Also called same-day or ambulatory surgery. The patient arrives for surgery and returns home on the same day. Outpatient surgery can take place in a hospital, surgical center, or outpatient clinic.

**OVARIAN CYST.** A benign or malignant growth on an ovary. An ovarian cyst can disappear without treatment or become extremely painful and have to be surgically removed.

**OVARY.** One of the two essential female reproductive organs that produce eggs and sex hormones.

**OVEREXPRESSION.** Production in abnormally high amounts.

**OVULATION.** A process in which a mature female egg is released from one of the ovaries (egg-shaped structures located to each side of the uterus) every 28 days.

**OXIMETRY.** Measuring the degree of oxygen saturation of circulating blood.

**OXYGENATION.** Saturation with oxygen.

**OXYHEMOGLOBIN.** Hemoglobin combined with oxygen.

## P

**PACEMAKER.** A surgically implanted electronic device that sends out electrical impulses to regulate a slow or erratic heartbeat.

**PACU.** The postanesthesia care unit, where the patient is cared for after surgery.

**PAIN DISORDER.** A psychiatric disorder in which pain in one or more parts of the body is caused or made worse by psychological factors. The lower back is one of the most common sites for pain related to this disorder.

**PALATE.** The roof of the mouth composed of two anatomical structures, the hard and soft palates.

**PALLIATIVE.** A type of care that is intended to relieve pain and suffering, but not to cure.

**PALPATE.** To examine by means of touch.

**PALPATION.** The examination of the body using the sense of touch. There are two types: light and deep.

**PALPEBRAL FISSURE.** Eyelid opening.

**PALPITATIONS.** Forcible pulsation or pounding of the heart that is perceptible to the patient.

**PANCREAS.** An organ located near the liver and stomach, responsible for various digestive functions. The pancreas produces insulin and glucagon, hormones that are responsible for maintaining safe blood levels of glucose.

**PANCREATODUODENECTOMY.** Removal of all or part of the pancreas along with the duodenum. Also known as “Whipple’s procedure” or “Whipple’s operation.”

**PANCREATITIS.** Inflammation of the pancreas, either acute (sudden and episodic) or chronic, usually caused by excessive alcohol intake or gallbladder disease.

**PANIC DISORDER.** An disorder in which people have sudden and intense attacks of anxiety in certain situations.

**PAP TEST.** The common term for the Papanicolaou test, a simple smear method of removing cervical cells to screen for abnormalities that indicate cancer or a precancerous condition.

**PARACENTESIS.** Surgical puncture of the abdominal cavity for the aspiration of peritoneal fluid.

**PARAQUAT.** A highly toxic restricted-use pesticide. Death following ingestion usually results from multiple organ failure.

**PARASYMPATHETIC NERVOUS SYSTEM.** The division of the autonomic (involuntary) nervous system that slows heart rate, increases digestive and glandular activity, and relaxes the sphincter muscles that close off body organs.

**PARATHYROID GLANDS.** Two pairs of smaller glands that lie close to the lower surface of the thyroid gland. They secrete parathyroid hormone, which regulates the body’s use of calcium and phosphorus.

**PARATHYROIDECTOMY.** A surgical procedure in which one or more parathyroid glands are removed.

**PARENCHYMA.** The essential elements of an organ, used in anatomical nomenclature as a general term to

designate the functional elements of an organ, as distinguished from its framework.

**PARENTERAL NUTRITION.** The administration of liquid nutrition through an intravenous catheter placed in the patient's vein.

**PARENTERAL NUTRITIONAL SUPPORT.** Intravenous nutrition that bypasses the intestines and its contribution to digestion.

**PARESTHESIA.** An abnormal touch sensation, such as a prickling or burning feeling, often in the absence of an external cause.

**PARIETAL CELLS.** Cells of the gastric glands that secrete hydrochloric acid.

**PARIETAL PERICARDIUM.** External or outer layer of the pericardial cavity.

**PARKINSON'S DISEASE.** A neurological disease resulting from a deficiency of the neurotransmitter dopamine that is associated with specific recognizable movements, affects, and behavior patterns.

**PARONYCHIA.** Inflammation of the folds of tissue surrounding the nail.

**PARTIAL THROMBOPLASTIN TIME.** A test that checks the clotting factors of the intrinsic pathway.

**PATELLA.** The knee cap; the quadriceps tendon attaches to it above and the patellar tendon below.

**PATELLECTOMY.** Surgical removal of the patella, or kneecap removal.

**PATENCY.** The state of being open or unblocked.

**PATENT DUCTUS ARTERIOSUS.** A congenital defect in which the temporary blood vessel connecting the left pulmonary artery to the aorta in the fetus fails to close in the newborn.

**PATERNITY.** Refers to the father.

**PATHOGEN.** A disease-causing organism.

**PATHOLOGIST.** A doctor who specializes in the diagnosis of disease by studying cells and tissues under a microscope.

**PATIENT SELF-DETERMINATION ACT (PSDA).** Federal law that ensures that medical providers offer the option of medical directives to patients and include the documents in their medical records.

**PATIENT-CONTROLLED ANALGESIA (PCA).** An approach to pain management that allows the patient to control the timing of intravenous doses of analgesic drugs.

**PEAK EXPIRATORY FLOW RATE.** A test used to measure how fast air can be exhaled from the lungs.

**PECTORALIS MINOR.** A triangular-shaped muscle in front of (anterior) the axilla.

**PECTUS CARINATUM.** A chest wall deformity characterized by a protrusion of the sternum.

**PECTUS EXCAVATUM.** A chest wall deformity in which the chest wall takes on a sunken appearance.

**PEDIATRIC AGED PATIENT.** The pediatric aged patient encompasses several periods during development. The first four weeks after birth are called the neonatal period. The first year after birth is called infancy, and childhood is from 13 months until puberty (between the ages of 12 and 15 years in girls and 13 and 16 years in boys).

**PEDIATRICS.** The medical specialty of caring for children.

**PEDICLE FLAP.** Also called an attached flap; a section of tissue, with its blood supply intact, which is maneuvered to another part of the body.

**PELVIC.** Located near the pelvis, the skeletal structure comprised of four bones that encloses the pelvic cavity.

**PELVIC INFLAMMATORY DISEASE (PID).** Inflammation of the female reproductive tract, caused by any of several microorganisms. Symptoms include severe abdominal pain, high fever, and vaginal discharge. Severe cases can result in sterility.

**PELVIC ORGANS.** The organs inside of the body that are located within the confines of the pelvis. This includes the bladder and rectum in both sexes, and the uterus, ovaries, and fallopian tubes in females.

**PERCUSSION.** An assessment method in which the surface of the body is struck with the fingertips to obtain sounds that can be heard or vibrations that can be felt. It can determine the position, size, and consistency of an internal organ. It is done over the chest to determine the presence of normal air content in the lungs, and over the abdomen to evaluate air in the loops of the intestine.

**PERCUTANEOUS.** Through the skin.

**PERCUTANEOUS BIOPSY.** A biopsy in which the needle is inserted and the sample removed through the skin.

**PERCUTANEOUS TRANSLUMINAL CORONARY ANGIOPLASTY (PTCA).** A cardiac intervention in which an artery blocked by plaque is dilated, using a balloon catheter to

flatten the plaque and open the vessel; it is also called balloon angioplasty.

**PERCUTANEOUS.** Denoting the passage of substances through unbroken skin; also refers to passage through the skin by needle puncture, including introduction of wires and catheters by the Seldinger technique.

**PERCUTANEOUS.** Effected or performed through the skin.

**PERCUTANEOUS.** Performed through the skin. It is derived from two Latin words, *per* (through) and *cutis* (skin).

**PERFORATION.** The rupture or penetration by injury or infection of the lining of an organ or canal that allows infection to spread into a body cavity, as in peritonitis, the infection of the lining of the stomach or intestines.

**PERFUSION SCAN.** A lung scan in which a tracer is injected into a vein in the arm. It travels through the bloodstream and into the lungs to show areas of the lungs that are not receiving enough air or that retain too much air.

**PERICARDIAL FRICTION RUB.** A crackly, grating, low-pitched sound and is heard in both inspiration and expiration.

**PERICARDIAL TAMPONADE.** The collection of blood in the sac surrounding the heart that causes compression.

**PERINEUM.** The area between the opening of the vagina and the anus in a woman, or the area between the scrotum and the anus in a man.

**PERIODONTITIS.** Generalized disease of the gums in which unremoved calculus has separated the gingiva or gum tissue from the teeth and threatens support ligaments of the teeth and bone.

**PERIPHERAL ARTERIAL DISEASE (PAD).** An occlusive disease of the arteries most often caused by progressive atherosclerosis.

**PERIPHERAL ARTERIES.** Arteries other than those of the heart and brain, especially those that supply the lower body organs and limbs.

**PERIPHERAL ENDARTERECTOMY.** The surgical removal of fatty deposits, called plaque, from the walls of arteries other than those of the heart and brain.

**PERIPHERAL NERVOUS SYSTEM (PNS).** Nerves that are outside of the brain and spinal cord.

**PERIPHERAL STEM CELL TRANSPLANT.** The process of transplanting peripheral stem cells instead of using bone marrow. The stem cells in the circulating blood that are similar to those in the bone marrow are given to the patient after treatment to help the bone marrow recover and continue producing healthy blood cells. A peripheral stem cell transplant may also be used to supplement a bone marrow transplant.

**PERIPHERAL STEM CELLS.** Stem cells that are taken directly from the circulating blood and used for transplantation. Stem cells are more concentrated in the bone marrow, but they can also be extracted from the bloodstream.

**PERIPHERAL VISION.** The outer portion of the visual field.

**PERISTALSIS.** The wavelike contraction of the muscle fibers in the esophagus and other parts of the digestive tract that pushes food through the system.

**PERITONEUM.** The smooth membrane that lines the cavity of the abdomen, and surrounds the viscera, forming a closed sac.

**PERITONITIS.** Inflammation of the membrane lining the abdominal cavity. It causes abdominal pain and tenderness, constipation, vomiting, and fever.

**PERIURETHRAL.** Surrounding the urethra.

**PERSONAL CARE ATTENDANT.** An employee hired either through a healthcare facility, home care agency, or private agency to assist a patient in performing ADLs.

**PERSONALITY DISORDER.** Group of behavioral disorders characterized by maladaptive patterns of behavior, social interactions, or lifestyles that deviate from the healthy normal. Personality disorders are distinct from psychotic disorders.

**PH.** A measure of the acidity or alkalinity of a solution, relative to a standard solution. A neutral pH value is 7.0. An acidic pH value is below 7.0. An alkaline pH value is above 7.0.

**PHACOEMULSIFICATION.** A surgical procedure for removal of the crystalline lens in which a needle is inserted through a small incision on the side of the cornea of the eye, allowing the lens contents to fall through the dilated pupil into the anterior chamber where they are broken up by ultrasound and aspirated out of the eye through the incision.

**PHACOLYTIC GLAUCOMA.** Type of glaucoma causing dissolution of the lens.

**PHAGOCYTOSIS.** A process by which a white blood cell envelopes and digests debris and microorganisms to remove them from the blood.

**PHARMACOLOGIC CARDIOVERSION.** The use of medications to restore normal heart rhythm. It is also called chemical cardioversion.

**PHARMACOLOGICAL.** Referring to therapy that relies on drugs.

**PHARMACOLOGIST.** Medication specialist who checks patients' blood levels to monitor their response to immunosuppressive medications.

**PHARYNX.** The cavity at the back of the mouth. It is cone shaped and has an average length of about 3 in (76 mm) and is lined with mucous membrane. The pharynx opens into the esophagus at the lower end.

**PHENOTYPE.** A trait produced by a gene. For example, the specific HLA antigen(s) inherited for the HLA-A locus is the phenotype for that gene.

**PHENYLKETONURIA.** (PKU) A genetic disorder in which the body lacks an important enzyme. If untreated, the disorder can lead to brain damage and mental retardation.

**PHEOCHROMOCYTOMA.** A tumor of specialized cells of the adrenal gland.

**PHILTRAL DIMPLE.** The skin or depression below the nose, extending to the upper lip in the midline.

**PHILTRAL UNITS.** Consists of several anatomical landmarks: the philtral dimple (the skin or depression below the nose extending to the upper lip in the midline); philtral columns (the skin columns on the right and left side of the philtral dimple); philtral tubercle (in the midline of the upper lip); white roll (a linear tissue prominence that joins the upper lip portion of the philtral dimple and vermilion—the dark pink tissue that makes up the lip); nasal columella (the outer portion of the nose that divides the nostrils).

**PHIMOSIS.** A tightening of the foreskin that may close the opening of the penis.

**PHLEBECTOMY.** Surgical removal of a vein or part of a vein.

**PHLEBITIS.** An inflammation of the walls of a vein.

**PHLEBOLOGY.** The study of veins, their disorders, and their treatments. A phlebologist is a doctor who specializes in treating spider veins, varicose veins, and associated disorders.

**PHLEBOTOMIST.** Health care professional trained to obtain samples of blood.

**PHOBIA.** An intense, abnormal, or illogical fear of something specific such as heights or open spaces.

**PHOBIA.** An irrational and unfounded fear of a situation, place, or object that causes a state of panic.

**PHOTOCOAGULATION.** Condensation of material by laser.

**PHOTODYNAMIC THERAPY.** A cancer treatment that uses a drug that is activated by exposure to light. When the drug is exposed to light, the cancer cells are killed.

**PHOTON.** A light particle.

**PHYSICAL ACTIVITY.** Any activity that involves moving the body and results in the burning of calories.

**PHYSICAL FITNESS.** The combination of muscle strength and cardiovascular health usually attributed to regular exercise and good nutrition.

**PHYSIOLOGICAL STATE.** The status of the normal vital life functions of a living organism.

**PILES.** Another name for hemorrhoids.

**PILOCARPINE.** Drug used to treat glaucoma.

**PILONIDAL CYST.** A special kind of abscess that occurs in the cleft between the buttocks. Forms frequently in adolescence after long trips that involve sitting.

**PINNA.** Another name for the auricle; the visible portion of the external ear.

**PISTON.** The plunger that slides up and down inside the barrel of a syringe.

**PITUITARY GLAND.** A small, oval-shaped endocrine gland situated at the base of the brain in the fossa (depression) of the sphenoid bone. Its overall role is to regulate growth and metabolism. The gland is divided into the posterior and anterior pituitary, each responsible for the production of its own unique hormones.

**PITUITARY TUMORS.** Tumors found in the pituitary gland. Most pituitary tumors are benign, meaning that they grow very slowly and do not spread to other parts of the body.

**PLACENTA.** The organ that develops along with the fetus to connect the fetus to the mother.

**PLACENTA PREVIA.** The placenta totally or partially covers the cervix, preventing vaginal delivery.



**PLACENTAL ABRUPTION.** Separation of the placenta from the uterine wall before the baby is born, cutting off blood flow to the baby.

**PLANTAR FASCIITIS.** An inflammation of the fascia on the bottom of the foot.

**PLAQUE.** An abnormal deposit on the wall of an artery. Plaque is made of cholesterol, triglyceride, dead cells, lipoproteins and calcium.

**PLASMA.** The liquid portion of blood, as distinguished from blood cells. Plasma constitutes about 55% of blood volume.

**PLASMA CELLS.** Cells in the blood and bone marrow that are formed from B lymphocytes, and that produce antibodies.

**PLATELET.** A disk-shaped structure found in blood that binds to fibrinogen at the site of a wound to begin the clotting process.

**PLETHYSMOGRAPHY.** A test in which a patient sits inside a booth called a plethysmograph and breathes through a mouthpiece, while pressure and air flow measurements are collected to measure the total lung volume.

**PLEURAL CAVITY.** The space between the lungs and the chest wall.

**PLEURAL SPACE.** The small space between the two layers of the membrane that covers the lungs and lines the inner surface of the chest.

**PNEUMATIC RETINOPEXY.** Reattachment of a detached retina using an injected gas bubble to hold the retina against the back of the eye.

**PNEUMOCYSTIS CARINII PNEUMONIA (PCP).** A lung infection that affects people with weakened immune systems, such as patients with AIDS or people taking medicines that weaken the immune system.

**PNEUMONIA.** A disease characterized by inflammation of the lungs. Pneumonia may be caused by bacteria, viruses, or other organisms, or by physical or chemical irritants.

**PNEUMOTHORAX.** A collection of air or gas in the chest cavity that causes a lung to collapse. Pneumothorax may be caused by an open chest wound that admits air.

**PODIATRIST.** A physician who specializes in the care and treatment of the foot.

**PODIATRY.** The surgical specialty that treats disorders of the foot.

**POLAND SYNDROME.** A condition associated with chest wall deformities in which varying degrees of underdevelopment of one side of the chest and arm may occur.

**POLIOMYELITIS.** Disorder caused by a viral infection (poliovirus) that can affect the whole body, including muscles and nerves.

**POLYCYSTIC KIDNEY DISEASE.** A hereditary kidney disease that causes fluid- or blood-filled pouches of tissue called cysts to form on the tubules of the kidneys. These cysts impair normal kidney function.

**POLYCYTHEMIA VERA.** A disease in which the bone marrow makes too many blood cells.

**POLYCYTHEMIA.** A condition in which the amount of RBCs are increased in the blood.

**POLYDACTYLY.** A developmental abnormality characterized by an extra digit on the hand or foot.

**POLYGLYCOLIC ACID (PGA).** A polyester compound used to make bioabsorbable sutures and staples. It is also used in tissue engineering.

**POLYMYALGIA RHEUMATICA.** A condition with symptoms of achiness and stiffness, primarily striking older adults.

**POLYP.** A small growth, usually not cancerous, but often precancerous when it appears in the colon.

**POLYSOMNOGRAPHY.** A test administered in a sleep laboratory to analyze heart rate, blood circulation, muscle movement, brain waves, and breathing patterns during sleep.

**POLYSYNDACTYLY.** Condition involving both webbing and the presence of an extra number of fingers or toes.

**PORPHYRIAS.** A group of disorders involving heme biosynthesis, characterized by excessive excretion of porphyrins. The porphyrias may be either inherited or acquired (usually from the effects of certain chemical agents).

**PORPHYRIN.** A dark red pigment, sensitive to light, that is found in chlorophyll as well as in a substance in hemoglobin known as heme.

**PORTABILITY.** A feature that allows employees to transfer health insurance coverage or other benefits from one employer to another when they change jobs.

**PORTABLE CHEST X RAY.** An x ray procedure taken by equipment that can be brought to the patient. The resulting radiographs may not be as high in quality as

stationary x-ray radiographs, but allow a technologist to come to the patient.

**PORTAL HYPERTENSION.** A condition caused by cirrhosis of the liver. It is characterized by impaired or reversed blood flow from the portal vein to the liver, an enlarged spleen, and dilated veins in the esophagus and stomach.

**PORTAL HYPERTENSION.** Abnormally high pressure within the veins draining into the liver.

**PORTAL VEIN.** A large vein that carries blood from the stomach and intestines to the liver.

**PORTAL VEIN THROMBOSIS.** The development of a blood clot in the vein that brings blood into the liver. Untreated portal vein thrombosis causes portal hypertension.

**POSITRON.** One of the particles that make up an atom. A positron has the same mass and amount of charge as an electron, but the positron has a positive charge, the electron a negative one.

**POSITRON EMISSION TOMOGRAPHY (PET) SCAN.** A procedure to find malignant tumor cells in the body. A small amount of radionuclide glucose (sugar) is injected into a vein. The PET scanner rotates around the body and makes a picture of where the glucose is being used in the body. Malignant tumor cells show up brighter in the picture because they are more active and take up more glucose than normal cells.

**POSTERIOR CAPSULE OPACIFICATION (PCO).** This refers to the opacities that form on the back of the lens capsule after cataract removal or extraction. It is synonymous with a secondary cataract.

**POSTERIOR CHAMBER.** The posterior part of the eye bound by the lens in front and the retina in back. The posterior chamber is filled with a jellylike substance called the vitreous.

**POSTOPERATIVE CARE.** Medical care and support required after surgery to promote healing and recovery.

**POSTPARTUM.** After childbirth or after delivery.

**POTASSIUM.** A mineral found in whole grains, meat, legumes, and some fruits and vegetables. Potassium is important for many body processes, including proper functioning of nerves and muscles.

**PREECLAMPSIA.** A condition occurring in pregnancy in which high blood pressure leads to a number of complications, including a decreased ability of the kidneys to appropriately filter wastes from the blood.

**PREFERRED PROVIDER ORGANIZATIONS (PPOS).** Private health insurance plans that require beneficiaries to select their health care providers from a list approved by the insurance company.

**PREGNANCY CATEGORY.** A system of classifying drugs according to their established risks for use during pregnancy: category A: controlled human studies have demonstrated no fetal risk; category B: animal studies indicate no fetal risk, and there are no adequate and well-controlled studies in pregnant women; category C: no adequate human or animal studies, or adverse fetal effects in animal studies, but no available human data; category D: evidence of fetal risk, but benefits outweigh risks; category X: evidence of fetal risk, which outweigh any benefits.

**PREMATURE.** Happening early or occurring before the usual time.

**PREMIUM.** The amount paid by an insurance policyholder for insurance coverage. Most health insurance policy premiums are payable on a monthly basis.

**PREOPERATIVE.** Before surgery.

**PREPUCE.** A fold like the foreskin that covers the clitoris; another name for foreskin.

**PRESBYOPIA.** A condition affecting people over the age of 40 in which the focusing of near objects fails to work because of age-related hardening of the lens of the eye.

**PRESSURE ULCER.** Also known as a decubitus ulcer, pressure ulcers are open wounds that form whenever prolonged pressure is applied to skin covering bony outcrops of the body. Patients who are bedridden are at risk of developing pressure ulcers, commonly known as bedsores.

**PREVALENCE.** The number of cases of a disease or disorder that are present in a given population at a specific time.

**PRIMARY CARE PHYSICIAN (PCP).** A family practitioner, pediatrician, internist, or gynecologist who takes care of a patient's routine medical needs and refers him or her to a surgeon or other specialist when necessary.

**PRIMARY SNORING.** Simple snoring; snoring that is not interrupted by episodes of breathing cessation.

**PRIMARY TEETH.** A child's first set of teeth, sometimes called baby teeth.

**PROCTOSIGMOIDOSCOPY.** A visual examination of the rectum and sigmoid colon using a sigmoidoscope, also known as sigmoidoscopy.

**PROGNOSIS.** Expected resolution or outcome of an illness or injury.

**PROLAPSE.** The falling down or sinking of an internal organ or part of the body. Internal hemorrhoids may prolapse and cause a spasm of the anal sphincter muscle.

**PROLAPSED CORD.** The umbilical cord is pushed into the vagina ahead of the baby and becomes compressed, cutting off blood flow to the baby.

**PROLAPSED UTERUS.** A uterus that has slipped out of place, sometimes protruding down through the vagina.

**PROLIFERATION.** The rapid growth stage of a hemangioma.

**PROLOTHERAPY.** A technique for stimulating collagen growth in injured tissues by the injection of glycerin or dextrose.

**PRONATION.** The foot leans toward the inside of the foot, towards the center of the body.

**PROPHYLACTIC.** Intended to prevent or protect against disease.

**PROPRIETARY HOSPITALS.** Hospitals owned by private entities, mostly corporations, that are intended to make a profit as well as provide medical services. Most hospitals in health maintenance organizations and health networks are proprietary institutions.

**PROSTAGLANDINS.** A group of unsaturated fatty acids involved in the contraction of smooth muscle, control of body temperature, and other body functions.

**PROSTATE GLAND.** A gland in the male that surrounds the neck of the bladder and urethra. The prostate contributes to the seminal fluid.

**PROSTATECTOMY.** Prostate cancer surgery that includes partial or complete removal of the prostate.

**PROSTATITIS.** Inflammation of the prostate gland that may be accompanied by discomfort, pain, frequent urination, infrequent urination, and sometimes fever.

**PROSTHESIS.** A synthetic replacement for a missing part of the body such as a knee or a hip.

**PROTEIN.** A polypeptide chain, or a chain of amino acids linked together.

**PROTHROMBIN.** A protein in blood plasma that is converted to thrombin during the clotting process.

**PROTHROMBIN TEST.** A common test to measure the amount of time it takes for a patient's blood to clot; measurements are in seconds.

**PROTOZOAN.** A single-celled, usually microscopic organism that is eukaryotic and, therefore, different from bacteria (prokaryotic).

**PROXY.** A person authorized or empowered to act on behalf of another; also, the document or written authorization appointing that person.

**PRUNE BELLY SYNDROME (PBS).** A genetic disorder associated with abnormalities of human chromosomes 18 and 21. Male infants with PBS often have cryptorchidism along with other defects of the genitals and urinary tract. PBS is also known as triad syndrome and Eagle-Barrett syndrome.

**PSEUDOANEURYSM.** A dilation of a blood vessel that resembles an aneurysm.

**PSEUDOPHAKIC BULLOUS KERATOPATHY (PBK).** Painful swelling of the cornea occasionally occurring after surgery to implant an artificial lens in place of a lens affected by cataract.

**PSORIASIS.** A skin disease characterized by itchy, scaly, red patches on the skin.

**PSYCHIATRIC NURSING.** The nursing specialty concerned with the prevention and treatment of mental disorders and their consequences.

**PSYCHIATRIST.** A medical doctor (MD) who specializes in the treatment of mental health problems and can prescribe medication.

**PSYCHOACTIVE.** Affecting the mind or behavior.

**PSYCHOLOGIST.** A health care professional (PsyD or PhD) who is not a medical doctor but can evaluate or provide counseling for patients with mental health issues.

**PSYLLIUM.** The seeds of the fleawort plant, taken with water to produce a bland, jelly-like bulk which helps to move waste products through the digestive tract and prevent constipation.

**PTOSIS.** The medical term for drooping of the upper eyelid.

**PUBIS.** The front portion of the pelvis located in the anterior abdomen.

**PUBOCERVICAL FASCIA.** Fibrous tissue that separates the vagina and the bladder.

**PUBOVAGINAL SLING.** A general term for a procedure that places a sling around the urethra without the

use of tension between the sling and the urethra. The is often referred to as the Tension-Free Vaginal Tape (TVT) procedure.

**PULMONARY.** Refers to the respiratory system, or breathing function and system.

**PULMONARY ARTERY.** The major artery that carries blood from the right ventricle of the heart to the lungs.

**PULMONARY DISEASE.** Any disease involving the lungs.

**PULMONARY EMBOLISM.** Potentially life-threatening blockage of a pulmonary artery by fat, air, or a blood clot that originated elsewhere in the body. Symptoms include acute shortness of breath and sudden chest pain.

**PULMONARY EMBOLUS.** A thrombus that typically detaches from a deep vein of a lower extremity.

**PULMONARY FIBROSIS.** Chronic inflammation and progressive formation of fibrous tissue in the pulmonary alveolar walls, with steadily progressive shortness of breath, resulting in death from lack of oxygen or heart failure.

**PULMONARY FUNCTION TEST.** A test that measures the capacity and function of the lungs as well as the blood's ability to carry oxygen. During the test, the patient breathes into a device called a spirometer.

**PULMONARY HYPERPLASIA.** Underdeveloped lungs.

**PULMONARY HYPERTENSION.** Abnormally high blood pressure within the pulmonary artery.

**PULMONARY HYPOPLASIA.** Underdeveloped lungs.

**PULMONARY NODULE.** A lesion surrounded by normal lung tissue. Nodules may be caused by bacteria, fungi, or a tumor (benign or cancerous).

**PULMONARY REHABILITATION.** A program that helps patients learn how to breathe easier and improve their quality of life. Pulmonary rehabilitation includes treatment, exercise training, education, and counseling.

**PULMONARY VALVE.** The heart valve connecting the left atrium and the pulmonary arteries.

**PULMONARY VEIN ISOLATION.** A surgical procedure used to treat atrial fibrillation. During the procedure, a radio frequency probe, microwave probe, or cryoprobe is inserted and, under direct vision, used to create lesion lines in the heart to interrupt the conduction of abnormal impulses.

**PULMONOLOGIST.** A physician who specializes in caring for people with lung diseases and breathing problems.

**PULP.** The soft innermost layer of a tooth, containing blood vessels and nerves.

**PULP CHAMBER.** The area within the natural crown of a tooth occupied by dental pulp.

**PULPITIS.** Inflammation of the pulp of a tooth involving the blood vessels and nerves.

**PULSE OXIMETRY.** A non-invasive test in which a device that clips onto the finger measures the oxygen level in the blood.

**PULSUS PARADOXUS.** A variation of the systolic pressure with respiration (diminished systolic pressure with inspiration and increased pressure with expiration).

**PUNCH GRAFTING.** A method of treating a deep scar involving excision of the damaged area, followed by the suturing in of similarly shaped punch of skin that is often taken from behind the ear.

**PUPIL.** The opening in the center of the iris of the eye that allows light to enter the eye.

**PURSE-STRING CLOSURE.** A technique used to close circular or irregularly shaped wounds that involves threading the suture through the edges of the wound and pulling it taut, bringing the edges together.

**PURULENT.** Containing, consisting of or forming pus.

**PUS.** A fluid that is the product of inflammation and infection containing white blood cells and debris of dead cells and tissue.

**PYLORIC SPHINCTER.** A broad band of muscle in the pylorus valve at the bottom end of the stomach.

**PYLOROPLASTY.** Widening of the pyloric canal and any adjacent duodenal structure by means of a longitudinal incision.

**PYLORUS.** The valve at the bottom end of the stomach that releases food from the stomach into the intestines.

**PYREXIA.** A temperature of 101°F (38.3°C) or higher in an infant younger than three months or above 102°F (38.9°C) for older children and adults.



## Q

**QRST COMPLEX.** The combined waves of an electrocardiogram for monitoring the heart.

**QUADRANCTOMY.** Removal of a quadrant, or about a quarter of the breast.

**QUADRICEPS MUSCLES.** A set of four muscles on each leg located at the front of the thigh. The quadriceps straighten the knee and are used every time a person takes a step.

**QUINOLONES.** A group of synthetic antibacterial drugs originally derived from quinine. Nalidixic acid is the first quinolone that was approved for clinical use.

## R

**RADIAL.** Referring to the lower arm. The radial artery is an artery that runs from the elbow, through the wrist, and into the palm of the hand. Also, star-shaped or radiating out from a central point; used to describe the scar-folds that results from a purse-string closure.

**RADIAL ARTERY.** An artery present in the wrist that is convenient for drawing blood intended for laboratory testing.

**RADIATION THERAPY.** The use of high-energy radiation from x rays, cobalt, radium, and other sources to kill cancer cells and shrink tumors. Radiation may come from a machine outside the body (external beam radiation therapy) or from materials called radioisotopes. Radioisotopes produce radiation and are placed in or near the tumor or in the area near the cancer cells. This type of radiation treatment is called internal radiation therapy, implant radiation, interstitial radiation, or brachytherapy. Systemic radiation therapy uses a radioactive substance, such as a radio-labeled monoclonal antibody that circulates throughout the body.

**RADIO WAVES.** Electromagnetic energy of the frequency range corresponding to that used in radio communications, usually 10,000 cycles per second to 300 billion cycles per second. Radio waves are the same as visible light, x rays, and all other types of electromagnetic radiation, but are of a higher frequency.

**RADIOFREQUENCY ABLATION.** A procedure in which a catheter is guided to an area of heart where abnormal heart rhythms originate. The cells in that

area are killed using a mild radiofrequency energy to restore normal heart contractions.

**RADIOGRAPH.** The actual picture or film produced by an X-ray study.

**RADIOGRAPHICALLY DENSE.** An abundance of glandular tissue that results in diminished anatomic detail on the mammogram.

**RADIOIMAGING.** The process of using a radioactively labeled compound to visualize specific types of body tissue.

**RADIOIMMUNOASSAY.** A method that uses a radioisotope label in an immunoassay.

**RADIOLOGIC EXAMS.** The use of radiation or other imaging methods to find signs of cancer.

**RADIOLOGIST.** A medical doctor specially trained in radiology (x ray) interpretation and its use in the diagnosis of diseases and injuries.

**RADIOSURGERY.** A method of delivering radiation directly to the tumor. This method does not involve surgery and causes little damage to healthy tissue.

**RADIOTHERAPY.** The treatment of disease with high-energy radiation, such as x rays or gamma rays.

**RADIUS.** One of the two forearm bones. The largest portion of the radius is at the wrist joint where it articulates with the carpal bones of the hand. Above, the radius articulates with the humerus at the elbow joint.

**RANGE OF MOTION.** The normal extent of movement (flexion and extension) of a joint.

**RAYNAUD'S DISEASE.** A disease found mainly in young women that causes decreased circulation to the hands and feet. Its cause is unknown.

**REAL-TIME.** A type of ultrasound that takes multiple images over time in order to record movement, or the observations obtained while scanning (rather than obtained by looking at films after the procedure).

**RECEPTOR.** A sensory nerve ending that responds to chemical or other stimuli of various kinds.

**RECIPIENT.** The person who receives the donated blood marrow.

**RECTAL PROLAPSE.** Sagging or bulging of the lining of the rectum into the rectum or actually through and out of the anal opening.

**RECTOCELE.** Sagging or bulging of the rectum through the back wall of the vagina.

**RECTUM.** The last part of the large intestine (colon) that connects to the anus.

**RECTUS MUSCLES.** The muscles responsible for movement of the eye.

**RECURRENT LARYNGEAL NERVE.** A nerve which lies very near the parathyroid glands and serves the larynx or voice box.

**RECURRENT ULCER.** Stomach ulcers that return after apparently complete healing. These ulcers appear to be caused by helicobacter pylori infections and can generally be successfully treated with a combination of antibiotics and gastric acid reducing compounds, particularly the proton pump inhibitors.

**RED BLOOD CELLS.** Cells that carry hemoglobin (the molecule that transports oxygen) and help remove wastes from tissues throughout the body.

**RED CELL DISTRIBUTION WIDTH (RDW).** A measure of the variation in the size of red blood cells.

**REDUCTION.** The correction of a hernia, fracture, or dislocation.

**REFERRAL.** The process of directing a patient to a specialist for further diagnostic evaluation or treatment.

**REFLEX.** An automatic response to a stimulus.

**REFLUX.** Backflow, also called regurgitation.

**REGIONAL ANESTHESIA.** Anesthesia that does not makes the patient unconscious; it works by blocking sensation in a region of the body.

**REGISTERED NURSE.** A graduate nurse who has passed a state nursing board examination and been registered and licensed to practice nursing.

**REGULATORY ORGANIZATION.** Organization designed to maintain or control quality in health care.

**REJECTION.** Occurs when the body tries to attack a transplanted organ as a foreign object and produces antibodies to destroy it. Anti-rejection (immunosuppressive) drugs help prevent rejection.

**REMISSION.** Disappearance of the signs and symptoms of cancer. When this happens, the disease is said to be "in remission." A remission can be temporary or permanent.

**RENAL ARTERY ANEURYSM.** An aneurysm relating to, involving, or located in the region of the kidneys.

**RENAL CELL CARCINOMA.** Cancer of the kidney.

**REOPERATION.** The repeat of a surgical procedure required for a variety of reasons, from surgical failure, replacement of failed component parts, or treatment of progressive disease.

**REPERFUSION THERAPY.** Restoration of blood flow to an organ or tissue; following a heart attack, quickly opening blocked arteries to reperfuse the heart muscles to minimize damage.

**REPLANTATION.** The medical term for the reattachment of an amputated digit.

**RESECTABLE.** Part or all of an organ that can be removed by surgery.

**RESECTION.** The complete or partial removal of an organ or tissue.

**RESIDENCY TRAINING.** A five-year period of additional training that follows completion of medical school.

**RESIDUAL VOLUME.** The volume of air remaining in the lungs, measured after a maximum expiration.

**RESISTANT INFECTIONS.** Infections that are not cured by standard antibiotic treatment.

**RESISTANT ORGANISMS.** Organisms that are difficult to eradicate with antibiotics.

**RESORBED.** Absorbed by the body because of lack of function. This happens to the jawbone after tooth loss.

**RESPIRATION.** The exchange of gases between red blood cells and the atmosphere.

**RESPIRATORY ACIDOSIS.** A condition in which abnormal exchange of oxygen and carbon dioxide in the lungs results in too much carbon dioxide being accumulated, and a resultant drop in the blood pH (towards acidity).

**RESPIRATORY ALKALOSIS.** A condition in which abnormal exchange of oxygen and carbon dioxide in the lungs results in the exhalation of too much carbon dioxide, and a resultant rise in the blood pH (towards alkalinity).

**RESPIRATORY DEPRESSION.** Decreased rate (number of breaths per minute) and depth (how much air is inhaled with each breath) of breathing.

**RESPIRATORY DISTRESS SYNDROME (RDS).** Difficulty breathing; found in infants with immature lungs.

**RESPIRATORY FAILURE.** The sudden inability of the lungs to provide normal oxygen delivery or normal carbon dioxide removal.

**RESPIRATORY FUNCTION.** The ability of the breathing structures of the body, including the lungs, to function.

**RESPIRATORY INFECTIONS.** Infections that relate to or affect respiration or breathing.

**RESPIRATORY THERAPIST.** A health care professional who specializes in assessing, treating, and educating people with lung diseases.

**RESPIRATORY THERAPY.** The department of any health care facility or agency that provides treatment to patients to maintain or improve their breathing function.

**RESTENOSIS.** The repeat narrowing of blood vessels that may occur after surgical removal of plaque when preventive measures are not taken.

**RESTRAINT.** A physical device or a medication designed to restrict a person's movement.

**RESTRICTIVE.** A type of bariatric surgery that works by limiting the amount of food that the stomach can hold. Vertical banded gastroplasty is a restrictive procedure.

**RESUSCITATION.** Reviving an unconscious person or restoring breathing.

**RETINA.** The light-sensing tissue within the eye that sends signals to the brain in order to generate a visual image.

**RETINAL DETACHMENT.** A serious vision disorder in which the light-detecting layer of cells inside the eye (retina) is separated from its normal support tissue and no longer functions properly.

**RETINOBLASTOMA.** Malignant (cancerous) tumor of the retina.

**RETINOPATHY OF PREMATURITY (ROP).** A disorder that occurs in premature infants in which blood vessels in the eye continue to grow in an abnormal pattern after delivery. It can lead to retinal detachment and blindness. ROP is also known as retrolental fibroplasia.

**RETRACTOR.** An instrument used during surgery to hold an incision open and pull back underlying layers of tissue.

**RETROBULBAR HEMATOMA.** A rare complication of blepharoplasty, in which a pocket of blood forms behind the eyeball.

**RETROGRADE PYELOGRAPHY.** A test in which dye is injected through a catheter placed with a cystoscope

into the ureter to make the lining of the bladder, ureters, and kidneys easier to see on x rays.

**RETROPUBIC URETHROPEXY.** A generic term for the Burch procedure and its variants that treat mild stress incontinence by stabilizing the urethra with retropubic surgery.

**REVASCULARIZATION.** Restoring the body's blood flow after an interruption or blockage has disrupted normal circulation.

**REYE'S SYNDROME.** A life-threatening disease that affects the liver and the brain and sometimes occurs after a viral infection, such as flu or chickenpox. Children or teenagers who are given aspirin for flu or chickenpox are at increased risk of developing Reye's syndrome.

**RH (RHESUS) FACTOR.** An antigen present in the red blood cells of 85% of humans. A person with Rh factor is Rh positive (Rh+); a person without it is Rh negative (Rh-). The Rh factor was first identified in the blood of a rhesus monkey.

**RH BLOOD TYPE.** In general, refers to the blood type based on the presence or absence of the D antigen on the red blood cells. There are, however, other antigens in the Rh system.

**RH NEGATIVE.** Lacking the Rh factor, which are genetically determined antigens in red blood cells that produce immune responses. If an Rh-negative woman is pregnant with an Rh-positive fetus, her body will produce antibodies against the fetus's blood, causing a disease known as Rh disease. Sensitization to the disease occurs when the woman's blood is exposed to the fetus's blood. Rh immune globulin (RhoGAM) is a vaccine that must be given to a woman after an abortion, miscarriage, or prenatal tests in order to prevent sensitization to Rh disease.

**RHABDOMYOLYSIS.** A condition causing the rapid breakdown of muscle tissue that may be caused by severe injuries or toxic chemicals. It causes the release of muscle tissue breakdown products into the blood in such excess that it may lead to acute renal failure.

**RHEUMATIC CARDITIS.** Inflammation of the heart muscle associated with acute rheumatic fever.

**RHEUMATIC FEVER.** An inflammatory disease that arises as a complication of untreated or inadequately treated strep throat infection. Rheumatic fever can seriously damage the heart valves.

**RHEUMATOID ARTHRITIS.** A condition in which the immune system damages and destroys the synovial lining of the joints. Red, warm, swollen, stiff joints

are a common symptom. Over time, other organ systems may also be affected, including the heart, eyes, lungs, and kidneys.

**RHINITIS.** Inflammation of the membranes inside the nose.

**RHINOPLASTY.** Surgery performed to change the shape of the nose.

**RHYTIDECTOMY.** Wrinkle excision. It is an older, alternative term for a face lift.

**RHYTIDES.** Very fine wrinkles, often of the face.

**RICKETTSIA (PLURAL, RICKETTSIAE).** A microorganism belonging to a subtype of gram-negative bacteria that multiply only within the cells of a living host. Rickettsiae are usually transmitted to humans and other animals through the bites of ticks, fleas, and lice. They are named for Howard Ricketts (1871–1910), an American doctor.

**ROCKY MOUNTAIN SPOTTED FEVER.** An infectious disease that is caused by a rickettsia and spread by ticks. Its symptoms include high fever, muscle pain, and spots on the skin.

**ROOT CANAL.** The space within a tooth that runs from the pulp chamber to the tip of the root.

**ROOT CANAL TREATMENT.** The process of removing diseased or damaged pulp from a tooth, then filling and sealing the pulp chamber and root canals.

**ROSACEA.** A disease of the skin marked by constant flushing and acne-like lesions.

**ROTABLATION.** A nonsurgical technique for treating diseased arteries in which a special catheter with a diamond-coated tip is guided to the point of narrowing in the artery. The catheter tip spins at high speed and grinds away the blockage or plaque on the artery walls.

**ROUTINE TEST.** A medical test performed on all patients without regard to specific medical conditions.

**RUPTURE.** The bursting of a blood vessel or organ that has suffered enlargement, bulging, and weakening from unusual pressure.

## S

**SACRAL NERVE.** The nerve in the lower back region of the spine that controls the need to urinate.

**SALICYLATES.** A group of drugs that includes aspirin and related compounds; used to relieve pain, reduce inflammation, and lower fever.

**SALIVARY GLANDS.** Three pairs of glands that secrete into the mouth and aid digestion.

**SALPINGECTOMY.** The surgical removal of a fallopian tube.

**SANITIZE.** To reduce the number of microorganisms to safe levels.

**SAPHENOUS VEIN.** A long vein in the thigh or calf commonly used for bypass grafts.

**SARCOIDOSIS.** A chronic disease with unknown cause that involves formation of nodules in bones, skin, lymph nodes, and lungs.

**SARCOMA.** A form of cancer that arises in the supportive tissues such as bone, cartilage, fat, or muscle.

**SCALING AND ROOT PLANING.** A dental procedure to treat gingivitis in which the teeth are scraped inside the gum area and the root of the tooth is planed to dislodge bacterial deposits.

**SCAPULA.** A large, flat, triangular bone that forms the back portion of the shoulder. It articulates with the clavicle (at the acromion process) and the humerus (at the glenoid). Also called the shoulder blade.

**SCAR TISSUE.** Scar tissue is the fibrous tissue that replaces normal tissue destroyed by injury or disease.

**SCHLEMM'S CANAL.** A circular channel located at the point where the sclera of the eye meets the cornea. Schlemm's canal is the primary pathway for aqueous humor to leave the eye.

**SCIATICA.** Pain in the lower back, buttock, or leg along the course of the sciatic nerve.

**SCLERA.** The tough, fibrous, white outer protective covering of the eyeball.

**SCLEROSANT.** An irritating solution that stops bleeding by hardening the blood or vein it is injected into.

**SCLEROSE.** To harden or undergo hardening. Sclerosing agents are chemicals that are used in sclerotherapy to cause swollen veins to fill with fibrous tissue and close down.

**SCLEROTHERAPY.** A technique for shrinking hemorrhoids by injecting an irritating chemical into the blood vessels.



**SCROTUM.** The external pouch containing the male reproductive glands (testes) and part of the spermatic cord.

**SEDATION.** A condition of calm or relaxation, brought about by the use of a drug or medication.

**SEDATIVE.** A type of medication given to calm or relax patients before surgery.

**SEDENTARY.** Characterized by inactivity and lack of exercise. A sedentary lifestyle is a risk factor for high blood cholesterol levels.

**SEIZURES.** Attacks consisting of sudden and abnormal muscle, sensory, or psychic events resulting from transient dysfunction of the brain.

**SENSORINEURAL DEAFNESS.** Hearing loss due to the inability to convert sound from vibration to electrical signals. Often involves defects in the function of cochlear hair cells.

**SENTINEL LYMPH NODE.** The lymph node(s) closest to a cancerous tumor. They are the first nodes that receive lymphatic drainage from the tissues surrounding the tumor.

**SEPARATION ANXIETY.** A fear of being separated from a parent or loved one; a normal developmental process, occurring at certain points in a young child's life.

**SEPSIS.** A dangerous physiological state of extensive, systemic bacterial infection.

**SEPTAL DEFECTS.** Openings in the septum, the muscular wall separating the right and left sides of the heart. Atrial septal defects are openings between the two upper heart chambers and ventricular septal defects are openings between the two lower heart chambers.

**SEPTAL MUCOSA.** The epithelium in the nasal mucosa.

**SEPTIC ARTHRITIS.** A pus-forming bacterial infection of a joint.

**SEPTICEMIA.** Systemic disease associated with the presence and persistence of pathogenic microorganisms or their toxins in the blood.

**SEPTUM (PLURAL, SEPTA).** The dividing partition in the nose that separates the two nostrils. It is composed of bone and cartilage. Also, an extra fold of tissue down the center of the uterus; this tissue can be removed with a wire electrode and a hysteroscope. Also, the muscular wall that separates the two sides of the heart; an opening in the septum that allows

blood to flow from one side to the other is called a septal defect.

**SEQUELA (PLURAL, SEQUELAE).** An abnormal condition or event resulting from a previous disease or disorder.

**SEQUESTRATION.** A process in which the spleen withdraws blood cells from the circulation and stores them.

**SERIAL X RAYS.** A number of x rays performed at set times in the disease progression or treatment intervals. The radiographs will be compared to one another to track changes.

**SEROMA.** A collection of blood serum or lymphatic fluid in body tissues. It is an occasional complication of vascular surgery.

**SERUM (PLURAL, SERA).** The clear fluid that separates from blood when the blood is allowed to clot completely. Blood serum can also be defined as blood plasma from which fibrinogen has been removed.

**SERUM ALBUMIN.** A crystallizable albumin or mixture of albumins that normally constitutes more than half of the protein in blood serum and serves to maintain the osmotic pressure of the blood.

**SESTAMIBI.** A type of radioimaging pharmaceutical compound that has been deemed medically safe to use in the human body for sestamibi scans.

**SETBACK OTOPLASTY.** A surgical procedure done to reduce the size or improve the appearance of large or protruding ears; it is also known as pinback otoplasty.

**SETON TUBE.** An implant placed in the eye that provides an alternative route for aqueous fluid drainage.

**SEXUALLY TRANSMITTED DISEASE (STD).** A disease that is passed from one person to another through sexual intercourse or other intimate sexual contact.

**SHARPS.** A general term for needles, lancets, scalpel blades, and other medical devices with points or sharp edges requiring special disposal precautions.

**SHINGLES.** A disease caused the Herpes zoster virus—the same virus that causes chickenpox. Symptoms of shingles include pain and blisters along one nerve, usually on the face, chest, stomach, or back.

**SHOCK.** A serious condition in which the body's blood circulation and metabolism is severely impaired by injury, pain, blood loss, or certain diseases. The symptoms of shock include a pale complexion, very low blood pressure, and a weak pulse.

**SHORT BOWEL SYNDROME.** A condition in which digestion and absorption in the small intestine are impaired.

**SHOULDER RESECTION ARTHROPLASTY.** Surgery performed to repair a shoulder acromioclavicular (AC) joint. The procedure is most commonly recommended for AC joint problems resulting from osteoarthritis or injury.

**SHUNT.** A channel through which blood or another body fluid is diverted from its normal path by surgical reconstruction or the insertion of a synthetic tube.

**SICKLE CELL DISEASE.** Also called sickle cell anemia. An inherited disorder characterized by a genetic flaw in hemoglobin production. (Hemoglobin is the substance within red blood cells that enables them to transport oxygen.) The hemoglobin that is produced has a kink in its structure that forces the red blood cells to take on a sickle shape, inhibiting their circulation and causing pain. This disorder primarily affects people of African descent.

**SIGMOID COLON.** The last third of the intestinal tract that is attached to the rectum.

**SIGMOID SINUS.** An S-shaped cavity on the inner side of the skull behind the mastoid process.

**SIGMOIDOSCOPY.** Endoscopic examination of the lower colon.

**SILICOSIS.** A progressive disease that results in impairment of lung function and is caused by inhalation of dust containing silica.

**SIMPLE OBSTRUCTION.** A blockage in the intestine that does not affect the flow of blood to the area.

**SIMULATION SCAN.** The process of making a mask for the patient and other images in order to plan the radiation treatment.

**SINOATRIAL NODE.** Specialized tissue in the right atrium that initiates electrical activity in the heart.

**SINUS.** A cavity in a bone of the skull that usually communicates with the nostrils and contains air.

**SINUSITIS.** Inflammation of the sinuses.

**SITZ BATH.** A shallow tub or bowl, sometimes mounted above a toilet, that allows the perineum and buttocks to be immersed in circulating water.

**SJÖGREN'S SYNDROME.** A disease in which the immune system damages and destroys exocrine glands, such as those that produce tears and saliva. Dry eyes and mouth are the usual initial symptoms of

this disorder, but other organ systems can also be severely affected over time, including the skin, pancreas, liver, lungs, brain, and kidneys.

**SKELETAL TRACTION.** Traction in which pins, screws, or wires are surgically connected to bone to which weights or pulleys are attached to exert force.

**SKILLED NURSING FACILITY (SNF).** A facility equipped to handle individuals with 24-hour nursing needs, postoperative recuperation, or complex medical care demands, as well as chronically-ill individuals who can no longer live independently. These facilities must be licensed by the state in which they operate to meet standards of safety, staffing, and care procedures. Another name for a nursing home.

**SKIN FLAP.** A piece of skin with underlying tissue that is used in grafting to cover a defect and that receives its blood supply from a source other than the tissue on which it is laid.

**SKIN TRACTION.** Traction in which weights or other devices are attached to the skin.

**SLEEP APNEA SYNDROME.** A disorder in which the patient's breathing temporarily stops at intervals during the night due to obstruction of the upper airway. People with sleep apnea syndrome do not get enough oxygen in their blood and often develop heart problems.

**SLIDING GENIOPLASTY.** A complex plastic surgery procedure in which the patient's jawbone is cut, moved forward or backward, and repositioned with metal plates and screws.

**SMALL INTESTINE.** The small intestine consists of three sections: duodenum, jejunum and ileum, all of which are involved in the absorption of nutrients. The total length of the small intestine is approximately 22 ft (6.5 m).

**SMOKING CESSATION.** The act of quitting smoking or withdrawal from nicotine.

**SOCIAL WORKER.** A health care provider who can provide support to patients and families, including assistance with a patient's psychosocial adjustment needs and referrals for community support.

**SOFT TISSUE.** Layers of cells that form the skin.

**SOMATIZATION DISORDER.** A chronic condition in which psychological stresses are converted into physical symptoms that interfere with work and relationships. Lower back pain is a frequent complaint of patients with somatization disorder.

**SOMNOPLASTY.** A technique that uses radiofrequency signals to heat a thin needle inserted into the tissues of the soft palate. The heat from the needle shrinks the tissues, thus enlarging the patient's airway. Somnoplasty is also known as radiofrequency volumetric tissue reduction (RFVTR).

**SONOGRAM.** Image, or picture, obtained when using a machine called an ultrasound to look inside the uterus when the mother is pregnant. It is a painless procedure that sends out sound waves to the baby, and as the sound waves bounce off the object—the baby—an image is created on a monitor.

**SONOGRAPHER.** A technologist or physician who uses an ultrasound unit to take ultrasound images of patients.

**SORBENT.** A material used during hemoperfusion to adsorb toxic or waste substances from the blood. Most hemoperfusion systems use resin or activated carbon as sorbents.

**SPASM.** Sudden, involuntary tensing of a muscle or a group of muscles.

**SPECIFIC GRAVITY.** The ratio of the weight of a body fluid when compared with water.

**SPECULUM.** A retractor used to separate the walls of the vagina and aid in visual examination.

**SPEECH-LANGUAGE PATHOLOGY.** Formerly known as speech therapy, it includes the study and treatment of human communication—its development and disorders.

**SPERM GRANULOMA.** A collection of fluid that leaks from an improperly sealed or tied vas deferens. The fluid usually disappears on its own, but can be drained, if necessary.

**SPERMATIC CORD.** A tube-like structure that extends from the testicle to the groin area. It contains blood vessels, nerves, and a duct to carry spermatic fluid.

**SPHENOIDAL ELECTRODES.** Fine wire electrodes that are implanted under the cheek bones, used to measure temporal seizures.

**SPHINCTER.** A circular band of muscle fibers that constricts or closes a passageway in the body. The esophagus has sphincters at its upper and lower ends.

**SPHINCTER DEFICIENCY.** A term related both to urinary and fecal incontinence in which the inability of the sphincter to keep the reservoir closed is a source of severe incontinence.

**SPIDER NEVUS (PLURAL, NEVI).** A reddish lesion that consists of a central arteriole with smaller branches radiating outward from it. Spider nevi are also called spider angiomas; they are most common in small children and pregnant women.

**SPIDER VEINS.** Telangiectasias that appear on the surface of the legs, characterized by a reddish central point with smaller veins branching out from it like the legs of a spider.

**SPINA BIFIDA.** A congenital defect in the spinal column, characterized by the absence of the vertebral arches through which the spinal membranes and spinal cord may protrude.

**SPINAL ANESTHESIA.** Involves inserting a needle into a region between the vertebrae of the lower back and injecting numbing medications.

**SPINAL CANAL.** The cavity or hollow space within the spine that contains the spinal cord and the cerebrospinal fluid.

**SPINAL FUSION.** An operation in which the bones of the spine are permanently joined together using a bone graft obtained usually from the hip.

**SPINAL STENOSIS.** Narrowing of the canals in the vertebrae or around the nerve roots, causing pressure on the spinal cord and nerves.

**SPIRAL CT.** Also referred to as helical CT, this method allows for continuous 360-degree X-ray image capture.

**SPIROCHETE.** A spiral-shaped bacterium. Spirochetes cause such diseases as syphilis and Lyme disease.

**SPLEEN.** An organ that traps and breaks down red blood cells at the end of their useful life and manufactures some key substances used by the immune system.

**SPLENOMEGALY.** Enlargement of the spleen.

**SPLINT.** A thin piece of rigid material that is sometimes used during nasal surgery to hold certain structures in place until healing is underway.

**SPONGES.** Pieces of absorbent material, usually cotton gauze, used to absorb fluids, protect tissue, or apply pressure and traction.

**SPURS.** A sharp horny outgrowth of the skin.

**SPUTUM.** A mucus-rich secretion that is coughed up from the passageways (bronchial tubes) and the lungs.

**SPUTUM CYTOLOGY.** A lab test in which a microscope is used to check for cancer cells in the sputum.

**SQUAMOUS CELL CANCER.** A form of skin cancer that usually originates in sun-damaged areas or pre-existing lesions; at first local and superficial, it may later spread to other areas of the body.

**SQUAMOUS CELLS.** Scaly or plate-like cells.

**STABILIZER.** A device used to depress the movement of the area around the coronary artery where the anastomosis is made. The stabilizer is used to provide a still, motionless field for suturing.

**STAGHORN CALCULUS.** A kidney stone that develops a branched shape resembling the antlers of a stag. Staghorn calculi are composed of struvite.

**STAGING.** The classification of cancers according to the extent of the tumor.

**STAHL'S DEFORMITY.** A congenital deformity of the ear characterized by a flattened rim and pointed upper edge caused by a fold in the cartilage; it is also known as Vulcan ear or Spock ear.

**STAPEDOTOMY.** A procedure in which a small hole is cut in the footplate of the stapes.

**STAPH INFECTION.** Infection with *Staphylococcus* bacteria. These bacteria can infect any part of the body.

**STAPHYLOCOCCAL INFECTION.** An infection caused by any of several pathogenic species of *Staphylococcus*, commonly characterized by the formation of abscesses in the skin or other organs.

**STEATORRHEA.** An excess of fat in the stool.

**STEM CELLS.** Unspecialized cells, or “immature” blood cells, that serve as the precursors of white blood cells, red blood cells, and platelets.

**STENOSIS (PLURAL, STENOSES).** The narrowing or constriction of an opening or passageway in the body.

**STENT.** A tube made of metal or plastic that is inserted into a vessel or passage to keep it open and prevent closure.

**STEREOTACTIC.** Characterized by precise positioning in space. When applied to radiosurgery, stereotactic refers to a system of three-dimensional coordinates for locating the target site.

**STERILE.** Free from living microorganisms.

**STERILIZATION.** To make sterile, meaning to deprive of the power of reproducing.

**STERNOTOMY.** A surgical opening into the thoracic cavity through the sternum (breastbone).

**STERNOXIPHOID JUNCTION.** The lower junction of the sternum or breastbone.

**STERNUM.** The breastbone. It connects to ribs one through seven on either side of the chest.

**STEROIDS.** A component of commonly used immunosuppressive drugs that have negative effects on insulin production.

**STETHOSCOPE.** A rubber Y-shaped device used to listen to sounds produced by the human body.

**STEVENS-JOHNSON SYNDROME.** A severe inflammatory reaction that is sometimes triggered by sulfa medications. It is characterized by blisters and eroded areas in the mouth, nose, eyes, and anus; it may also involve the lungs, heart, and digestive tract. Stevens-Johnson syndrome is also known as erythema multiforme.

**STIMULANT.** A drug or other substance that increases the rate of activity of a body system.

**STIMULUS.** A factor capable of eliciting a response in a nerve.

**STOCKINETTE.** A soft elastic material used for bandages and clothing for infants.

**STOMA (PLURAL, STOMATA).** A surgically created opening in the abdominal wall to allow digestive wastes to pass to the outside of the body.

**STOOL.** The solid waste that is left after food is digested. Stool forms in the intestines and passes out of the body through the anus.

**STRABISMUS.** A condition in which the muscles of the eye do not work together, often causing double vision.

**STRANGULATED HERNIA.** A twisted piece of herniated intestine that can block blood flow to the intestines.

**STRANGULATION.** A condition in which a vessel, section of the intestine, or other body part is compressed or constricted to the point that blood cannot circulate.

**STREP THROAT.** A sore throat caused by infection with *Streptococcus* bacteria. Symptoms include sore throat, chills, fever, and swollen lymph nodes in the neck.

**STREPTOCOCCAL INFECTION.** An infection caused by a pathogenic bacterium of one of several species of



the genus *Streptococcus* or their toxins. Almost any organ in the body may be involved.

**STRESS INCONTINENCE.** Involuntary loss of urine that occurs during physical activity such as coughing, sneezing, laughing, or exercise.

**STRESS TEST.** A test used to determine how the heart responds to stress. It usually involves walking on a treadmill or riding a stationary bike at increasing levels of difficulty, while the electrocardiogram, heart rate and blood pressure are monitored. If the patient is unable to walk on a treadmill or ride a stationary bike, medications may be used to produce similar results.

**STRESS ULCERS.** Stomach ulcers that occur in connection with some types of physical injury, including burns and invasive surgical procedures.

**STRICTURE.** An abnormal narrowing of a body canal or opening. A stricture may also be called a stenosis.

**STROKE.** An event causing impairment of blood circulation to the brain, causing death of brain tissue and potentially drastically affecting mental functioning.

**STROMA.** The thickest part of the cornea between Bowman's membrane and Decemet's membrane.

**STRUVITE.** A crystalline form of magnesium ammonium phosphate. Kidney stones made of struvite form in urine with a pH above 7.2.

**SUB-FERTILITY.** A decreased ability to become pregnant.

**SUBARACHNOID HEMORRHAGE.** Bleeding from a ruptured blood vessel in the brain that contaminates the cerebrospinal fluid.

**SUBARACHNOID SPACE.** A space between membranes that covers and protects the brain.

**SUBCAPSULAR.** Inside the outer tissue covering of the testicle. A subcapsular orchiectomy is a procedure in which the surgeon removes the inner glandular tissue of the testicle while leaving the outer capsule intact.

**SUBCUTANEOUS.** Beneath the skin.

**SUBCUTANEOUS EMPHYSEMA.** A pathologic accumulation of air underneath the skin resulting from improper insufflation technique.

**SUBDURAL ELECTRODES.** Strip electrodes that are placed under dura mater (the outermost, toughest, and most fibrous of the three membranes [meninges] covering the brain and spinal cord). They are used to

locate foci of epileptic seizures prior to epilepsy surgery.

**SUBGLOTTIC STENOSIS.** An abnormal narrowing of the trachea below the level of the vocal cords.

**SUBLINGUAL.** Under the tongue.

**SUBMENTAL.** Underneath the chin.

**SUBSTRATE.** A substance acted upon by an enzyme.

**SUPERIOR VENA CAVA.** Large vein that returns blood to the heart from the head, neck, and upper limbs.

**SUPINE.** Lying horizontally on one's back.

**SUPPLEMENTAL SECURITY INCOME (SSI).** A federal entitlement program that provides cash assistance to low-income blind, disabled, and elderly people. In most states, people receiving SSI benefits are eligible for Medicaid.

**SUPRAVENTRICULAR TACHYCARDIA (SVT).** A fast heartbeat that originates above the ventricles.

**SURFACTANT.** A compound made of fats and proteins that is found in a thin film along the walls of the air sacs of the lungs. Surfactant keeps the surface pressure low so that the sacs can inflate easily and not collapse.

**SURGEON.** A physician that has completed surgical residency training, passed all examinations and is a Fellow of the American College of Surgeons.

**SURGICAL ALTERNATIVES.** Surgical options within a range of surgical procedures used to treat a specific condition.

**SURGICAL REVISION.** The failure of a procedure, which requires surgery be performed to improve the result.

**SURGICENTER.** Another term for ambulatory surgical center.

**SURROGATE.** A person who represents the wishes of the patient, chosen by the patient and stipulated by a legal document as power of attorney.

**SUTURES.** Stiches that are used in surgical procedures to bring two pieces of flesh together or close a wound.

**SWAGED NEEDLE.** An eyeless surgical needle with the suture material preattached by the manufacturer. Most surgical needles used in the early 2000s are swaged needles.

**SWAN-GANZ CATHETER.** Also called a pulmonary artery catheter. This type of catheter is inserted into a large vessel in the neck or chest and is used to measure the amount of fluid in the heart and to determine how well the heart is functioning.

**SYMPATHETIC NERVOUS SYSTEM.** The part of the autonomic nervous system that is concerned with preparing the body to react to situations of stress or emergency; it contains chiefly adrenergic fibers and tends to depress secretion, decrease the tone and contractility of smooth muscle, and increase heart rate.

**SYMPATHOMIMETIC DRUGS.** Another name for adrenergic drugs.

**SYNCHRONIZED ELECTRICAL CARDIOVERSION.** The term used to describe cardioversion by the application of a controlled electric shock to the patient's chest.

**SYNCOPE.** A fainting episode.

**SYNDACTYLY.** A developmental abnormality in which two or more fingers or toes are joined by webbing between the digits.

**SYNDROME.** A set of signs or a series of events occurring together that often point to a single disease or condition as the cause.

**SYNERGISTIC.** Enhancing the effects of another drug. Anesthetics given in combination are often synergistic.

**SYNGENEIC.** Referring to a bone marrow transplant from one identical twin to the other.

**SYNOVIAL FLUID.** A fluid that lubricates the joint and helps prevent wear on the bones.

**SYNOVITIS.** Inflammation of the synovium, the thin membrane lining the joint.

**SYSTEMIC CIRCULATION.** Circulation supplied by the aorta including all tissue and organ beds, except the alveolar sacs of the lungs used for gas exchange and respiration.

**SYSTEMS ANALYSIS.** An approach to medical errors and other management issues that looks for problems in the work process rather than singling out individuals as bad or incompetent.

**SYSTOLE.** Period while the heart is contracting.

**SYSTOLIC.** Maximum arterial blood pressure during ventricular contraction.

## T

**T CELLS.** Any of several lymphocytes that have specific antigen receptors, and are involved in cell-mediated immunity and the destruction of antigen-bearing cells.

**TACHYCARDIA.** Rapid heart beat, generally over 100 beats per minute.

**TACTILE FREMITUS.** A tremor or vibration in any part of the body detected by palpation (palpation is when the clinician gently feels or presses with hands).

**TARDIVE DYSKINESIA.** A disorder brought on by certain medications that is characterized by uncontrollable muscle spasms.

**TAY-SACHS DISEASE.** An inherited disease prevalent among the Ashkenazi Jewish population of the United States. Infants with the disease are unable to process a certain type of fat that accumulates in nerve and brain cells, causing mental and physical retardation, and death by age four.

**TEACHING HOSPITALS.** Hospitals whose primary mission is training medical personnel in collaboration with (or ownership by) a medical school or research center.

**TELANGIECTASIA.** The medical term for the visible discolorations produced by permanently swollen capillaries and smaller veins.

**TEMPLATING.** A term that refers to the surgeon's use of x-ray images of an old prosthesis as a template or pattern guide for a new implant.

**TEMPORAL ARTERITIS.** A condition in which inflammation of the blood vessels that supply the head and neck result in severe, chronic headache, particularly over one temple, as well as fever, weight loss, and severe fatigue.

**TEMPORAL LOBE EPILEPSY (TLE).** The most common type of epilepsy, with elaborate and multiple sensory, motor, and psychic symptoms. A common feature is the loss of consciousness and amnesia during seizures. Other manifestations may include more complex behaviors like bursts of anger, emotional outbursts, fear, or automatisms.

**TENACULUM (PLURAL, TENACULA).** A small, sharp-pointed hook set in a handle, used to seize or pick up pieces of tissue during surgical operations.

**TENDINITIS.** Inflammation of a tendon—a tough band of tissue that connects muscle to bone.

**TENDON.** A fibrous cord of strong connective tissue that connects muscle to bone.

**TESTICLES.** The two egg-shaped organs found in the scrotum that produce sperm.

**TESTICULAR TORSION.** Twisting of the testicle around the spermatic cord, cutting off the blood supply to the testicle. It is considered a urologic emergency.

**TESTIS (PLURAL, TESTES).** The medical term for a testicle.

**TESTOSTERONE.** The major male sex hormone, produced in the testes.

**TETANUS.** A potentially deadly disease produced by a bacterium that may infect crush injuries or penetrating wounds.

**TETANY.** Inappropriately sustained muscle spasms.

**TETRALOGY OF FALLOT.** A cyanotic defect in which the blood pumped through the body has too little oxygen. Tetralogy of Fallot includes four defects: a ventricular septal defect, narrowing at or beneath the pulmonary valve, infundibular pulmonary stenosis (obstruction of blood flow out of the right ventricle through the pulmonary valve), and overriding aorta (the aorta crosses the ventricular septal defect into the right ventricle).

**THALASSEMIA.** A group of inherited disorders that affects hemoglobin production. Because hemoglobin production is impaired, a person with this disorder may suffer mild to severe anemia. Certain types of thalassemia can be fatal.

**THORACENTESIS.** Removal of fluid from the pleural cavity.

**THORACIC.** Pertaining to the chest cavity, including the lungs and the area around the lungs.

**THORACIC AORTIC ANEURYSM.** Occurs when an area in the thoracic section of the aorta (the chest) is weakened and bulges like a balloon. The thoracic section supplies blood to the upper body.

**THORACIC VERTEBRAE.** The vertebrae in the chest region to which the ribs attach.

**THORACOTOMY.** A surgical opening into the thoracic cavity.

**THORASCOPY.** Examination of the chest through a tiny incision using a thin, lighted tube-like instrument (thorascopy).

**THORAX.** The chest area, which runs between the abdomen and neck and is encased in the ribs.

**THROMBIN.** An enzyme in blood plasma that helps to convert fibrinogen to fibrin during the last stage of the clotting process.

**THROMBIN INHIBITOR.** One type of anticoagulant medication used to help prevent formation of harmful blood clots in the body by blocking the activity of thrombin.

**THROMBOCYTOPENIA.** A disorder characterized by a drop in the number of platelets in the blood.

**THROMBOCYTOSIS.** A vascular condition characterized by high blood platelet counts.

**THROMBOEMBOLISM.** A blood clot that originates in one area of the body, but travels through the venous system to another area, where it obstructs blood flow. This is particularly problematic when the thromboembolus lodges in the lung.

**THROMBOLYSIS.** A treatment that opens up blood flow and may prevent permanent damage to the blood vessels.

**THROMBOPHLEBITIS.** A condition in which blood clots form in veins near surgery site, causing swelling and pain; clots may travel via veins to the heart or lungs causing serious complications.

**THROMBOPLASTIN.** A protein in blood that converts prothrombin to thrombin.

**THROMBOSED.** Affected by the formation of a blood clot, or thrombus, along the wall of a blood vessel. Some external hemorrhoids become thrombosed.

**THROMBOSIS.** The formation or presence of a blood clot within a blood vessel.

**THROMBUS.** A blood clot that is blocking a blood vessel.

**THYMUS.** An unpaired organ in the mediastinal cavity that is important in the body's immune response.

**THYROID CARTILAGE.** The largest cartilage in the human larynx, or voice box. It is sometimes called the Adam's apple.

**THYROID DYSFUNCTION.** A physical state that involves the failure of the thyroid gland to function properly. Thyroid dysfunction not only affects a person's physical state, but may have secondary effects on their mental state as well.

**THYROID GLAND.** An endocrine organ in the neck which produces thyroid hormone. Thyroid hormone is involved in important growth and metabolic processes throughout the body.

**THYROID STORM.** An unusual complication of thyroid function that is sometimes triggered by the stress of thyroid surgery. It is a medical emergency.

**TIBIA.** The larger of two leg bones that lie beneath the knee. The tibia is sometimes called the shin bone.

**TINNITUS.** A sensation of noise in the ears, usually a buzzing, ringing, clicking, or roaring sound.

**TOCOLYTICS.** Drugs administered to stop or delay the onset of labor.

**TOLERANCE.** A decrease in sensitivity to a drug. When tolerance occurs, a person must take more of the drug to get the same effect.

**TONOMETRY.** Measurement of the fluid pressure inside the eye.

**TONSILLECTOMY.** Surgical removal of the tonsils.

**TONSILLITIS.** Inflammation of a tonsil, a small mass of tissue in the throat.

**TONSILS.** Oval masses of lymphoid tissue on each side of the throat.

**TOPICAL.** Applied to the skin surface.

**TOTAL LUNG CAPACITY TEST.** A test that measures the amount of air in the lungs after a person has breathed in as much as possible.

**TOURNIQUET.** Any device that is used to compress a blood vessel to stop bleeding or as part of collecting a blood sample. Phlebotomists usually use an elastic band as a tourniquet.

**TRABECULAR MESHWORK.** Area of fibrous tissue that forms a canal between the iris and cornea, through which aqueous humor flows.

**TRABECULOPLASTY.** Laser surgery that creates perforations in the trabeculum, to drain built-up aqueous humor and relieve pressure.

**TRACHEA.** The windpipe; a tough, fibrocartilaginous tube passing from the larynx to the bronchi before the lungs.

**TRACHEOBRONCHIAL.** Pertaining both to the tracheal and bronchial tubes or to their junction.

**TRACHEOSTOMY TUBE.** A breathing tube inserted in the neck, used when assisted breathing is needed for a long period of time.

**TRACHEOTOMY.** The surgical creation of an opening into the windpipe through the neck; it is also called a tracheostomy.

**TRANQUILIZER.** Medicine that has a calming effect and is used to treat anxiety and mental tension.

**TRANSCONJUNCTIVAL BLEPHAROPLASTY.** A type of blepharoplasty in which the surgeon makes no incision on the surface of the eyelid, but, instead, enters from behind to tease out the fat deposits.

**TRANSDUCER.** The handheld part of the ultrasound unit that produces the ultrasound waves and receives the ultrasound echos.

**TRANSESOPHAGEAL ECHOCARDIOGRAM (TEE).** An invasive imaging procedure used to create a picture of the heart's movement, valves, and chambers. The test uses high-frequency sound waves that come from a small transducer passed down the patient's throat. TEE may be used in combination with Doppler ultrasound to evaluate the blood flow across the heart's valves.

**TRANSFUSION.** The therapeutic introduction of blood or a blood component into a patient's bloodstream.

**TRANSILLUMINATION.** A technique in which the doctor shines a strong light through body tissues in order to examine an organ or structure.

**TRANSPLANTATION.** Surgically cutting out hair follicles and replanting them in a different spot on the head.

**TRANSPOSITION OF THE GREAT VESSELS.** A cyanotic defect in which the blood pumped through the body has too little oxygen because the pulmonary artery receives its blood incorrectly from the left ventricle and the aorta incorrectly receives blood flow from the right ventricle.

**TRANSSEXUAL.** Person desiring to acquire the external appearance of a member of the opposite gender.

**TRANSTRACHEAL JET VENTILATION (TTJV).** A technique for ventilating a patient that involves passing oxygen under pressure through a catheter that has been passed through the patient's cricothyroid membrane.

**TRANSURETHRAL SURGERY.** Surgery in which no external incision is needed. For prostate transurethral surgery, the surgeon reaches the prostate by inserting an instrument through the urethra.

**TRANSVERSE PRESENTATION.** The baby is laying sideways across the cervix instead of head first.



**TRAUMA CENTERS.** Specialized hospital facilities that are equipped to deal with emergency life-threatening conditions.

**TRAUMA SURGERY.** Surgery performed as a result of injury.

**TREACHER COLLINS SYNDROME.** A disorder that affects facial development and hearing, thought to be caused by a gene mutation on human chromosome 5. Treacher Collins syndrome is sometimes called mandibulofacial dysostosis.

**TREMOR.** A trembling, quivering, or shaking.

**TRENDELENBURG'S TEST.** A test that measures the speed at which the lower leg fills with blood after the leg has first been raised above the level of the heart. It is named for Friedrich Trendelenburg (1844–1924), a German surgeon.

**TREPINE.** A small surgical instrument that is rotated to cut a circular incision.

**TREPONEME.** A term used to refer to any member of the genus *Treponema*, which is an anaerobic bacteria consisting of cells, 3–8  $\mu\text{m}$  in length, with acute, regular, or irregular spirals and no obvious protoplasmic structure.

**TRIAGE.** Prioritizing the needs of patients according to the urgency of their need for care and their likelihood of survival.

**TRICHOMONADS.** Parasitic protozoa commonly found in the digestive and genital tracts of humans and other animals. Some species cause vaginal infections in women characterized by itching and a frothy discharge.

**TRICUSPID VALVE.** The right atrioventricular valve of the heart; it has three flaps, whereas the mitral valve has only two.

**TRIGLYCERIDE (TAG).** A chemical compound that forms about 95% of the fats and oils stored in animal and vegetable cells. TAG levels are sometimes measured as well as cholesterol levels when a patient is screened for heart disease.

**TROCAR.** A small sharp instrument used to puncture the abdomen at the beginning of the laparoscopic procedure.

**TUBAL LIGATION.** A surgical sterilization procedure that involves ligating, or blocking and/or tying, the fallopian tubes so eggs can no longer descend from the ovaries to the uterus. Also referred to as getting one's tubes tied.

**TUBE FEEDING.** Feeding or nutrition through a tube placed into the body through the esophagus, nose, stomach, intestines, or via a surgically constructed artificial orifice called a stoma.

**TUBERCULOSIS (TB).** An infectious disease that usually affects the lungs, but may also affect other parts of the body. Its symptoms include fever, weight loss, and coughing up blood.

**TUMESCENT ANESTHESIA.** A type of local anesthesia originally developed for liposuction in which a large volume of diluted anesthetic is injected into the tissues around the vein until they become tumescent (firm and swollen).

**TUMOR MARKER.** A circulating biochemical compound that indicates the presence of cancer. Tumor markers can be used in diagnosis and in monitoring the effectiveness of treatment.

**TUMOR STAGING.** The method used by oncologists to determine the risk from a cancerous tumor. A number—ranging from 1A–4B—is assigned to predict the level of invasion by a tumor, and offer a prognosis for morbidity and mortality.

**TUNICA (PLURAL, TUNICAE).** The medical term for a membrane or piece of tissue that covers or lines a body part. The retina is the innermost of three tunicae that surround the eyeball.

**TUNICA VAGINALIS.** A sac-like membrane covering the outer surface of the testes.

**TURBIDITY.** The degree of cloudiness of a urine sample (or other solution).

**TURBINATE.** Relating to a nasal concha.

**TWILIGHT ANESTHESIA.** An intravenous mixture of sedatives and other medications that decreases one's awareness of the procedure being performed.

**TYMPANIC MEMBRANE.** The eardrum. A thin disc of tissue that separates the outer ear from the middle ear.

**TYMPANOPLASTY.** Procedure to reconstruct the tympanic membrane (eardrum) and/or middle ear bone as the result of infection or trauma.

**TYMPANOSTOMY TUBE.** Ear tube. A small tube made of metal or plastic that is inserted during myringotomy to ventilate the middle ear.

**TYPE 2 DIABETES.** Sometimes called adult-onset diabetes, this disease prevents the body from properly using glucose (sugar), but can often be controlled with diet and exercise.

# U

**ULCER.** A lesion or rough spot formed on the surface of an artery.

**ULCERATION.** Death of tissue cells in a specific area, such as skin.

**ULCERATIVE COLITIS.** A chronic condition in which recurrent ulcers are found in the colon. It is manifested clinically by abdominal cramping and rectal bleeding.

**ULNA.** One of the two bones of the forearm. The largest section articulates with the humerus at the elbow joint and the smallest portion of the ulna articulates with the carpal bones in the wrist.

**ULTRASOUND,(ULTRASONOGRAM,ULTRASONOGRAPHY).** A procedure where high-frequency sound waves that cannot be heard by human ears are bounced off internal organs and tissues. These sound waves produce a pattern of echoes which are then used by the computer to create sonograms, or pictures of areas inside the body.

**UMBILICAL CORD BLOOD TRANSPLANT.** A procedure in which the blood from a newborn's umbilical cord, which is rich in stem cells, is used as the donor source for bone marrow transplants. Currently, umbilical cord blood transplants are mainly used for sibling bone marrow transplants or to store blood for an anonymous donation. In most cases, umbilical cord blood does not contain enough stem cells to safely use for adult bone marrow transplants.

**UMBILICAL RING.** An opening through which the umbilical vessels pass to the fetus; it is closed after birth and its site is indicated by the navel.

**UMBILICUS.** The area where the umbilical cord was attached; also known as the navel or belly button.

**UNCINATE PROCESS.** A downwardly and backwardly directed process of each lateral mass of the ethmoid bone that joins with the inferior nasal conchae.

**UNILATERAL CLEFT LIP.** A cleft that occurs on either the right or left side of the lip.

**UNITED STATES PHARMACOPOEIA (USP).** An authoritative book, updated annually, that contains lists of medicines, dietary supplements, and surgical supplies; defines their doses or other units of measurement; and sets quality standards for their production and proper use. The USP is used by 130 countries around the world in addition to the United States.

**UREA.** A by-product of protein metabolism that is formed in the liver. Because urea contains ammonia, which is toxic to the body, it must be quickly filtered from the blood by the kidneys and excreted in the urine.

**URETER.** Either of the paired channels that carry urine from a kidney to the bladder.

**URETEROSCOPE.** A special type of endoscope that allows a surgeon to remove kidney stones from the lower urinary tract without the need for an incision.

**URETHRA.** The small tube-like structure that allows urine to empty from the bladder.

**URETHRA HYPERMOBILITY.** Main factor in stress urinary incontinence, with severity based upon how far the urethra has descended into the pelvic floor through herniation or cystocele.

**URETHRAL FASCIAL SLING.** A support and compression aid to urethral function using auxiliary material made of patient or donor tissue to undergird the urethra.

**URETHRITIS.** Inflammation of the urinary bladder.

**URGENCY.** A sudden compelling need to urinate.

**URIC ACID.** A product of purine breakdown that is excreted by the kidney. High levels of uric acid, caused by various diseases, can cause the formation of kidney stones.

**URINALYSIS (PLURAL, URINALYSES).** The diagnostic testing of a urine sample.

**URINARY CONDUIT DIVERSION.** A type of urinary diversion or rerouting that uses a conduit made from an intestinal segment to channel urine to an outside collection pouch.

**URINARY CONTINENT DIVERSION.** A surgical procedure that restores urinary continence by diverting urinary function around the bladder and into the intestines, thereby allowing for natural evacuation through the rectum or an implanted artificial sphincter.

**URINARY INCONTINENCE.** Inability to prevent the leakage or discharge of urine. It becomes more common as people age, and is more common in women who have given birth to more than one child.

**URINARY RETENTION.** The inability to void (urinate) or discharge urine.

**URINARY STRESS INCONTINENCE.** The involuntary release of urine due to pressure on the abdominal muscles during exercise or laughing or coughing.

**URINARY TRACT.** The passage through which urine flows from the kidneys out of the body.

**URINE.** A fluid containing water and dissolved substances excreted by the kidney.

**URINE CREATININE LEVEL.** A value obtained by testing a 24-hour collection of urine for the amount of creatinine present.

**URINE CULTURE.** A test which tests urine samples in the lab to see if bacteria are present.

**URINE CYTOLOGY.** The examination of the urine under a microscope to look for cancerous or precancerous cells.

**UROGYNECOLOGIST.** A physician that specializes in female medical conditions concerning the urinary and reproductive systems.

**UROLITHIASIS.** The medical term for the formation of kidney stones. It is also used to refer to disease conditions related to kidney stones.

**UROLOGIST.** A physician who specializes in problems of the urinary system.

**UROLOGY.** The branch of medicine that deals with disorders of the urinary tract in both males and females, and with the genital organs in males.

**URORADIOLOGIST.** A radiologist that specializes in diagnostic imaging of the urinary tract and kidneys.

**UTERINE FIBROID.** A non-cancerous tumor of the uterus that can range from the size of a pea to the size of a grapefruit. Small fibroids require no treatment, but those causing serious symptoms may need to be removed.

**UTERINE PROLAPSE.** A condition which the uterus descends into or beyond the vagina.

**UTERINE SUSPENSION.** Procedure that places a sling under the uterus and holds it in place.

**UTERUS.** The womb, an organ in females for containing and nourishing the young during development before to birth.

**UVEA.** The middle of the three tunicae surrounding the eye, comprising the choroid, iris, and ciliary body. The uvea is pigmented and well supplied with blood vessels.

**UVEITIS.** Inflammation of any part of the uvea.

**UVULA.** A triangular piece of tissue that hangs from the roof of the mouth above the back of the tongue. Primary snoring is often associated with fluttering or vibrating of the uvula during sleep.

**UVULOPALATOPHARYNGOPLASTY (UPPP).** An operation to remove the tonsils and other excess tissue at the back of the throat to prevent it from closing the airway during sleep.

## V

**V/Q SCAN.** A test in which both a perfusion scan and ventilation scan are done (separately or together) to show the quantity of air that different areas of the lungs are receiving.

**VACUTAINER.** A tube with a rubber top from which air has been removed.

**VAGINA.** A canal in the female body that leads from the cervix to the external orifice opening to the outside of the body.

**VAGINAL PROLAPSE.** Weakening of the supportive tissues of the uterus and vagina, such that the uterus and cervix bulge into the vaginal canal, or even out through the vaginal opening.

**VAGINAL SPECULUM.** An instrument that is inserted into the vagina that expands and allows for examination of the vagina and cervix.

**VAGOTOMY.** A surgical procedure in which the nerves that stimulate stomach acid production and gastric motility (movement) are cut.

**VAGUS NERVE.** The tenth cranial nerve, running from the head through the neck and chest into the abdomen. Intermittent electrical stimulation of the vagus nerve can help to control epileptic seizures.

**VALGUS ALIGNMENT.** Alignment of the knee that angles outward due to injury or deformity.

**VALGUS.** A deformity in which a body part is angled away from the midline of the body.

**VALVE.** Flaps (leaflets) of tissue in the passageways between the heart's upper and lower chambers.

**VAPORIZE.** To dissolve solid material or convert it into smoke or gas.

**VARICES.** Uneven, permanent dilation of veins.

**VARICOSE VEIN.** A vein that is abnormally enlarged, swollen, and/or dilated, and may be twisted or tortuous.

**VARIX (PLURAL, VARICES).** The medical term for an enlarged blood vessel.

**VARUS ALIGNMENT.** Alignment of the knee that angles inward due to injury or deformity.

**VARUS.** A deformity in which a body part is angled toward the midline of the body.

**VAS DEFERENS (PLURAL, VASA DEFERENTIA).** The Latin name for the duct that carries sperm from the testicle to the epididymis. In a vasectomy, a portion of each vas deferens is removed to prevent the sperm from entering the seminal fluid.

**VASCULAR SURGERY.** A branch of medicine that deals with the surgical repair of disorders of or injuries to the blood vessels.

**VASCULOGENIC ERECTILE DYSFUNCTION.** The inability to attain or sustain an erection satisfactory for coitus, due to atherosclerotic disease of penile arteries, inadequate impedance of venous outflow (venous leaks), or a combination of both.

**VASECTOMY.** Surgical sterilization of the male, done by removing a portion of the tube that carries sperm to the urethra.

**VASOCONSTRICTION.** Narrowing of blood vessels, especially as a result of vasomotor action.

**VASOEPIDIDYMOSTOMY.** A type of vasectomy reversal in which the vas deferens is attached to the epididymis, the structure where sperm matures and is stored.

**VASOSPASM.** A deadly side effect of aneurysm rupture where the vessels in the brain spontaneously constrict; can cause brain damage or death.

**VASOVAGAL REACTION.** A collection of symptoms that includes dizziness, fainting, profuse sweating, hyperventilation, and/or low blood pressure that occurs in a small percentage of individuals who donate blood.

**VASOVASOSTOMY.** A surgical procedure that is done to reverse a vasectomy by reconnecting the ends of the severed vasa deferentia.

**VBAC.** Vaginal birth after cesarean.

**VEIN.** A blood vessel that returns oxygen-depleted blood from various parts of the body to the heart.

**VENA CAVA.** The large vein that drains directly into the heart after gathering incoming blood from the entire body.

**VENIPUNCTURE.** Puncture of a vein with a needle for the purpose of withdrawing a blood sample for analysis.

**VENOUS BLOOD.** Blood that carries carbon dioxide from the tissues to the heart and then the lungs to be oxygenated.

**VENOUS GRAFT.** Transfer of living vein tissue within the same host (from one place of the body to another in the same person).

**VENOUS STASIS DISEASE.** A condition in which there is pooling of blood in the lower leg veins that may cause swelling and tissue damage, and lead to painful sores or ulcers.

**VENOUS SYSTEM.** Circulation system that carries blood that has passed through the capillaries of various tissues, except the lungs, and is found in the veins, the right chambers of the heart, and the pulmonary arteries; it is usually dark red as a result of a lower oxygen content.

**VENOUS THROMBOSIS.** The formation or presence of a blood clot in a vein.

**VENOUS VALVES.** Folds on the inner lining of the veins that prevent the backflow of blood.

**VENTILATE.** To assist a patient's breathing by use of a mechanical device or surgical procedure.

**VENTILATION SCAN.** A lung scan in which a tracer gas is inhaled into the lungs to show the quantity of air that different areas of the lungs are receiving.

**VENTILATOR.** A machine that helps patients to breathe. It is sometimes called a respirator.

**VENTRICLE.** A lower pumping chambers of the heart. There are two ventricles, right and left. The right ventricle pumps oxygen-poor blood to the lungs to be re-oxygenated. The left ventricle pumps oxygen-rich blood to the body.

**VENTRICULAR FIBRILLATION.** An erratic, disorganized firing of impulses from the ventricles, the lower chambers of the heart. The ventricles quiver instead of pumping in an organized way, preventing blood from pumping through the body. Ventricular fibrillation is a medical emergency that must be treated with cardiopulmonary resuscitation (CPR) and defibrillation as soon as possible.

**VENTRICULAR TACHYCARDIA.** A rapid heart beat, usually over 100 beats per minute. Ventricular tachycardia originates from the lower chambers of the heart (ventricles). The rapid rate prevents the heart from filling adequately with blood, so less blood is able to pump through the body. Ventricular tachycardia can be a serious type of arrhythmia and may be associated with more symptoms.

**VERMILION.** The dark pink tissue that makes up the lip.



**VERTEBRA (PLURAL, VERTEBRAE).** The bones of the spinal column. There are 33 along the spine, with five (called L1-L5) making up the lower lumbar region.

**VERTEBRAL RECONSTRUCTION.** Procedure for reconstruction and support of the vertebrae of the skeletal system.

**VERTIGO.** An illusory feeling that either one's self or the environment is revolving. It is usually caused either by diseases of the inner ear or disturbances of the central nervous system.

**VIDEOSCOPE.** A surgical camera.

**VIRCHOW'S TRIAD.** Three categories of factors that affect a patient's risk of venous thrombosis: alterations in the rate of blood flow; injuries to the tissue lining the walls of the veins; and alterations in the blood's ability to coagulate.

**VIRTUAL COLONOSCOPY.** Two new techniques that provide views of the colon to screen for colon polyps and cancer. The images are produced by computerized manipulations rather than direct observation through the colonoscope; one technique uses the X-ray images from a CT scan, and the other uses magnetic images from an MRI scan.

**VISCERAL PERICARDIUM.** Single layer of cells that lines both the internal surface of the heart with the parietal pericardium and the external surface of the heart.

**VISUAL FIELD.** The total area in which one can see objects in one's peripheral vision while the eyes are focused on a central point.

**VISUALIZE.** To achieve a complete view of a body structure or area.

**VITAL CAPACITY (VC).** The volume of air that can be exhaled following a full inspiration.

**VITAL SIGNS.** Measurements of a patient's essential body functions, usually defined as pulse rate, breathing rate, and body temperature.

**VITRECTOMY.** Surgical removal of the vitreous body.

**VITREOUS BODY.** The transparent gel that fills the inner portion of the eyeball between the lens and the retina. It is also called the vitreous humor or crystalline humor.

**VOIDING.** The medical term for emptying the bladder or urinating.

**VOLAR.** Pertaining to the palm of the hand or the sole of the foot.

**VOLATILE ANESTHETICS.** Another name for inhalation anesthetics.

**VOLVULUS.** An intestinal obstruction caused by a knotting or twisting of the bowel.

**VULVA.** The external parts of the female genital organs that include the mons pubis, labia majora, labia minora, clitoris, vestibule of the vagina, bulb of the vestibule, and Bartholin's glands.

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## W

**WARFARIN.** A drug given to control the formation of blood clots. The PT test can be used to monitor patients being treated with warfarin.

**WATCHFUL WAITING.** Monitoring a patient's disease state carefully to see if the condition worsens before trying surgery or another therapy. This term is often associated with prostate cancer.

**WATERMELON STOMACH.** A type of arteriovenous malformation (AVM) that develops in the antrum. The dilated blood vessels in the AVM resemble the stripes of a watermelon. Watermelon stomach is also known as gastric antral vascular ectasia, or GAVE syndrome.

**WEGENER'S GRANULOMATOSIS.** A rare condition that consists of lesions within the respiratory tract.

**WEIGHT TRACTION.** Sometimes used interchangeably with skin traction.

**WHITE BLOOD CELLS (LEUKOCYTES).** Cells of the blood that are responsible for fighting infection.

**WITHDRAWAL SYMPTOMS.** A group of physical or mental symptoms that may occur when a person suddenly stops using a drug on which he or she has become dependent.

**WOLFF-PARKINSON-WHITE SYNDROME.** An abnormal, rapid heart rhythm, due to an extra pathway for the electrical impulses to travel from the atria to the ventricles.

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## X

**X RAY.** A form of electromagnetic radiation with shorter wavelengths than normal light. X rays can penetrate most structures.

**XENOGRAFT.** Tissue that is transplanted from one species to another (e.g., pigs to humans).

**XTB.** Extreme drug-resistant tuberculosis

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## Z

**Z-TRACK INJECTION.** A special technique for injecting a drug into muscle tissue so that the drug does not leak (track) into the layers of tissue just beneath the skin.

**ZOLLINGER-ELLISON SYNDROME.** A condition marked by stomach ulcers, with excess secretion of stomach acid and tumors of the pancreas.

**ZYGOMA.** The cheek bone in the front of the face below the eye socket, it is connected to the frontal bone of the forehead and the maxilla (upper jaw); sometimes called the zygomaticum, zygomatic bone, or zygomatic arch.

**ZYGOTE INTRAFALLOPIAN TUBE TRANSFER (ZIFT).** The woman's eggs are fertilized in a laboratory dish and then placed in her fallopian tube.



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